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CONTENT

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FACTORS INFLUENCING LIVELIHOOD DIVERSIFICATION AMONG FARMING HOUSEHOLDS IN EJIGBO LOCAL GOVERNMENT AREA OF OSUN STATE, NIGERIA

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Abstract

The study identified farming households' livelihood activities and reasons for their multiplication, determined the underlining factors for livelihood diversification, and examined the militating constraints faced. The study was conducted in the poverty-ladened Ejigbo Local Government of Iwo zone, Osun State. A multi-stage sampling procedure was employed for sampling households for data collection. A total of 130 households were selected for data collection from the household heads. Collected were subjected to descriptive analysis and logit regression analysis. The results showed that the mean farm size per household was 1.2±0.6 hectares just as the mean annual income was estimated to be ₦105,394±26,546. The off-farm livelihood activities identified include trading (28.4%) and carpentry (27.2%), among others. The foremost reasons for off-farm diversification were limited agricultural income (75.2%), large family (63. 3%), and poverty (60.6%). Indicated as influencing the household likelihood of off-farm livelihood diversification are household size (b=0.33), farming experience (0.049), and income (b=1.01). More so, households' livelihoods were constrained mainly by the unfavorable market price of a commodity (68.8%), inadequate credit access (64%) as well as insecurity (62%). It was concluded that trading and artisanal activities represented major off-farm livelihoods and their likelihood of exploration is chiefly underpinned by the household size, income, and farming experience. Rural markets development is recommended for capacitating the households to substantiate their farm and off-farm livelihoods.

Key words: *livelihood, farmers, rural households, off-farm diversification*

INTRODUCTION

Agriculture as a source of income is fraught with dangers and uncertainties, exposing farming households to low living standards, poverty, and lowering their country's food security position. The consequence of unanticipated shocks and unpredicted natural problems in agriculture drives farming household towards alternative methods of income generation [3]. According to [10], the smallholder farmers in rural Nigeria are confronting with the imminent agricultural risks which necessitate livelihood diversification. Increasing climatic circumstances such as erratic rainfall, rising temperatures, overgrazing in the far north, desertification, unending violent conflicts between ranchers and farmers, and the on-going Boko Haram insurgency in the North-East Nigeria can be addressed by livelihood diversification [17]. Moreover, the current global pandemic (Covid 19) forces poorer smallholder farmers to seek alternative sources of income in the non-farm sector. According to [23], diversification can be defined as the involvement of an individual in the series of economic activities with the shares in the unit's overall economic activity. Furthermore, according to [1], livelihood diversification is very important in the socio-economic life of the agricultural household. As a way of mitigating against risk from agricultural disasters or shocks compel farming households to engage in other income-generating activities. Livelihood diversification of rural farming households includes other agricultural sectors and non-farm activities such as artisans and civil services. Depending on the economic opportunities and constraints, [18] classified rural households' diversification into three categories: (i) agricultural intensification (using productivity-enhancing inputs, mixed cropping, and rearing different kinds of livestock), (ii) non-farm diversification (skill acquisition, self-employment, and wage labor), and (iii) migration [5]. In Nigeria, [21] looked at factors such as inconsistent government regulations, inadequate processing techniques, poor storage facilities, weak road networks, and natural disasters, all of which have a detrimental influence on farmer production and drive livelihood diversification. Farmers are also finding it difficult to obtain high-quality agricultural inputs, such as seeds, insecticides, fertilizer, and financing, which they need to expand their farm operations [10]. In keeping with this, non-farm sector labor productivity per worker in Nigeria is almost three times higher than farm sector productivity, and non-farm sector average income is higher than farm sector income [11]. Affluent farming household head tends to be economical stable and may not involve in diversification unlike less affluent farming household head that may need diversification to survive, according to [13]. Several authors have engaged in a content duel to analyse the factors influencing the livelihood diversification. Gender, marital status, poverty status, principal occupation, and association participation are among the characteristics found by [6]. [5] found a favorable association between educational level and diversified livelihood, while [7] observed credit usage and accessibility has direct relationship. [13] concluded that the variables such as age, household size, primary occupation, farm income, access to credit, farming experience, and membership of cooperative society all have direct positive effect on non-farm diversification. [6] poised that those decisions on diversification to be seen as an adaptation strategy rather than alternative means of income generation. In the light of the aforementioned issues raised, it is imperative to examine the factors influencing the livelihood diversification of farming households in the study area. The specific objectives of the study are to, analyze the livelihood activities engaged by the farming household head and reasons for livelihood diversification, evaluate the determinants of livelihood diversification and identify the constraints limiting the diversification in Ejigbo Local Government Area of Osun State, Nigeria.

MATERIALS AND METHODS

Study Area

This study was conducted in Ejigbo. It is an ancient town in Yoruba land which is the headquarters of Ejigbo Local Government Area, one of the oldest local government areas in the state. The town is located by distance of 35 kilometers from Iwo at North-East, share boundary with Ogbomoso in the North in the distance of 30 kilometers, and located in the South-East of Ede with distance of 24 kilometers. It is also situated about 40 km North-West of Osogbo, the capital of Osun State, and about 95 kilometers North-East of Ibadan. It is part of the Ede North/Ede South/Egbedore/Ejigbo federal constituency. The average annual rainfall is 52.35 inches (1,330 mm), though there are great deviations from this mean value from year to year. Usually, the rainy season lasts from April to October. Usually, the rainy season lasts from April to October. They are major occupation is farming and drumming. The common crops planted are maize, cassava, and vegetables.

Sampling techniques and Data collection

The study made use of a multi-stage sampling procedure in the selection of the farming households. The procedure commenced with use of purposive sampling techniques in the selection of two (2) districts (Ilawo and Olla) from the four (4) districts (Ejigbo, Olla, Ilawo, and Ife-Odan) in Ejigbo local government based on the preponderance of farming activities. The second stage involved the simple random selection of 50% of the villages in each district which translates to ten (10) villages out of 20 in Ilawo and three (3) villages out of the 6 villages in Ola. The last stage involved a technique of randomly selection of ten (10) farming households from each village to give a total of 130 respondents sampled. However, 109 questionnaires were used for the data analysis, 21 were dropped due to incomplete information and inconsistent data

Source and type of data

The primary data that were used for the study sourced with the structured questionnaires. The questionnaires captured data on socio-economic variables of the farming households, non-farm livelihoods activities engaged, and constraints to livelihood diversification.

Analytical techniques and models

The study engaged analytical tools based on the stated objectives. They include descriptive statistics and logit model.

The structure of the model

The variables determining livelihood diversification were evaluated using binary Logistic model. Adapting [13], the logistic (logit) probability model is expressed as:

$$P_i = b_o(b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \ldots\ldots\ldots\ldots b_8x_8 + \varepsilon i) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Pi = 1, if respondents diversify to non-farm income, while Pi = 0 if otherwise.
Y = livelihood diversification (1 if diversify; 0 if otherwise).
X_1 = Age (years)
X_2 = Sex (1 if male; 0 if female)
X_3= Level of Education (1 if no-formal education, 2 if primary education, 3 if secondary education and 4 if tertiary education)
X_4 = Household size (number of persons)
X_5= Farming experience (years)
X_6= Farm size (ha)
X_7 = Net farm income (₦)
X_8= Access to credit (1 if yes; 0 if otherwise)
εi= Error term

RESULTS AND DISCUSSIONS

Socioeconomic characteristics of the respondents

The results in Table 1 depict the socio-economic variables of head of farming households. Results show that few (14.6%) of the head of farming households were below the age of 39 while about three-quarters (68. 0%) of them were between the ages of 40 and 59. Also, 17.4 percent were of age 60 years or more.

The average age of the head of farming households was 48.26±12.11 which implies that they were mature enough to manage their family independently. This result on age of the farmer agrees with [22] in a similar study in Southeast, Nigeria. More than half (50.5%) of farming households were male.

The majority (84.4%) of the head of farming households were married. Also, majority (84.4%) of the head of farming households had formal education. The implication of high level of literacy is that they will be enrich with knowledge to facilitate the decision-making process, managerial skills, and awareness about the best sources of credit facilities. Earlier similar findings by [8]; and [27] also agreed to these assertions. The results further revealed that half (52.3%) of the farming households had a household size of above 7 persons, less than half (45.9%) of the farming households had between 4 and 6 persons while few (1.8%) had less than 3 persons in their household.

The mean household size was 7.0±5.0 persons. This implies that the household size of the farming households was large enough which may assist them in livelihood diversification activities in supply of labour. This result agrees with the similar study of [12] that reported that household size influenced diversification in a rural household study in Abia State, Nigeria.

Results in Table 1 revealed that more than half (55.1%) of the farmers had a farm size of fewer than 2 acres of land for farming, 33.9 percent had between 3 and 6 acres, 7.3 percent had above 10 acres of land while 3.7 percent had between 7 and 9 acres of land. The average farm size was 1.2±0.6 hectares which implies that farming in Ejigbo Local Area of Osun State can be described as small-holding practices.

Table 1. Socio-economic characteristics of the head of farming households (n=109)

Characteristics	Frequency	%
Age (Years)		
< 30	2	1.8
30-39	14	12.8
40-49	40	36.7
50-59	34	31.3
60+	19	17.4
Mean = 48.26	S.D = 12.11	
Gender		
Male	55	50.5
Female	54	49.5
Marital Status		
Single	2	1.8
Married	92	84.4
Separate	10	9.2
Divorced	5	4.6
Level of Education		
No formal education	24	20.0
Primary	35	32.1
Secondary	36	33.0
Tertiary	14	12.9
Household Size		
≤ 3	2	1.8
4 – 6	50	45.9
≥ 7	57	52.3
Farm Size (Hectares)		
≤ 2	60	55.1
3 – 6	37	33.9
7-9	4	3.7
≥ 10	8	7.3
Mean = 1.2	S.D = 0.6	
Farming Experience (Years)		
≤ 5	16	14.7
6 – 10	21	19.3
11 – 15	10	9.1
≥ 16	62	56.9
Mean = 19.0	S.D = 12.42	
Access to Credit		
Yes	94.5	103
No	5.5	6
Non-farm livelihood diversification		
Yes	53.2	48
No	46.8	51
Annual farm income		
≤₦19,000	12	11
₦20,000 – ₦50,000	40	36.7
₦51,000 – ₦80,000	21	19.3
≥ ₦81,000	36	33.0
Mean = 105,394	S.D = 26,546	

Source: Field survey, 2021.

More than half (56.9%) of the farmers had more than 16 years of farming experience, with a mean of 19±12.42 years which implies that an average years of farming experience is about two decades which may be a deciding factor of an efficiency in agricultural production and the knowledge about non-farm income diversification of the farmers. The majority (94.5%) of the farmers had access to credit. This can however be used to diversify to other areas of agricultural venture or for the expansion of their current business. Households can use the credit for another income-generating venture especially when such is of less risk and there is a higher likelihood of higher returns. This conforms to the study of [4] and that of [15] that farmers have access to credit.

More than half (53.2%) of the farmers participated in the non-farm business. Few (11.0%) of the respondent earned ₦19,000 or less. Few (36.7%) of the farmers earned between ₦20,000 and 50,000 on annual basis, a few (19.3%) of the farmers earned an average of annual earnings of between ₦51,000 and ₦80,000, 33.0 percent earned above ₦81,000 as annual earnings**.** The mean farm income was estimated to be ₦105,394±26,546 which shows that the annual farm income was not substantial enough which may be among the motivating factor for the livelihood diversification. In contrast, [2] reported that agriculture contributed mostly to the total households' income.

Livelihoods activities engaged in by the respondents

Table 2 presents the information on the distribution of the farmers based on the livelihood activities they engaged in. The three most preferred activities were trading (28.4%), carpentry (27.2%), and bricklaying (15.6%). Other activities are undertaken to complement farming include basket making (11.0%) and public transport (8.3%). The least preferred activities by the farmers included sales and or renting of agricultural land (7.3%), Hairdressing/Barbing (5.5%), and shoemaking (3.7%). The table revealed that all the farming households engaged in two or more non-farm livelihood activities to enhance household income and reduce poverty. This is in tandem with the findings of [15] in a similar study in the Eastern Tigray Region of Ethiopia, [9] where a majority (83.1%) and 71.5% of the farmers diversified their livelihoods into either of the three livelihood diversification strategies (on-farm, off-farm, and non-farm). The study also corroborates other studies that reported that livelihood diversification improved rural household income [16]; [20].

Table 2. Distribution of respondents by livelihood activities

Income source	Frequency	%	Rank
Trading	31	28.4	1st
Carpentry	30	27.2	2nd
Bricklaying	17	15.6	3rd
Basket making	12	11.0	4th
Public Transport	9	8.3	5th
Sales and or renting of agricultural land	8	7.3	6th
Hairdressing/Barbing	6	5.5	7th
Shoemaking	4	3.7	8th

Source: Field survey, 2021.

Reasons for non-farm livelihood diversification

Table 3 shows that the farmers had various reasons for diversifying into other activities. Some of these reasons included limited agricultural income (75.2%) which ranked 1st, large family size (63.3%) ranked 2nd, the reduced poverty level in the family (60.6%) ranked 3rd, and the well-being of the household (52.3%) ranked 4th.

Table 3. Reasons for non-farm livelihood diversification

Reasons	Frequency	%	Rank
Limited agricultural income	82	75.2	1st
Large family	69	63.3	2nd
Reduce poverty level in the family	66	60.6	3rd
For the well-being of the household	57	52.3	4th
Generate sufficient income	54	49.5	5th
High cost of labour	42	38.5	6th
High-cost farm input	42	38.5	6th
Availability of government grant	40	36.7	7th
Poor productivity	37	33.9	8th
Identification of market opportunities	34	31.1	9th

Source: Field survey, 2021.
*Multiple responses.

Others were to generate sufficient income (49.5%) ranked 5th, high cost of labour (38.5%) ranked 6th, high cost of farm input (38.5%) ranked 6th, availability of government grant (36.7%) ranked 7th, poor productivity (33.9%) ranked 8th and identification of market opportunities (31.1%) ranked 9th. This implies the main reasons for diversification reported by almost all the farmers in the study area were low agricultural income and large household size which is consistent with the results of some studies [15] and [19].

Factors influencing farming household livelihood diversification

Table 4 presents the result of the binary logit regression to investigate the variables determining the non-farm livelihood diversification of farming households. The diagnostics statistics indicated that the chi-square distribution to examine the overall model adequacy was significant (χ^2 = 8.51, p<0.01).

The result also shows that the variables which include education, household size, years of farming experience, and annual farm income were all significant in determining the non-farm livelihood diversification of the farming household head in the study area. The coefficient of education was significant at 10% level and had a direct influence on livelihood diversification. Also, the coefficients of household size, years of farming experience, and annual farm income were all positive and significant at 5% level. This finding agrees with that of [12] in a similar study among farm households in Abia state, Nigeria who reported that diversification of livelihood means from agriculture to other sources was positively influenced by household size, amount of credit received, education of the household head and monthly income. [25] in an earlier study revealed that farm size, age, level of education, farm income, non-farm income, credit use, livestock ownership, household size, poverty status, and occupation were the significant determinants of income diversification

A variable that has a positive coefficient and significant at any level portends its higher values to increase the high probability level of livelihood diversification of farmers. Also, a negative value of a significant variable reflects its higher values of such variables concerned to reduce the likelihood of livelihood diversification. The probit results show that the coefficient of education was positive with a marginal effect of 0.7 percent which implied that a unit increase in the level of formal education of farmers will increase the chance of farmer to diversify by 0.7%. It is expected that a higher level of education should have a direct positive effect on livelihood diversification of farmers in such a way that higher level of education will assist farmers in getting adequate information on available different sources of investment opportunities.

To corroborate this result, some studies reported that education has a tendency of increasing the livelihood diversification [15]; [26] while [9] holds a divergent assertion of negative influence.

Household size was positive signed with a marginal effect of 1 percent on livelihood diversification, indicating that an increase in the household by one person had a probability of increasing the livelihood diversification of farming households by 1.0%.

This implies that there is a likelihood of a household head with a larger household size to seek alternatives of catering for the family in diversifying the sources of income.

This finding conforms to those of [13].

In the same vein, years of farming experience has a positive effect with livelihood diversification and had a marginal effect of 4.9%.

This implies that a unit increase in the years of farming experience will increase the likelihood of diversification by about 5%. However, [24] had divergent assertion of inverse relationship between years of farming experience and livelihood diversification. The coefficient of farm income was in direct with livelihood diversification and a marginal effect of 10.6 percent which implies that a unit increase in farm income has probability of increasing livelihood diversification by 10.6 percent.

This finding implies that a farmer that makes a higher level of income will be encouraged to explore other income-generating ventures. An earlier study by [14] also reported that farmers' income positively and significantly influenced livelihood diversification.

Table 4. Binary logit regression analysis of factors influencing livelihood diversification

Variable	Coefficient	Std. Err.	P>|z|	Marginal effect
Age	0.1389	0.0022	0.415	0.0018
Sex	-0.0472	0.0335	0.995	-0.0002
Education	0.1587*	0.0040	0.079	0.0070
Household size	0.3284**	0.0078	0.012	0.0095
Farming Experience	0.0493**	0.0221	0.026	0.0493
Farm size	0.0350	0.0038	0.674	0.0016
Net farm income	1.0134**	0.0720	0.019	0.1057
Access to Credit	-0.5462	0.0001	0.142	-0.0002
Constant	-2.4822**	2.6839	0.026	
Number	103			
LR $chi^2(7)$	8.51			
Prob > Chi^2	0.0000***			
Pseudo R^2	0.2897			

Source: Field Survey Data, 2021.
*Significant at 10%; ** Significant at 5%;
*** Significant at 1%.

CONCLUSIONS

Rural households were opportune with off-farm income generation through engagement in trading and artisanal activities including carpentry, bricklaying, basket making among others. These were retorted to as a panacea to buffer the limited income accruing from their traditional engagement in agricultural production, the overbearing responsibility for catering for large households, and the associated poverty scourge among other reasons. In other words, household characteristics or capacities such as the relative size, annual income as well as members' farming experience positively dispose of household members' exploration of off-farm sources for livelihood generation. As such, conclusion is drawn that trading and artisanal activities were the main off-farm livelihoods and their likelihood of intensity was discovered to be affected by the factors such as the household size, income, and farming experience. Arose from the empirical findings of this study, it is recommended that the rural household heads should organize themselves under community assistantship groups to tackle the poor development of their local markets and their better inclusion in the pricing of agricultural products. This could as well be employed to provide cooperative services especially credits provision to their members.

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ECONOMETRIC ANALYSIS AND ASSESSMENT OF FACTORS AFFECTING THE EFFICIENCY OF AGRICULTURAL PRODUCTION

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Abstract

Taking into account that agricultural production interacts with various biological and natural processes, it is considered a fairly complex type of economic activity. The study of factors affecting the economic efficiency of agricultural production plays an important role in terms of efficient organization of production. The article presents the results of the analysis of the influence of the main factors on the gross output of the agricultural sector. The results obtained can be useful for both agricultural enterprises and private farmers, as well as government agencies for the optimal assessment of the state of agricultural policy and the development of the necessary conditions for the sustainable development of this industry. The main purpose of the article is to determine the level of influence of the most important factors on agricultural products, as well as forecasting these indicators for the prospective period.
In the study of this issue in the article, methods of econometric analysis and modeling, economic and statistical analyzes, and the method of comparative analysis of indicators were used. For this, the literature was studied, including articles, scientific journals, textbooks. The empirical statistical data were taken from the State Statistics Committee of the Republic of Azerbaijan. The results of research by some scientists were also considered, as well as their methodologies were used in econometric analysis. At the end of the study, using the software, predictive indicators of the degree of influence of factors on agricultural products were determined.

Key words: *agriculture, efficiency of production, correlation, econometric modeling, factors of production*

INTRODUCTION

Effective management of agricultural production depends on several factors. Based on the analysis of the activities of agricultural enterprises operating in the Republic of Azerbaijan, 2 groups of factors were identified that significantly affect the various processes of the value chain of agribusiness. These include production-technological factors that determine the characteristics of the production of agricultural products and market factors that ensure the sale and availability of products. The first group of factors includes the natural and climatic characteristics of the regions, energy resources, the existing financial and credit policy in the country, the level of scientific and technological development of the country, etc. factors that ensure the implementation of agricultural production. The second group of factors includes the factors that ensure the sale of products, such as the mechanism of agro-market activity. According to most economists, the factors affecting agricultural production are classified as follows: technical-technological, organizational, economic, social, and natural factors.

In addition, scientists have identified a subgroup of internal and external factors. Internal factors include factors that can be managed by agricultural enterprises, and external factors include factors that are outside the control and management of enterprises.

The results of the research show that these factors affect agricultural production to varying degrees, depending on the characteristics of the sector and the region, which creates several problems in determining which factors have the greatest impact on improving the efficiency of agricultural production. Scientists have identified a subgroup of internal and external factors.

Internal factors include factors that can be managed by agricultural enterprises, and external factors include factors that are outside the control and management of enterprises.

To ensure global competitiveness and food security at the national level, the analysis of the scientific views of various economists on the sustainable development of the agricultural sector plays an important role. Thus, according to the Azerbaijani economist E.A. Guliyev, it can be considered more effective to ensure the development of the agricultural sector through the joint application of extensive and mainly intensive forms of development. He attributed the expansion of arable and pasture areas, which directly affect the volume of agricultural production, based on extensive development factors. He noted that the intensive factors include the improvement of fixed assets, improving the quality of arable land, the application of scientific, technical, and technological innovations in production, improving investment attractiveness, and improving human capital. In addition, according to E.A. Guliyev's analysis, there are several fundamental conditions for ensuring large-scale reproduction in agriculture. These include reducing inflation, reducing price disparities, improving the material and technical base, and improving the financial and credit mechanism [11].

According to Baytasov R. and Zaharova V.S., several factors have significantly affected the efficiency of agricultural production, technical and technological restructuring of enterprises, state programs and laws to facilitate access to technical equipment, natural and climatic conditions of the regions, and labor potential [1].

According to Gurnovich's research in this area [4], sustainable agricultural production is a key factor in ensuring the country's food security. Taking into account the existing problems of the agrarian sector at several specific macro levels, sustainable development is considered one of the tasks facing the state. Gurnovich's research has identified a significant impact of several factors on the expansion of agricultural production. These include market factors (supply by suppliers, demand by traders, competition), scientific and technological progress (creation of new plant varieties resistant to drought or cold, creation of more productive hybrids, creation of innovative techniques and technologies, etc.), and mainly state support and regulation.

Gurnovich noted the special role of the state in achieving macro-stability in the agricultural sector. The formation of effective state investment and financial-credit mechanisms is of particular importance to increase the investment attractiveness of the agricultural sector, ensure economic and financial sustainability, expand the application of technical and technological progress in production and increase production in general [4].

Shamin's research emphasized that material and intangible resources affect the production performance of agricultural enterprises. Land and capital can be mentioned as material resources, and labor as intangible resources. In modern times, the main tasks of the country's agricultural development policy include the intensification of agricultural production [14].

Nechayev sustains that forecasting and planning are the basis of the activities of agricultural entities. Thus, in his opinion, forecasting is a scientific justification of the possible situation of agricultural producers in the long run and the optimization of economic activity, and improvement of activities in priority areas and forms the basis for planning the production activities of agricultural entities [9].

Kundius also affirmed that forecasting determines the optimization of agricultural production for the future, and the possibility of effective use of resource potential [7].

Kolmykov sustains that forecasting includes the implementation of important measures to achieve the goals of agricultural entities and the definition of development directions. Enterprise managers have the tasks to determine the direction of investment, diversify production, apply innovative technologies, identify the need to renew fixed assets and improve management and forecasting [6].

To ensure the efficiency of the production activities of agricultural enterprises and individual entrepreneurs by the conditions of a market economy, the study of market relations at the micro and macro levels comes to the fore. At the micro-level, the operational strategies of the agricultural entity, production technologies, features of resources, and business process management are included. At the macro level, there are improvements in the legal framework governing agricultural production, effective financial and credit policies, increasing investment attractiveness, state programs for human capital development, state projects to stimulate exports, and state programs to improve the material and technical base, etc.

Given the importance of agriculture to the country's economy, ensuring its sustainability is a priority for the government. From this point of view, it is important to identify the factors of high importance in ensuring the efficiency of agricultural production, to make more rational decisions on their use. It is necessary to determine the level of impact of these factors, implement them systematically, prevent problems in this area, and identify priorities for the development of the agricultural sector, to ensure food security and international competitiveness of production [6].

Any economic activity is the basis of correct and effective management decisions. The economy is such a complex multi-level system that its effective management is possible only if it is possible to predict and comprehensively evaluate the results of decisions made. Therefore, it is necessary to develop multifaceted forecasts of indicators for the adoption of effective management decisions, as well as the formation of strategies and alternatives for the development of the country's economy, industries, regions, enterprises, and organizations.

Studies suggest that high-quality management of different levels of economic systems in modern conditions is possible only through the use of effective forecasting and planning mechanisms. This, in turn, allows predicting and evaluating the results of decisions made, as well as developing promising development programs.

In a market economy, given the uncertainty, intense competition, high level of risk and several other specific features of agricultural entities, it is important to identify and effectively manage the development of the sector in the long term.

In terms of the formation of an effective management system, the analysis of the factors affecting the sustainability of the field and, based on this, forecasting priorities for the future, as well as identifying key trends in rational use, characterizes the purpose and relevance of the article.

In modern times, the complexity of economic processes has laid the foundation for the formation and improvement of special methods of their analysis. From this point of view, economic-mathematical modeling and econometric analysis have become widely used. The econometric analysis allows us to express the results of research on the impact of one or another economic factor on another economic indicator. One of the main directions of econometric analysis is the development of forecasts for economic indicators. Forecasting of economic processes serves as a scientific basis for the formation of a strategy for any field or process. Economic forecasting allows determining the main criteria for the operation of productive forces, and their components in an interconnected and dependent situation, using special methods of calculation and modeling [11].

The analysis of economic indicators is based on the use of econometric modeling to substantiate analytical dependencies. The econometric research methods are used to check, evaluate and substantiate quantitative regularities based on the analysis of statistical data. The result of such research is the assessment of economic models and their elements, the examination of the characteristics of economic indicators, and their forms of communication. The results of economic analysis are used to forecast and make sound economic decisions.

After conducting economic analysis and calculations, the developed model will determine the characteristics of the economic process, and on this basis, will provide a basis for predicting the future behavior of the process in the event of changes in any elements. In the created model, all the relationships of the variables are clearly shown and expressed in terms of quantity, which in turn allows to make a more accurate and qualitative forecast [12].

As a result of econometric analysis, using the tools of mathematical statistics and probability theory, it is possible to determine the existence, level, dynamics, and impact of the relationship between different economic indicators based on real statistical data. The econometric analysis identifies and analyzes quantitative patterns in socio-economic events and processes. These regularities are manifested in the form of correlation and dependence of economic indicators, and such correlation and dependence must be confirmed by real statistics [12].

Econometric methods and models are an important part of a system that supports sound economic and management decision-making. These methods are used to perform various tasks and analyses, such as studying the state of the enterprise, assessing the effectiveness of investment and innovation activities, building a supply-demand balance model, and identifying factors influencing any process. It is characterized by an econometric model, a system of equations and variables, which allows finding the most optimal variant of its development, taking into account the activities and characteristics of any object under study. It is known that the more accurate and detailed the analysis of the nature and content of the process or object under study, the interrelationships of its elements, and their impact on the final result, the more accurate and effective economic decisions will be. Econometric methods allow us to answer 2 main questions: what can happen in the future (forecasting of economic situations) and how one factor, its change can affect any other indicator [15].

Sustainable development of the agrarian sector of the Republic of Azerbaijan determines the food security of the country and the economic development of the country's economy. Ensuring sustainable agricultural production requires regular analysis of the current situation, development trends, market structure, and various factors affecting production. As a result of these analyzes, the development of a demand-supply balance model at the next stage is of particular importance. Thus, the market balance will ensure the dynamic development of local production, as well as the formation of a balance between supply and demand through the principle of independent pricing [11].

In a market economy, in an environment of uncertainty, it is important to estimate production for the foreseeable future, taking into account the specific characteristics of the agricultural sector, demand, and the factors that affect it. To some extent, this includes forecasting quantitative indicators based on past statistics.

Determining the factors that affect supply, including demand, has a special role in shaping the supply-demand balance model. However, each factor affects the volume of production to a different extent. From this point of view, the current state of the tax system in agriculture, the number of agricultural subsidies, favorable natural and climatic conditions, technical and technological progress, the number of producers, the price of substitute products, seasonality, etc. The implementation of modeling based on the identification of factors affecting the volume of production and regression-correlation analysis has high accuracy and stability. Thus, it has become necessary to determine the relationship between these factors and production volumes, and thus to assess the extent of their impact on market equilibrium. Regression and correlation analyzes are carried out to determine the share of various independent variables in the change in the volume of the object under study.

Thus, to optimize the production structure of agribusiness, it is important to study the dependence of production on several economic factors and conditions for the implementation of econometric analysis [6].

In modern conditions, ensuring the effective operation of the agricultural sector is possible through the effective use of organizational and economic methods and forms of activity in this sector. Along with the generally accepted methodology for assessing the use of agricultural resources, as well as the efficiency of production and economic activities, the application of specific methods of assessment is of particular importance. Thus, in this case, a special role is played by the analysis based on econometric methods related to the study of quantitative and qualitative relationships of economic objects and processes through mathematical-statistical methods and models. The basis of the econometric method is econometric modeling, which is a form of manifestation of socio-economic processes with scientific abstraction. An econometric model is the main tool of econometrics and is used to analyze and forecast economic processes. Correlation-regression analysis, which is used in the analysis of factors involved in the development of any enterprise or industry in general, to increase labor productivity and is considered one of the main methods of econometrics, provides a quantitative expression of the relationship between economic variables [2].

In this context, the purpose of the paper is to study the main factors influencing the development of agricultural production, econometric analysis of factors, determining the dependence and level of influence of these factors on gross agricultural output using correlation-regression analysis, as well as determining the forecast indicators of all factors and gross output using econometric modeling

MATERIALS AND METHODS

The econometric model is based on the construction of a multifactor regression equation, which takes into account the following aspects:

1. Selection of factors to be included in the model:

-Predicting the factors affecting the dependent variable;

-Comparative assessment, verification of collinearity between factors and subsequent selection of factors;

-Final selection of factors from the model development processand assessmentof the importance of the criteria;

2.Choosing the form of the relationship between the factors: the outcome factor and the influencing factors

3.Evaluation of the criteria (coefficient/indicator) of the equation

4.General evaluation of the model, analysis of residues

5.Evaluation of the results obtained as a result of practical application and forecasting of the developed model [5].

As in agribusiness, it is important to determine the extent to which the factors influencing supply can affect supply, usually correlation-regression analysis is used to solve this type of problem.

For example, to characterize the relationship between the volume of supply Y and the independent factors Y, it is possible to use the regression function X_1, X_2, ...X_z, which in turn determines how the expression Y will be for specific indicators of X [3]. If the number of factors influencing the result is large, the model of multivariate regression is used, and the purpose of this is to compile a model with multiple factors and determine their individual and cumulative effect on the result:

$$y = f(x_1, x_{2,\dots\dots\dots}x_m) + \varepsilon \qquad \dots\dots\dots\dots\dots (1)$$

where:

-X_1, X_2,....X_m are the supply factors, which have to meet the following requirements: to be expressed in quantitative terms, to be closely related to the outcome factor and not depend on each other.

-ε is the random error coefficient of the model for various factors.

The supply factors X_1, X_2,....X_m, as a rule, are selected in several stages. First of all, based on economic-theoretical research, the factors related to the studied economic process are identified. Then, using mathematical-statistical methods, the selected factors are re-analyzed, their impact on the studied process is checked, and the factors that have a little impact are reduced. Proper selection of factors plays an important role in the development of a multivariate regression model. The result of the wrong choice is reflected in the model in the following form:

1)If the variable to be included is not included, the regression value is often distorted.

2)If the included variable should not be included, the regression value will be ineffective, even if it is not distorted.

Depending on the form of dependence, linear and nonlinear models of the multivariate regression model are used. Thus, according to the linear regression model, the coefficients a_j, j = 1, 2, ... m, in the case of invariance of other factors, with the change of the factor x_j, characterize the average change of the result, and are expressed in the following form:

$$Y= a_0+a_1x_1 +a_2x_2+........+a_mx_m+\varepsilon \qquad .. (2)$$

Here, the factors of influence must be determined by certain quantitative characteristics, in particular by the correlation coefficient, to determine the force of influence on the economic indicator. Thus, if the correlation coefficient is close to 1, then the influence of X_i factors on the variable Y is considered high, if the coefficient is equal to +1, then the relationship is directly proportional, otherwise, if equal to -1, the relationship is inverse is proportional if the correlation coefficient is 0, it means that the influence of X_i factors on the variable Y is insignificant.

In general, the development of an econometric model is a central problem of econometric research. Thus, it is the quality of this modeling that determines the validity and accuracy of the results of the analysis of development trends, the necessary forecasting capabilities for economic processes, and the necessary economic and management measures [13].

In addition, as a result of the influence of the independent factors X_j studied, the R^2-determination coefficient is used to calculate the variance fraction of the Y factor, so that it is possible to determine the variance fraction of the Y factor in the model. The closer the R^2 coefficient is to 1, the higher the quality of the model.

Official data of the State Statistics Committee of the Republic of Azerbaijan and MS Office Excel software were used to study the factors affecting production in the field of agribusiness in our country.

Initially, the selection of factors is made by taking into account the economic nature of the outcome factor. Several factors affect the volume of production in agribusiness, and they can be grouped as follows:

-Land resources and their structure: arable lands, arable lands, irrigated lands, fallow lands

-Water needs.

-Financial condition: credit availability, interest rates, the volume of investments, amount of subsidies. Taxes and financial investments (investments, subsidies, loans) - if the tax rate in the country is high, producers earn less and reduce supplies. If the government subsidizes producers, they will increase the supply of products.

-The current state of labor resources.

-Natural-climatic conditions: floods, landslides, air temperature, water, sun

-Level of provision of fixed assets

-Political factors

-Several economic entities (producers) in this field.

-Technical and technological factors. Availability of agricultural machinery applied modern technologies (drainage and irrigation systems, chemicals, automation). Technology and technology improvement - the use of modern technology and high technology leads to increased labor productivity, which increases supply.

-Product price - there is a direct relationship between the price and supply reflected in the law of supply;

-Availability of fertilizers and drugs against diseases and pests: volume and cost

-Availability of seeds: cost and volume

-Producers' expectations regarding price increase

-Market demand.

Then, to be included in the model, the process of removing factors that do not meet several requirements is carried out by the

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methodology of factor selection. Because some factors are of the same economic nature, some are at different hierarchical levels, and some, for several reasons, lack the necessary statistical data, it is considered appropriate to exclude them from the model [8].

In this regard, the following factors were selected to be included in the developed model:

-Sown area X_1; thousand ha.
-Fixed assets X_2; mln. man
-Labor resources X_3; thousand people
-Directed investment volume X_4; mln. Man
-Modeled indicator - gross agricultural output Y; mln. man

RESULTS AND DISCUSSIONS

The study started from the primary empirical data provided by the State Statistics Committee of the Republic of Azerbaijan as shown in Table 1. The period of analysis was 2000-2020 for which the official data were available.

Table 1. Dynamics of changes in gross agricultural output and factors affecting it in the period 2000-2020

Years	Gross output, mln. man (Y)	Sowing area, thousand ha (X1)	Fixed assets, Mln man (X2)	Labor resources, thousand people (X3)	The volume of directed investment, million man (X4)
2000	1,112.4	1,766.8	2,634.4	1,509.4	6.5
2001	1,242.2	1,775.9	2,694.3	1,521.7	8.3
2002	1,342.9	1,783.2	2,727.1	1,530.4	18.5
2003	1,450.5	1,785.6	2,764.7	1,546.1	37.4
2004	1,572.7	1,790.8	2,821.5	1,551.6	35.0
2005	1,844.8	1,797.6	3,004.6	1,573.6	40.7
2006	2,115.5	1,795.5	3,467.3	1,583.2	58.3
2007	2,918.6	1,808.4	4,150.2	1,597.6	243.3
2008	3,505.9	1,818.4	4,521.9	1,611.3	336.5
2009	3,805.5	1,832.5	4,868.1	1,628.6	266.6
2010	3,877.7	1,842.7	5,099.8	1,655.0	431.0
2011	4,525.2	1,843.8	5,271.4	1,657.4	437.3
2012	4,844.6	1,855.0	5,611.9	1,673.8	648.8
2013	5,244.6	1,884.3	5,852.3	1,677.4	574.3
2014	5,225.8	1,885.6	6,106.4	1,691.7	363.9
2015	5,635.3	1,897.5	6,355.2	1,698.4	355.4
2016	5.632.4	1,959.1	6,891.2	1,729.6	325.1
2017	6,580.0	2,054.7	7,141.2	1,752.9	617.8
2018	7,010.0	2,057.9	7,441.1	1,770.8	764.4
2019	7,836.7	2,056.5	8,317.4	1,777.7	769.5
2020	8,428.9	2,045.2	9,604.1	1,771.9	520.6

Source: Official data of the State Statistics Committee of the Republic of Azerbaijan [16].

Compiling a matrix using Excel is the next important step to perform correlation analysis whose results are presented in Table 2.

Table 2. Analysis of correlation coefficients

	Gross product	Sowing place	Fixed assets	Labor resources	Directed investments
Total product	1				
Sowing place	0.93581	1			
Fixed assets	0.99407	0.93154	1		
Labor resources	0.98534	0.93847	0.97495	1	
Directed investments	0.90133	0.82668	0.86399	0.90322	1

Source: Own calculations using the software MS Office Excel.

Pearson's analysis of correlation coefficients shows that each factor has a high impact on the total output of agribusiness. The correlation coefficient for each is higher than 0.6, r_{yx1}= 0.935, r_{yx2} = 0.994, r_{yx3} = 0.985, r_{yx4} = 0.901. However, their ratios X_2 and X_3 are relatively higher, which means that in agriculture there is a close relationship with the volume of gross output (Y factor), rather than the indicators of fixed assets and labor resources. In addition, the relationship between factors Y and X is assessed as directly proportional and high according to the Ceddok criterion.

The results of the regerssion analysis are shown in Tabel 3.

Table 3. Regression analysis

Regression analysis					
Multifaceted R (multiple R)	0.998177062				
R^2 determination coefficient	0.996357448				
Normalized R (normalized R)	0.99544681				
The standard error	154.1259923				
Observations	21				
Analysis of variance					
	f	**SS**	**MS**	**F**	**F-importance**
Regression	4	103,963,565.725	25,990,891.431	1,094.131	2.78022620860696E-19
Residue	16	380,077.144	23,754.821		
Total	20	104,343,642.869			

Source: Own calculations using the software MS Office Excel.

In the regression model, the coefficient of determination allows us to express that the gross agricultural output (supply) depends 99% on the factors included in the model, and 1% on the factors not included in the model. The multivariate correlation coefficient indicates that there is a close relationship between the factors studied. In addition, the actual value of the F-criterion is statistically significant, given that the given probability level exceeds the critical threshold.

Table 4.The result of a multiple regression model for factors influencing the efficiency of agricultural production

	Coefficient	**Standard deviation**	**T-statistics**	**P-importance**	**Low 95%,**	**Top 95%**
Intersection	-7,891.6187	3,090.2137	-2.5537	0.0212	-14,442.5792	-1,340.6581
X_1	0.3711	1.0165	0.3651	0.7198	-1.7837	2.5259
X_2	0.7974	0.0786	10.1479	2.2382	0.6307	0.9639
X_3	4.1589	2.2711	1.8312	0.0857	-0.6556	8.9736
X_4	1.1309	0.3178	3.5587	0.0026	0.4572	1.8045

Source: Own calculations using the software MS Office Excel.

As a result, the regression equation is expressed in the following form:

$$Y= -7,891.6187 + 0.3711x_1 + 0.7974x_2 + 4.1589x_3 + 1.1309x_4$$

According to the regression equation, 1 unit change of factor X_1 will cause 0.3711 units to change in factor Y, 1 unit change of factor X_2 will cause 0.7974 units to change in factor Y, 1 unit change of factor X_3 will cause 4.1589 units to change in factor Y, 1 unit change of factor X_4 will change 1.1309 units of factor Y.

To check the quality of the regression model, several important indicators were calculated and compiled in tabular form. The overall determination coefficient of the multivariate regression equation was 0.9963. Relevant indicators for each factor are also shown in the table. Given that the closer the coefficient of determination is to 1, the more the outcome factor depends on the influence of the factors included in the model. Other indicators of the quality of the regression model include the Fisher and Student criteria. Here, as a result of a comparison of the critically developed criteria with the relevant indicators obtained, it is determined whether the model and the factor are statistically significant. Thus, for the model to be statistically significant, the actual F and T values for both indicators must be higher than the critical values. In addition, based on statistical data, it was determined that $F_{critical}$ = 3.01 $T_{critical}$ = 2.473.

To determine the real role of the factors influencing the supply in agribusiness, it is necessary to use relative indicators as well as absolute indicators. From this point of view, the elasticity coefficient characterizing the change of the resulting factor should be used for a 1% chance of the variable factor. The elasticity coefficient is considered to be one of the absolute conditions of the analysis in terms of determining this dependence. If the elasticity coefficient is less than 1, the effect on the resulting factor is not considered to be so high [10].

Table 5. Evaluation of quality criteria of the regression model

Indicators	X_1	X_2	X_3	X_4
F-Fisher criteria	67.553	3,113.166	689.834	505.972
T-student criteria	11.57	39.88	25.18	9.07
β coefficient	0.0164	0.713	0.159	0.128
Elasticity coefficient	0.17	0.998	1.674	0.0905

Source: Own calculations using the software MS Office Excel.

Looking at the elasticity coefficients, we can note that a 1% change in X_1 will lead to a 0.17% change in gross agricultural output, a 1% change in X_2, a 0.998% change in agricultural output, and X_3 change in 1.674%, and a 0.0905% change in X_4. The obtained coefficients of elasticity prove once again that the indicator of the availability of labor resources stands as the factor that has the greatest impact on the outcome factor. It is estimated that the approximation coefficient is 2.58%, which is less than 7%, indicating the high quality of the regression equation. According to the comparative analysis of the coefficients β, the highest β_2 = 0.713 means that the outcome factor Y is most affected by the factor X_2. According to the analysis of the autocorrelation coefficient, if the rei is less than <0.5, it means that there is no autocorrelation. According to the calculation of the standard error criterion of autocorrelation, there is no autocorrelation in the regression equation.

Another important issue is to check the autocorrelation between the remains. From this point of view, it is necessary to record the residual indicators obtained in the regression statistics table performed using the Excel program and the operations to be performed on them. However, it should be noted that in the effective model, there should be no autocorrelation between the residues. From this point of view, the implementation of the Darbin Watson and Brush Godfrey tests is important.

According to the analysis of the correlation between E_i and E_{i-1}, the correlation coefficient between the residues is -0.387. According to the Breuch Godfrey test, in order to test autocorrelation, it is first necessary to determine the actual (observed) value of the T criterion. According to the formula:

$$T= \frac{R*\sqrt{n-2}}{\sqrt{1-R^2}}$$

T= (-0.387*√19)/√(1-0.149) = 1.829

Then, using Excel, we determined the critical index to be equal to critical ≈2.08. Then the actual and critical indicators of the T criterion should be compared. If such a situation is observed in $T_{factual}$> $T_{critical}$, then we cannot accept the null hypothesis. The essence of the zero hypothesis is that there is an autocorrelation between the residues. If, on the contrary, the situation is observed, then it is possible to accept zero value. In our example, the actual value is lower than the critical value, which means that there is no autocorrelation between the residues.

Further, in the regression analysis, it is necessary to specify the approximation coefficient, to determine the extent to which the calculated coefficients distort the calculated indicators from the actual indicators. If the average approximation error does not exceed 10-15%, it indicates that the developed model is of high quality. The following formulas are used to determine the average quantitative value of the approximation error:

Aj = (residual index/actual Y index) * 100 (1)

Coefficient A= = $\frac{1}{n}*\sum A_j$(2)

The results for the average approximation error are presented in Table 6.

Table 6. Calculation of the average approximation error

Y indicator-actual	Predicted Y indicator	Residual indicator	A
1,112.4	1,149.58600990122	37.1860099012208	3.34286317
1,242.2	1,253.91583549832	-11.7158354983226	0.943152109
1,342.9	1,330.49648256913	12.4035174308704	0.923636714
1,450.5	1,448.03738799281	2.46261200719437	0.169776767
1,572.7	1,515.41713994564	57.2828600543619	3.64232594
1,844.8	1,761.87948373026	82.9205162697356	4.494824169
2,115.5	2,189.86382288467	-74.3638228846694	3.515188981
2,918.6	3,008.26494943851	-89.6649494385088	3.072190415
3,505.9	3,470.72795293927	35.1720470607324	1.00322448
3,805.5	3,744.90542081455	60.5945791854538	1.592289559
3,877.7	4,229.15168533928	-351.451685339281	9.063405765
4,525.2	4,383.49136983589	141.708630164107	3.131544024
4,844.6	4,966.53524541581	-121.93524541581	2.516931128
5,244.6	5,099.81430825914	144.78569174086	2.760662238
5,225.8	5,124.43901713588	101.360982864116	1.939626141
5,635.3	5,345.48907160708	289.810928392923	5.142777286
5,632.4	5,891.22594706493	-258.825947064934	4.595304791
6,580	6,553.95913166465	26.0408683353489	0.395757877
7,010	7,034.50553979247	-24.5055397924716	0.34957974
7,836.7	7,767.16839927008	69.5316007299161	0.887256125
8,428.9	8,483.32579890038	-54.4257989003781	0.645704646
Total			**54.12802207**
Approximate coefficient			**2.5775248605**

Source: Own calculations using the software MS Office Excel.

Based on the analysis of the above table, we found that the approximation coefficient was 2.57%, which indicates the high quality of the regression equation and the model to be constructed.

In order to form an efficient production system in the agribusiness and identify the most important factors affecting the system at the next stages, determine the impact of their changes on production volumes and make effective decisions, the model should be based on a statistical and econometric analysis of external and internal factors of the enterprise environment [4].

Thus, due to several indicators identified as a result of econometric analysis, as well as the fact that the correlation coefficient for each factor and the overall model is greater than 0.9, the coefficient of determination for the overall model is 0.9963, the Fisher and Student coefficients are too high. Against the background of the restoration of the production potential of the agrarian sector of our country, future needs and the restoration of the agrarian sector in our liberated territories, optimization of arable lands, the level of fixed assets, labor resources in this area, as well as their professionalism, domestic and foreign investment. is highly dependent, and this database will be used to forecast the future and build an effective supply model [2]. In agribusiness, it is important to make forecasts using econometric methods aimed at more rational use of production resources and optimization of production and processing of agricultural products, after determining the impact on the total output through the development of a regression model of production resources of different economic importance. is. Using Excel software, statistical forecasting for the next 11 years was performed based on the figures for 2000-2020 (Table 7).

Table 7. Forecasting gross agricultural production and its affecting factors

Years	Gross agricultural output, billion manat	Planting area, mln ha	Fixed assets, billion manat	Labor resources, million people	Fixed capital investment, mlnmanat
2022	8,445.295	2,053.543	8,977.739	1,811.946	768.3938
2023	8,808.783	2,068.572	9,299.907	1,825.997	805.2075
2024	9,172.271	2,083.601	9,622.075	1,840.047	842.0213
2025	9,535.759	2,098.631	9,944.244	1,854.098	878.8351
2026	9,899.247	2,113.66	10,266.41	1,868.148	915.6488
2027	10,262.73	2,128.689	10,588.58	1,882.199	952.4626
2028	10,626.22	2,143.719	10,910.75	1,896.25	989.2764
2029	10,989.71	2,158.748	11,232.92	1,910.3	1,026.09
2030	11,353.2	2,173.777	11,555.09	1,924.351	1,062.904
2031	11,716.69	2,188.806	11,877.253	1,938.402	1,099.717
2032	12,080.18	2,203.836	12,199.421	1,952.452	1,136.531

Source: Own calculations using the software MS Office Excel.

According to the analysis of the forecasted indicators, the gross agricultural output has a dynamics of growth. In 2032, compared to 2022, the corresponding indicator increased by 43% and amounted to 12.08 billion manats. The dynamics of growth of indicators were also observed on the factors affecting the gross agricultural output. Thus, compared to 2022, arable land increased by 7.3% in 2032, fixed assets by 36%, labor resources by 7.7%, and investments by 48%.

Table 8. The dynamics of the increase in indicators in the future in relation to the current indicators, in percent

Factors	**Actual indicators**			**Predicted indicators**		**Predicted growth rate in 2032 compared to 2020 and 2025, in %**	
	2010	**2015**	**2020**	**2025**	**2032**	**2020**	**2025**
Gross agricultural output, billion manat	3.8	5.6	8.4	9.5	12.08	43.8	26.7
Planting area, mln ha	1.8	1.9	2.04	2.09	2.2	7.8	5.01
Fixed assets, billion manat	5.1	6.3	9.6	9.9	12.2	27.1	22.7
Labor resources, million people	1.6	1.7	1.8	1.8	1.9	10.2	5.3
Fixed capital investment, mln manat	431	355	520.6	878.8	1136.5	118.3	29.3

Source: Own calculations using the software MS Office Excel.

Based on the analysis presented in Table 8, it can be determined that to increase the gross agricultural output in the long –term, an important task for the government is to increase investment in fixed assets and improve the equipment of fixed assets. In general, it can be concluded that as a result of increasing various indicators, gross agricultural output is projected to increase by 43.8%. At the same time, it is necessary to optimize several other quality indicators when identifying opportunities to increase productivity in the agricultural sector. In this regard, raising the level of wages of agricultural workers, increasing the professionalism of workers, more rational use of arable land in a scientifically sound manner, improving the organization of production and labor, increasing the intensity of fixed assets, diversifying production and deepening specialization, progress in livestock and crop production and the application of resource-saving technologies and other organizational, economic and social processes.

CONCLUSIONS

Thus, the above classification of factors for increasing the efficiency of agricultural production proposed by us allows us to accurately assess the place and importance of each factor in the results of agricultural business activities, as well as choose the most optimal way to achieve goals. Accounting and systematic use of the most important factors for increasing productivity make it possible to successfully overcome emerging economic difficulties, find priority areas for development, and quickly form competitive production. Economic forecasting of these factors for the next 10 years will help redirect the government's efforts to the most priority areas, thereby improving agricultural policy. At the same time, it should be borne in mind that all these factors are applicable in combination, some factors can compensate for others, however, it should be remembered that ignoring individual factors or downplaying their importance will curb the overall growth in production efficiency and will not bring the desired comprehensive effect.

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IMPACT OF PLANT SPACING ON THE GROWTH AND FRUIT YIELD OF WATERMELON VARIETIES IN SOUTH-WEST NIGERIA

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Abstract

Growth and yield of watermelon are significantly influenced by spacing and variety. To quantify these effects, field experiments were conducted from August to November 2016 in Ogbomoso and Sepeteri, Oyo State, Nigeria. The treatments consisted of four watermelon cultivars (Sugar baby, Kaolack, Grey belle and Collos F1) and five spacings (1.0 × 0.5 m, 1.0 × 0.75 m, 1.0 × 1.0 m, 1.0 × 1.5 m and 1.0 × 2.0 m). Data collection on reproductive and fruit yield attributes. Results showed that the growth parameters of the crop grown at Sepeteri were significantly better while those grown at Ogbomoso had higher fruit yield/yield parameters. In both locations, spacing significantly ($p \leq 0.05$) influenced the fruit yield parameters for all the varieties. In Collos F1, vine line, number of secondary vines, leaves, flowers and rotten fruits were the highest while the number of fruits/plot and fruit yield (t/ha) were significantly higher in Kaolack cultivar. Spacing however had no significant influence on growth parameters but significantly affected number of fruits/plot and fruit yield/ha. In Ogbomoso, Kaolack sown at 1.0 x 0.75 m had highest fruit yield (41.7 t/ha) while the least (9.3 t/ha) was obtained from Sugar baby sown at 1.0 x 0.5m. Similarly, in Sepeteri, Kaolack sown at 1.0 x 0.75 m produced the highest fruit yield (19.4 t/ha) while the least (5.0 t/ha) was obtained from Collos F1 at 1.0 x 1.5 m. Planting Kaolack at spacing 1.0 x 0.75 m in both Ogbomoso and Sepeteri was the best agronomic practices for achieving the best fruit yield.

Key words: *Citrullus lanatus, cultivar, fruit yield, location, plant spacing*

INTRODUCTION

Watermelon [*Citrullus lanatus* (Thunb.) Matsum. and Nakai] is native to drier areas of south central Africa [19]. Environment is the aggregate of all external conditions that influences growth and development of plant. Crops are not profitable unless they are adapted to the region in which they are produced. Among environmental factors such as temperature, light intensity, relative humidity and rainfall pattern have effect on crop growth and development. Temperature as the major regulator of development process. Higher temperature has more adverse effect on net photosynthesis than lower temperature leading to decreased production of photosythates above a certain temperature.

Plant spacing is an important factor affecting watermelon production [24]. Suitable plant spacing can lead to optimum fruit yield while too few or too many plants can result in waste of growth factors and poor yield per unit area of land.

Plant spacing determines level of competition among crops. Vine length, diameter, number of leaves and branches linearly increase with increase in spacing of watermelon [1]; [25]. One of the most important factors in vegetable production is correct spacing because it allows plants to develop to their full potential. Adequate space ensures less competition for sunlight, water, and fertilizers [7]; [26]; [31]. Adequate intra-row plant spacing enhanced total yield of watermelons while total yield and fruit number decreased with increased intra-row plant spacing and the fruit mass increased at wider plant spacing [7]. There is no consensus about the optimum spacing for watermelon.

The objective was to determine the best spacing for growth and fruit yield of watermelon.

MATERIALS AND METHODS

Experimental site

Field experiments was conducted at two locations from August to November in 2016 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria and Ogun – Osun River Basin Project Site at Sepeteri, Oyo State, Nigeria. Ogbomoso lies at latitude 8°10'N, longitude 4°16' E, in the Guinea savanna zone of Southwest Nigeria. Temperature of the area ranges from 23 to 25°C with relative humidity of about 75% all year except in January. Rainfall distribution is bimodal and extends to 8 to 9 months of the year. On average, total annual rainfall is about 1,131.4 mm while Sepeteri lies between latitude 8°30' and longitude 3°37', in the humid tropical region within the Guinea Savanna Zone of Nigeria. Temperature ranges from 28 to 30°C with humidity of about 82%. The area had a bimodal rainfall pattern and on average, total annual rainfall is about 1,500.4 mm.

Soil Sampling and analysis: Before the experiments were set up, ploughing was done twice and soil samples analyses was done for physical and chemical properties in both locations. Soil samples were collected at the depth of 0 – 15 cm. The sample was air-dried, crushed and sieved for the determination of pH, organic carbon, organic matter, total nitrogen, available phosphorus (P); Exchangeable K, Ca, Mg and Na.

Experimental design and treatments

In both locations, treatments consisted of factorial combination of the four watermelon cultivars: Sugar baby, Kaolack, Grey belle and Collos F1 and plant spacings of 1.0 × 0.5 m, 1.0 × 0.5 m, 1.0 × 1.0 m, 1.0 × 1.5 m and 1.0 × 2.0 m. The treatments were arranged in a randomized complete block design (RCBD) and replicated thrice. The gross experimental area was 1,027 m^2 (13 × 79 m) divided into 3 replicates each measuring 3 × 79 m (237 m^2). Each replicate was subdivided into 20 plots making a total of 60 plots. Plot size was 3 × 3 m (9 m^2) and contained 8, 12, 16, 24 or 28 plants according to the spacing. Other cultural practices were adequately performed as required, Data collection began 2 weeks after sowing (WAS) and continued fortnightly for a period of 8 weeks. Four plants per plot were tagged for growth, reproductive and fruit yield attributes. Growth parameters measured were: number of leaves, primary vine length, and number of branches, leaf area and number of flowers/plant. Leaf area was estimated using the linear model method of [32]. Mature fruit were picked at 10 WAS. Fruits were counted and weighed to determine number and yield per plot and these were extrapolated ha^{-1}. Six fruits per plot were randomly selected to assess mean fruit length and diameter. Thereafter, selected fruit were split open and seeds and pulp extracted separately. Numbers and weight of seed per fruit, pulp and rind weights were determined. Data were subjected to analysis of variance according to Statistical Analysis System (SAS Institute, 2009) and treatment means were compared using least significant difference at 5% probability.

RESULTS AND DISCUSSIONS

Weather data

Data on the temperature and rainfall of the two locations were presented on Table 1.

Table 1. Temperature (°C) and rainfall (mm) data of experimental sites

	Ogbomoso		**Sepeteri**	
	Temperature (°C)	Rain fall (mm)	Temperature (°C)	Rain fall (mm)
August	23.29	134.8	28.38	362.4
September	23.42	180.2	29.33	231.7
October	24.20	158.6	29.94	0
November	24.73	0	30.43	5.70
Total	23.91	473.6	29.52	599.8

Source: Nigeria Airport Meteorological Station, Ilorin and Ogun-Osun River basin, Abeokuta [22].

Sepeteri had the higher temperature and rainfall during the growing season than Ogbomoso.

Pre-cropping soil properties

The physico-chemical properties of the soils used for the experiments was presented in Table 2. The soil particle size of both locations showed that the soil was sandy-loam in texture. The organic carbon (2.19 and 2.14 %), organic matter (3.79 and 3.70 %), total N (0.68 and 0.52 gkg^{-1}) of Ogbomoso and Sepeteri, respectively, showed low soil fertility. The soil pH of Ogbomoso (6.48) and Sepeteri (6.58) was slightly acid. At Ogbomoso and Sepeteri, the available phosphorus (7.62 and 5.58 cmol kg^{-1}) was low while exchangeable K (078 and 0.75 cmol kg^{-1}), Na (0.18 and 0.22 cmol kg^{-1}), Ca (1.92 and 2.15 cmol kg^{-1}) and Mg (0.49 and 0.84 cmol kg^{-1}) respective, was medium based on the rating of [32] [12] [16].

Table 2. Pre-cropping chemical and physical characteristics of soil used for the study at Ogbomoso and Sepeteri

Location		
Property	Ogbomoso	Sepeteri
pH (H_2O)	6.48	6.58
Organic carbon (%)	2.19	2.14
Organic Matter (%)	3.79	3.70
Total N (gkg^{-1})	0.68	0.52
Available P (mg kg^{-1})	7.62	5.58
Exchangeable K (cmol kg^{-1})	0.78	0.75
Exchangeable Na (cmol kg^{-1})	0.18	0.22
Exchangeable Ca (cmol kg^{-1})	1.92	2.15
Exchangeable Mg (cmol kg^{-1})	0.49	0.84
Acidity (cmol kg^{-1})	0.1	0.1
Sand (%)	85.46	86.46
Silt (%)	8.00	7.00
Clay (%)	6.54	6.54

Source: Own primary data.

Length of primary vines/plant at various time of sowing

Effects of varieties, plant spacing and their interaction on length of primary of watermelon in Ogbomoso and Sepeteri were presented on Table 3. Variety significantly influenced the length of primary vine at all growth stages in both locations. In Ogbomoso, at 2 WAS, Kaolack variety had the longest (4.90 cm) primary vine while Sugar baby had the shortest (3.79 cm). At 4 WAS, Grey belle had the longest (66.53 cm) but statistically not different from Kaolack (65.19 cm) and Collos F1 (65.91 cm) while the shortest (47.58 cm) was recorded with Sugar baby variety. At 6 and 8 WAS, Collos F1 had the longest (108.75 and 219.54 cm) primary vine while Sugar baby had the shortest (87.69 and 166.14 cm), respectively. At Sepeteri 2, 4 and 8 WAS Collos F1 consistently had the longest (4.27, 42.31, 345 cm) primary vine while Sugar baby had the shortest (2.65, 20.02 and 204.99 cm) primary vine. At 6 WAS, there was no significant effects on length of primary vine among all the varieties.

In Ogbomoso, Spacing had no significant had no significant at 2 and 6 WAS but significant at 4 and 8 WAS on length of primary vine. At 4 and 8 WAS, 1.0 m × 2.0 m had the longest (68.58 and 217.71 cm) while 1.0 m × 1.0 m had shortest (54.36 cm) primary vine at 4 WAS and 1.0 m × 1.5 m had the shortest (171.79 cm) primary vine at 8 WAS. At Sepeteri, spacing was only significant at 8 WAS. At 8 WAS, 1.0 m × 2.0 had the longest (331.71 cm) primary vine while 1.0 m × 1.0 m had the shortest primary vine. The interaction effects of variety and spacing was not significant at all growth stages in the two locations (Table 3).

Number of leaves/ plant at various time of sowing

The main effects of variety, spacing and their interaction effects on number of leaves/plant at all growth stages in Ogbomoso and Sepeteri were presented in (Table 4). Varietal effects were significant ($p \leq 0.05$) at 2 and 8 WAS in Ogbomoso. At 2 WAS, Kaolack had the highest (3.74 leaves /plant) foliage production while Grey belle had the least (3.35 leaves /plant). At 8 WAS, the highest (85.22 leaves/plant) foliage production was recorded with Collos F1.

At Sepeteri, significant effects occurred at 8 WAS. The highest number of leaves (86.00 leaves/plant) was recorded with Collos F1while Sugar baby had the least (72.50 leaves/plant) number of leaves.

Table 3. Effect of spacing on length of primary vine of watermelon varieties plants in Ogbomoso and Sepeteri

	Ogbomoso				**Sepeteri**			
Treatments	Weeks after sowing							
	2	4	6	8	2	4	6	8
Variety(V)								
Sugar baby	3.79b	47.58b	87.69b	166.14b	2.65c	20.02b	152.47a	204.99c
Kaolack	4.90a	65.19a	96.73ab	185.93b	3.09b	28.02b	155.25a	311.47ab
Grey belle	4.67ab	66.53a	106.69a	195.77ab	3.25b	29.13b	144.87a	262.50bc
Collos F1	4.61ab	65.91a	108.75a	219.54a	4.27a	42.31a	152.45a	345.73a
Spacing(S)								
1 m x 0.5 m	5.02a	64.04ab	99.78a	189.42ab	3.05a	28.63a	150.26a	285.75ab
1 m x 0.75 m	4.40a	61.03ab	107.42a	198.01ab	3.04a	27.83a	151.63a	278.04ab
1 m x 1.0 m	4.37a	54.36b	100.59a	182.30ab	3.46a	32.78a	155.68a	240.03ab
1 m x 1.5 m	4.63a	58.50ab	93.38a	171.79b	3.16a	34.78a	155.38a	270.04ab
1 m x 2.0 m	4.05a	68.58a	98.66a	217.71a	3.41a	25.35a	143.35a	331.71a
Interaction								
V x S	Ns	ns	Ns	Ns	ns	ns	ns	ns

Note: Means along the column with the same letter are not significant at $p \leq 0.05$, ns = not significant.
Source: Own primary data.

Effects of different spacing on number of leaves in Ogbomoso was significant at 6 and 8 WAS. 1.0 m × 0.75 had the highest number of leaves (34.81 and 73.33 leaves/ plant) at 6 and 8 WAS while 1.0 m × 1.5 had the least (26.29 leaves /plant) at 6 WAS and 1.0 m × 1.30 m (32.27 leaves /plant) at 8 WAS, respectively. In Sepeteri, significant effects occurred at 2 WAS. At 2 WAS, 1.0 m × 0.75 had the highest (3.73 leaves /plant) while 1.0 m × 2.0 had the least (3.47 leaves /plant) number of leaves. The interaction effects of variety and spacing on number of leaves in both locations were not significant at all growth stages (Table 4).

Table 4. Effect of spacing on number of leaves of watermelon varieties plants in Ogbomoso and Sepeteri

	Ogbomoso				**Sepeteri**			
Treatments	Weeks after sowing							
	2	4	6	8	2	4	6	8
Variety(V)								
Sugar baby	3.74a	18.69a	30.42a	60.55b	3.37b	6.45b	47.97a	72.50b
Kaolack	3.58ab	19.71a	32.70a	72.07b	3.67a	7.59ab	49.26a	78.50ab
Grey belle	3.35b	19.01a	28.69a	70.27b	3.67a	7.66a	43.98a	75.20b
Collos F1	3.72ab	19.73a	33.14a	85.22a	3.83a	8.48a	48.40a	86.00a
Spacing(S)								
1 m x 0.5 m	3.59a	21.22a	30.24ab	66.79b	3.67ab	7.39a	44.67a	83.21a
1 m x 0.75 m	3.36a	19.11a	34.81a	73.33a	3.73a	7.36a	43.63a	78.63a
1 m x 1.0 m	3.53a	21.30a	32.27ab	32.27ab	3.62ab	7.77a	51.99a	76.95a
1 m x 1.5 m	3.75a	16.57a	26.29b	67.88ab	3.70ab	7.99a	48.97a	77.00a
1 m x 2.0 m	3.76a	18.23a	33.08ab	33.08ab	3.47ab	7.22a	47.74a	74.46a
Interaction								
V x S	ns	ns	ns	ns	ns	ns	ns	ns

Note: Means along the column with the same letter are not significant at $p \leq 0.05$, ns = not significant.
Source: Own primary data.

Leaf area/plant at different stages

Leaf area was significantly ($p \leq 0.05$) influenced by varietal differences in both locations at all growth stages (Table 5). Variability in leaf production in watermelon variety was influenced at 2 and 8 WAS in Ogbomoso and 2 WAS in Sepeteri. At 2 WAS in Ogbomoso Kaolack had the highest leaf area /plant (10.21 cm^2/plant) which is statistically not different from Sugar baby (9.71 cm^2/plant) while Grey belle and Collos F1 jointly had the least (7.83 cm^2/plant). In Sepeteri plants, leaf area was significantly influenced by variety only at 2 WAS. At this stage, Sugar baby had the widest leaf (8.27 cm^2/plant) while the narrowest leaf (4.18 cm^2/plant) was observed with Collos F1.

In Ogbomoso, spacing was only significant ($p \leq 0.05$) at 8WAS on leaf area/plant (Table 5). At 8 WAS, it was observed that Kaolack variety had the widest leaf (95.83 cm^2/plant) while 1.0 m × 1.0 m had the narrowest (86.28 cm^2/plant) leaf area. In Sepeteri, spacing had no significant effects of leaf area development. The interaction effects of variety and spacing are not significant on leaf area development in both locations (Table 5).

Table 5. Effect of spacing on leaf area (cm^2) of watermelon varieties plants in Ogbomoso and Sepeteri

	Ogbomoso				**Sepeteri**			
Treatments	Weeks after sowing							
	2	4	6	8	2	4	6	8
Variety(V)								
Sugar baby	9.71a	58.07a	66.00a	83.04c	8.27a	29.43b	75.76a	99.15a
Kaolack	10.21a	52.18a	75.97a	91.148ab	6.03ab	42.29a	79.14a	111.80a
Grey belle	7.83b	56.17a	69.00a	88.06bc	6.01ab	46.19a	77.83a	108.35a
Collos F1	7.83b	55.96a	71.09a	96.64a	4.18b	49.73a	76.32a	111.66a
Spacing(S)								
1 m x 0.5 m	8.72a	58.65a	73.77a	95.83a	6.40a	39.94a	74.80a	112.18a
1 m x 0.75 m	9.63a	57.34a	70.59a	86.31b	5.28a	40.25a	75.45a	103.58a
1 m x 1.0 m	9.59a	55.40a	63.52a	86.28b	6.61a	44.25a	78.78a	107.61a
1 m x 1.5 m	7.98a	54.62a	116.29a	88.10ab	5.34a	45.25a	82.04a	107.61a
1 m x 2.0 m	8.54a	52.00a	70.92a	92.11ab	6.98a	39.86a	75.24a	109.85a
Interaction								
V x S	Ns	ns	Ns	Ns	ns	ns	ns	ns

Note: Means along the column with the same letter are not significant at $p \leq 0.05$, ns = not significant.
Source: Own primary data.

Reproductive and fruit parameters of watermelon varieties as influenced by spacing in Ogbomoso and Sepeteri: Effects of variety, spacing and their interaction on number of flower/plant, number of fruit /plant and fruit yield in Ogbomoso and Sepeteri are presented in Table 6.

In Ogbomoso, varietal differenced significantly ($p \leq 0.05$) influenced the reproductive and fruit yield parameters. The highest number of flowers (7.34 flowers /plant) in Ogbomoso was observed with Collos F1 while the least (5.01 flowers /plant) was recorded with Sugar baby.

Grey belle had the highest number of rotten fruit (3.60 /plot) while the least was taken from Sugar baby (2.47/plot).

The highest fruit yield (29.89 t/ha) was recorded with Kaolack while the least (14.78 t/ha) was recorded with Sugar baby.

In Sepeteri, there was no significant effects of varieties on number of flowers /plant and fruit yield t/ha.

In Ogbomoso, watermelon plants spaced at 1.0 m × 2.0 m had significant highest number of flowers (6.84 flowers /plant) while 1.0 m × 1.0 m had the least number of flowers (5.10 flowers /plant).

The highest fruit yield (28.35 t/ha) was recorded with 1.0 m × 0.75 m while 1.0 m × 1.5 m had the least fruit yield (17.69 t/ha). Spacing had no significant effects on number of rotten fruits.

In Sepeteri, the highest fruit yield (14.27 t/ha) was recorded with 1.0 m × 0.75 m while the least (8.54 t/ha) was recorded with 1.0 m × 1.5 m which was not significantly different from 1.0 m × 1.0 m and 1.0 m × 2.0 m.

The interaction effects of variety and spacing was not significant on reproductive and fruit yield parameters in the two locations (Table 6).

Effect of locations

The significant differences among the two location on with respect to growth and fruit yield indicated that different environmental have great impact on the growth and yield outcome of watermelon. This differences in yield could be associated to differences in amount of rainfall and temperature as this result is in line with [11]; [23].

Table 6. Effect of plant spacing on reproductive and fruit yield parameters watermelon varieties planted in Ogbomoso and Sepeteri

	Ogbomoso			Sepeteri		
Treatment	No. of flower /plant	No. of rotten fruit/ plot	Fruit yield (t/ha)	No. of flower /plant	No. of rotten fruit/ plot	Fruit yield (t/ha)
Variety(V)						
Sugar baby	5.01b	2.47b	14.78b	13.92a	4.07ab	8.70a
Kaolack	5.19b	2.87ab	29.89a	15.31a	3.00b	10.69a
Grey belle	6.29ab	3.60a	20.75ab	14.57a	3.47ab	9.27a
Collos F1	7.34a	3.33ab	21.38ab	16.35a	3.60a	12.04a
Spacing(S)						
1 m x 0.5m	6.00ab	3.50a	19.00ab	14.56a	3.92a	10.57ab
1m x 0.75m	6.05ab	3.08a	28.35a	15.75a	3.92a	14.27a
1 m x 1.0m	5.10b	2.92a	24.40ab	14.55a	3.42a	8.68b
1 m x 1.5m	5.79ab	3.33a	17.69b	14.12a	3.75a	8.54b
1 m x 2.0m	6.84a	2.50a	19.07ab	16.20a	3.67a	8.81b
Interaction						
VxS	Ns	ns	ns	ns	ns	ns

Note: Means along the column with the same letter are not significant at $p \leq 0.05$; ns = Not significant
Source: Own primary data

In addition, watermelon expresses their genetic attributes differently with different ecological zone.

Effects of varieties on vegetative growth

Varietal differences were obtained with respect to vegetative development in the four varieties of watermelon used in this study. In most cases, Collos F1 variety had the highest values over other watermelon varieties tested except number of secondary vines which could be attributed to differences in its genetic constitution with the respect to its hybrid and higher growth rate of the vine, and to suitability of its agro-ecological conditions. This result is similar to the findings of [15] who reported that genetic constitution of crop varieties influences the growth characters. It is also in harmony with the findings of [18] who attributed the growth and yield differences among crop varieties to right choice of suitable agro-ecological zone. Similar observation was recorded by [2]; [29]; [3] on maize and okra. They reported variability in plant genetic potential which leads to differences in the observed performance.

Higher number of secondary branches/plant was recorded in Kaolack variety possibly because kaolack variety combined its good genetic make-up to exploit the agro-ecological conditions of the study area for rapid growth and branching. This report is similar to the findings of [9]; [10]; [4] who attributed the growth characters of crop species not only to genetic constitution of the crop but also to the suitability of agro-ecological zone where they can express their full genetic resources for growth and yield enhancement.

Effects of varieties on fruit yield

The highest fruit yield was observed in Kaolack variety. This yield could be attributed to its highest stomatal conductance, better partitioning of photosynthetic materials towards economic yield, better genetic structure and highest potential transport photosynthetic material within plants. This result is in line with the findings of [20]; [34] who attributed the yield difference in crop cultivars to stomatal conductance value and to difference in partitioning of photosynthetic materials towards economic yield. It is also in conformity with the findings of [15]; [21] attributed the difference in yield and its components between crop genotypes to variations in genetic structure, mineral concentration and potentials to transport photosynthetic materials within plants.

Effects of plant spacing on vegetative growth

Higher vegetative growth in plant with less population density is as a result of less competition for water, nutrient and light. The result showed that as spacing increases, watermelon vegetative growth also increases [30]. These results are in agreement with the findings of [14] who reported that the spacing has positive effect on growth parameters.

These results also in support with [7] who reported that spacing had significant effect on the growth and yield of watermelon. These results are also supported by [26] who reported an increase in watermelon vegetative growth with an increase in spacing. Inappropriate plant density has accounted for poor yields of watermelon among most small scale watermelon farmers. If plants are widely spaced, not all land area is covered by leaves and much light available for photosynthesis is wasted, also water and mineral resources in the soil [13].

Effects of plant spacings on fruit yield: Plant density is another factor that affects watermelon production. Suitable plant spacing ensures optimum fruit yield while too high or too low plant spacing could result to relatively low yield and quality. Spacing did not significantly influence the vegetative parameter. Adequate plant spacing strategies and nutrient management has been reported to have a positive impact on watermelon yield [7]; [5]; [17]; [8]. The highest vegetative growth was observed as plant spacing increases, but contrary to yield and yield parameters. This result is similar to the findings of [33] on maize and yield component. Ban [8] also reported increase in yield of watermelon fruit weight slightly increased with plant spacing up to 1.2m. The result also showed that vegetative growth and yield parameters are under the influence of plant spacing and varieties. Also in the study of [7] reported the significant increase in yield with decreased plant spacing on watermelon. In melon, yield generally increases with decrease spacing [27]; [28]. Awere and Onyeacholem [6] also reported the increased in vegetative growth as plant spacing increases but highest yield was noticed as plant spacing decreases on watermelon.

CONCLUSIONS

The experiment was carried out to study the effect of plant spacing on growth and fruit yield of watermelon varieties in southwest, Nigeria. Plant spacing significantly enhanced the growth, yield and yield attributes of the watermelon varieties. Based on the findings, it could be concluded that agro-ecological condition plays a vital role on the growth and yield likewise the variety as well as spacing. In both locations is it revealed that Kaolack variety and 1.0 m x 0.75 m are suitable for achieving higher economical yield of watermelon fruit.

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ASPECTS OF THE INFLUENCE OF PRICES ON CONSUMER BEHAVIOUR WHEN PURCHASING FOODSTUFFS: ANALYSIS OF CASES FROM SOFIA, BULGARIA

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Abstract

Foodstuffs have a strong presence in the daily lives of households. As a rule, consumers make purchases taking into account the prices of goods and the income they can spend on a purchase. Food prices are not constant, but a dynamic quantity. Based on the data of the National Statistical Institute of Bulgaria, it has been established that household expenditure for foodstuffs amounts to about 30% of total consumer expenditure. The main objective of this study is to track the dynamics of price changes overall as well as by groups of foodstuffs in Bulgaria, the dynamics of the changes of the total consumer income and of the consumer expenditure for the purchase of foodstuffs, and their influence on end consumers' behaviour. Based on the data available at the National Statistical Institute of Bulgaria, the article presents the consumer price index, the indices of the total consumer income and of the total consumer expenditure of households for the period 2015-2021. A comparison has been made between the general price index and the index of the prices of foodstuffs and soft drinks. An analysis of the indices of the prices of individual groups of foodstuffs has been carried out. On the basis of quantitative research carried out by the author by using an online survey, aspects of consumer attitudes are revealed that are based on price influence upon purchase. One-dimensional frequency distributions were used for this purpose.

Key words**:** *consumer behaviour, foodstuffs, prices, Bulgaria*

INTRODUCTION

Consumer buying behaviour is influenced by a number of factors. One of them is price [3, 5]. It must be present in every purchase and sale and reflects the divergent interests of market participants (producers, traders and consumers) because it measures value in monetary terms and based on this value the seller agrees to sell and the buyer agrees to buy a product and/or service [19]. While producers and traders aim to sell at the highest possible price, consumers seek the relatively lower price because it reflects the amount of money the buyer is ready to pay for a purchase at the point of sale and the seller agrees to receive for their product [6], [1], [17]. On the other hand, price is also the monetary sacrifice the consumer makes in order to obtain the aggregate of benefits related to the purchase, possession or use of the product or service [4], [11]. In addition, it reflects consumer expenditure in terms of money, time and efforts made by consumers for the purchase and consumption of goods and services to meet their needs [15]. Therefore price:

-is identified with the amount (quantity) of money a consumer has to allocate from their disposable income for the purchase of a certain quantity of the desired product;

-integrates the economic sacrifice that consumers are ready to make not only in the form of monetary expense, but also in the form of free time expenditure spent on the efforts to compare prices, compromise on shopping convenience in search of an acceptable price offer, etc.;

-reflects the value of goods and services when comparing different competing offers and consumer benefits of the acquisition and use of these goods and services. In this sense, through the price consumers are ready to pay for the desired product and/or service are realized two of the basic consumer activities in the process of purchasing – acquisition and use.

Value is closely related to price because it reflects the combination of the obtained benefits consumers consider important [18], and includes quality, price and sales service [9]. Or this is the overall consumer assessment of the usefulness of a product based on the consumers' perception of what they receive in return for what they give [20], the benefits obtained as a result of the possession and use of the product [16]. It is the economic value of goods that reflects the price of the best alternative for the customer. This is the maximum price a fully informed buyer would pay [14]. Thus value is tied to price based on the benefits obtained against the sacrifices (of money, time, etc.) consumers have to make. Consumers buy taking into account mainly:

-product prices;
-their disposable income;
-the time they have at their disposal.

This means that if one of these factors changes, consumer behaviour changes as well and, respectively, their willingness to make or temporarily postpone a given purchase.

On the other hand, the decision to buy is influenced by other factors as well: advertising, household size, shelf life of food products, purchase urgency, consumer experience, etc. Therefore, consumer decision to buy is influenced by consumer personal and demographic characteristics, marketing factors, influence of reference prices (internal and external), availability of time for a purchase. Very often, in the process of search and purchase of consumer goods, consumers compare the internal reference price formed in their minds as a result of previous buying experience or observations with the external reference price (currently advertised price; actual price traders usually offer or currently reduced price), i.e. they use internal reference price to evaluate current market prices [15] as low, average or high. Internal reference price is the price consumers expect to pay, perceive as normal or fair for the brand bought [12], [10]. Unlike internal reference price, external reference price is *the established and currently valid market price* [10]. In other words, this is the particular price consumers see in the point of sale and have to pay for the purchase of the product they prefer.

MATERIALS AND METHODS

The main objective of the study is to track the dynamics in the change of prices – overall and individually by groups of foodstuffs in Bulgaria, the dynamics in the change the total consumer income and expenditure for the purchase of foodstuffs and their influence on end consumers' behaviour. For this purpose, data from the National Statistical Institute of Bulgaria (NSI) are used.

The group of foodstuffs whose prices are observed by the National Statistical Institute of Bulgaria includes:

-bread and cereals;
-meat and meat products;
-fish and seafood;
-milk, dairy products and eggs;
-animal and vegetable oils and fats;
-fruit;
-vegetables;
-sugar, honey, chocolate and sugar products;
-coffee, tea, and cocoa;
-mineral waters, soft drinks, fruit and vegetable juices.

In addition, data is used from an author's survey conducted in the periods March-May 2021 and October-November 2021 through an online interview and regarding the influence of prices on consumer behaviour when buying foodstuffs. The scope of the survey includes people living in Sofia, the capital of Bulgaria. In order to determine the volume of the sample is used the most conservative possible estimate of the relative share of the overall aggregate of people π. It is obtained from the assumption that p=q=0.5. We assume that the maximum error in such studies is 0.05 with a guaranteed probability of 0.95. The calculation of the volume of the sample is done by the formula [8]:

$$\boldsymbol{n} = \frac{z^2\,\pi\,(1-\pi)}{E^2} = \frac{z^2\,p\,(1-p)}{E^2} \qquad .... (1)$$

where:
n – volume of sample;

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z – guarantee multiplier (it is assumed that its value is 1.96)
π - the most conservative estimate of the relative share of the overall aggregate;
E – maximum error.
Applying the above formula, it is established that the sample volume is:

$$\boldsymbol{n} = \frac{z^2\,\pi\,(1-\pi)}{E^2} = \frac{z^2\,p\,(1-p)}{E^2} = \frac{1.96^2\;0.5\,(1-0.5)}{0.05^2} =$$
384 respondents.

In order to achieve sustainability of the survey results, 468 respondents were included in the sample.
The data from the survey were processed using the statistical programme SPSS.
By demographics, the breakdown of consumers buying foodstuffs for their households is as follows:
By employment status – 60% working, 21% retired, 16% students, 3% unemployed;
By marital status – 58% married, 42% single;
By size of household – single-membered (25.9%), two-membered (28.9%), three-membered (24.4%), four-membered (17%) more than four-membered (3.8%);
By household monthly income – up to 700 lv. (18.3%), from 701 to 1,400 lv. (24.8%), from 1,401 to 2,100 lv. (29.2%), from 2,001 to 2,800 lv. (19.2%), over 2,800 lv. (8.5%). (1 EUR = 1.95583 BGN);
By gender – 48% men, 52% women.

RESULTS AND DISCUSSIONS

According to the data of the National Statistical Institute of Bulgaria for the period 2015-2021, the general index of consumer prices [7], the indices of the total consumer income and of the total consumer expenditure are dynamic quantities [2] (Figure 1).
As the figure shows, except for 2016 and 2020, the increase in the index of total consumer income for the period 2015-2021 outperforms the general index of consumer prices.
The situation in 2020 is negative with regard to the index of total consumer expenditure. In 2020, the total consumer expenditure outperforms the increase in the index of total household consumer income.

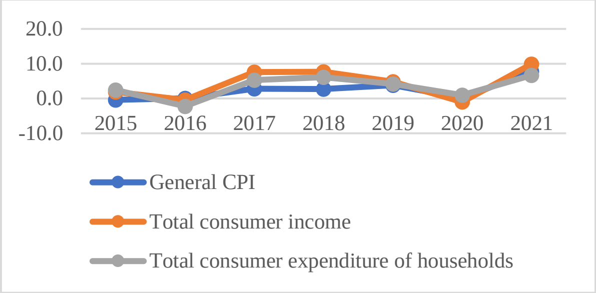

Fig. 1. General index of consumer prices, indices of the total consumer income and of the total consumer expenditure of households for the period 2015-2021 (December of the previous year =100).
Source: Author's own calculations based on data from NSI.

The dynamics of the prices of foodstuffs for the period considered is shown in Figure 2.

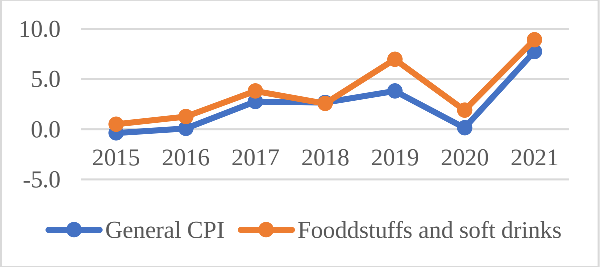

Fig. 2. General index of consumer prices and index of the prices of foodstuffs and soft drinks for the period 2015-2021 (December of the previous year =100).
Source: Author's own calculations based on data from NSI.

It is clear from the figure that the prices of foodstuffs and soft drinks are in an upward trend. Only for 2018 and 2020, there is a decrease on an annual basis compared to the previous year, respectively, compared to 2017 and 2019. The general negative trend for the period observed is that the prices of foodstuffs and soft drinks outperform the general price increase in the country. Only for 2018 the general price growth in the country is stronger than the growth in the prices of food products and soft drinks.
Figure 3 presents the price indices by groups of foodstuffs in Bulgaria for the considered period.

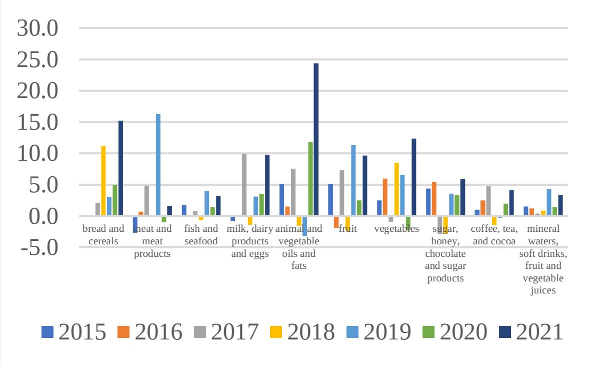

Fig. 3. Indices of the prices of foodstuffs for the period 2015-2021 (December of the previous year =100).
Source: Author's own calculations based on data from NSI.

Analyzing the indices of the prices for foodstuff, we may draw the following conclusions:

First, in 2015, the most considerable price increase is observed for the animal and vegetable oils and fats; fruit; sugar, honey, chocolate and sugar products. The prices of meat and meat products, and milk, dairy products and eggs show a drop while the prices of bread and cereals remain unchanged.

Second, in 2016, the prices of vegetables; sugar, honey, chocolate and sugar products; and coffee, tea and cocoa show the highest growth. There is no change in the prices of fish and seafood as well as of milk, dairy products and eggs.

Third, in 2017, the biggest increase is observed in the prices of milk, dairy products and eggs; animal and vegetable oils and fats; fruit.

Fourth, in 2018, the prices of bread and cereals; and vegetables go up the most.

Fifth, in 2019, the prices of meat and meat products; fruit; vegetables; mineral waters, soft drinks, fruit and vegetable juices; and fish and seafood rise the most.

Sixth, the prices of animal and vegetable oils and fats; bread and cereals; milk, dairy products and eggs; and sugar, honey, chocolate and sugar products increase the most in 2020.

Seventh, in 2021, the prices of animal and vegetable oils and fats; bread and cereals; vegetables; milk, dairy products and eggs; sugar, honey, chocolate and sugar products; and tea, coffee and cocoa have the most considerable rise.

For the period analyzed and with regard to the separate groups of foodstuffs compared with the general index of consumer prices for 2018, 2020 and 2021, the index of the prices of bread and cereals outperforms the general increase in the prices for the years. The index of the prices of meat and meat products outperforms the growth in the general index of consumer prices for 2016, 2017 and 2019. With regard to the group of fish and seafood, their price index is higher than the general index of consumer prices only in 2019. In terms of the groups of milk, dairy products and eggs, the group price index outperforms the general price index in 2017, 2020 and 2021. Only in 2018 and 2019, the index of the prices of animal and vegetable oils and fats is lower than the general index of prices. In 2016 and 2018, the index of the prices of fruit is smaller than the general price index. The index of the price of vegetables is higher than the general price index except for the years 2017 and 2020. The index of the prices of sugar, honey, chocolate and sugar products is higher than the general price index in 2015, 2016 and 2020. For the rest of the years, it lower than the general price index. The price index of the goods from the group of tea, coffee and cocoa is higher than the general price index for the years 2015, 2016, 2017 and 2020 and lower than the general index of consumer prices for the years 2018, 2019 and 2021. The index of the prices of mineral waters, soft drinks, fruit and vegetable juices for 2015, 2016, 2019 and 2020 is higher than the general index of consumer prices.

The change in the prices of food products and the changes in the income and consumer expenditure of households, household expenses for foodstuffs in particular, (for the period observed and based on the NSI data, household expenditure for the purchase of foodstuffs amounts to about 30% of the total consumer expenditure), form a specific consumer behaviour.

As Figure 4 shows, over 75% the consumers who participated in the author's survey say that they compare prices prior to a purchase.

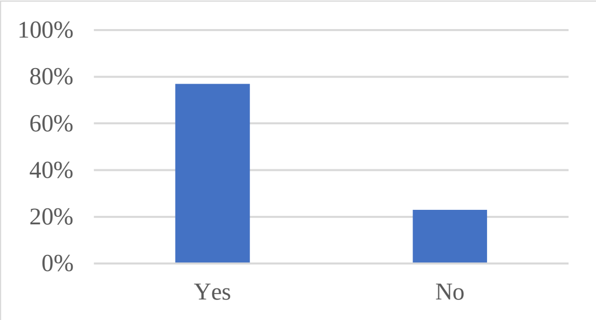

Fig. 4. Breakdown of opinions regarding price comparison prior to a purchase
Source: Author's own survey.

The results from the survey in Figure 5 show that in the process of buying foodstuffs, the respondent consumers are mostly influenced by the prices of meat and meat products; animal and vegetable oils and fats; and fish and seafood, whereas they are least influenced by the prices of bread and cereals.

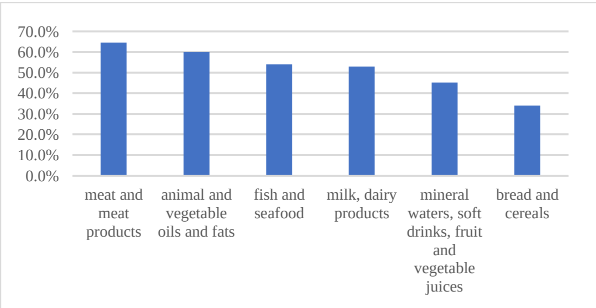

Fig. 5. Breakdown of opinions regarding the influence of prices on the process of buying foodstuffs
Source: Author's own survey.

It is common practice for retail chains for foodstuffs in Bulgaria to announce special price offers weekly and for a pre-determined assortment at temporarily reduced prices which allows consumers to avail of such opportunities.

As Figure 6 shows, over 60% of consumers get informed about current price offers every week and 18% do it several times a week.

It is noteworthy that the practice of the different chains (Billa, Kaufland, Lidl, T Market, Fantastico, etc.) in terms of the weekly current price offers is to have a different starting day of the week.

The search for information about current price offers forms both utilitarian (saving time and money) and hedonistic (emotional satisfaction from the finding of good price offers) consumer attitudes to prices [16].

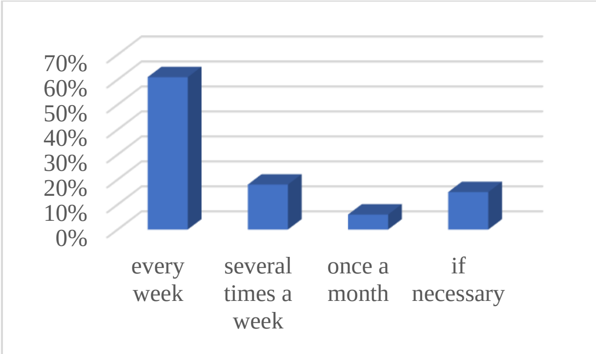

Fig. 6. Breakdown of opinions in terms of frequency of review of information sources for price reductions
Source: Author's own survey.

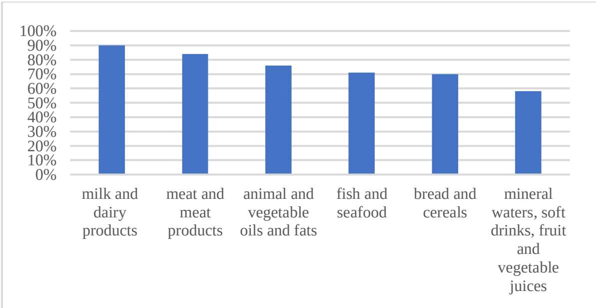

Fig. 7. Breakdown of opinions regarding the most frequently bought foodstuffs during periods of price reductions
Source: Author's own survey.

The preferred product groups that are subject of purchase during price reductions (Figure 7) are the various kinds of dairy products – cheese, yellow cheese, different kinds of yoghurt and milk, meat and meat products. Depending on the conditions and expiry date, the purchase of products from these groups allows consumers to realize the effect of forming consumer stocks [13] as well as to reduce consumer household expenditure, i.e. to save part of consumer income as the form of difference between the regular (not reduced) price and the temporarily reduced price. Consumers are least willing to buy when it comes to the product group of mineral waters, soft drinks, vegetable and fruit juices.

The established price dynamics show that apart from reductions, they register rises as well. As for consumer behaviour when prices are rising, survey results are presented in Figure 8.

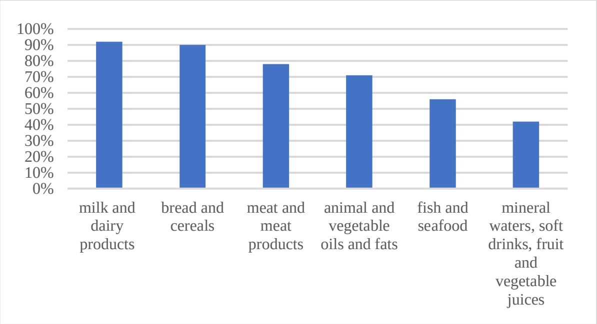

Fig. 8. Breakdown of opinions in terms of the most frequently bought products regardless of their price rise
Source: Author's own survey.

The figure shows that regardless of the price rise of foodstuffs, consumers are most willing to purchase products from the groups of milk, dairy products, bread and cereals, i.e. essential goods, which also indicates a strong price sensitivity to the prices of these goods. Consumers are least willing to buy when it comes to the product group of mineral waters, soft drinks, fruit and vegetable juices.

CONCLUSIONS

Price is a key factor in the purchasing process because it is a source of information about the price offers for the individual groups of foodstuffs as well as for the different brands within a group. It reflects consumer expenditure and is used as one of the criteria to choose a product in the process of comparing and of choosing different alternatives. The influence of the prices of foodstuffs on consumer behaviour in Bulgaria results in the formation of utilitarian and hedonistic attitudes to price, and in the realization of the effect of forming consumer stock by buying temporarily reduced foodstuffs and hence reducing part of their consumer expenditure as well.

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STUDY OF THE ADAPTIVE CAPACITY OF GRAIN SORGHUM DEPENDING ON THE SOWING TIME IN THE STEPPE ZONE

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Abstract

According to the studies, which were conducted on the experimental field of the Lugansk Agrarian University (steppe zone), on average for 2008-2017, the percentage of the contribution to the formation of grain sorghum yield by optimizing the sowing time was 38.8%. According to the set of indicators of adaptive capacity and ecological plasticity, the first earliest (April 25) sowing time for grain sorghum of the middle-early hybrid Sprint W was identified as the most appropriate. This sowing time provides not only the highest yield of the hybrid, but also the most favorable combination of the main indicators of adaptive capacity. At this sowing time, the hybrid behaves like a highly plastic genotype ($bi \approx 1.0$), which simultaneously has a reduced stability ($Si2= 0.67$). It indicates that it has better adaptability to environmental deterioration. The earliest sowing time also provides the maximum rates of genetic flexibility (6.58 t/ha), drought tolerance index (88.2%), general adaptive capacity (+1.25 t/ha), yield stability index (0.27) and hybrid stability indicator (169.6%).

Key words**:** *sorghum, sowing time, grain yield, adaptive capacity*

INTRODUCTION

Global warming, which can be observed during the last 25-30 years, has also affected the territory of Russia [10]. According to the Institute of Global Climate and Ecology of Russian meteorological service and the Russian Academy of Sciences, the average annual air temperature in Russia in 1976-2017 increased faster than the average planetary temperature by more than 2.5 times [7] and the increase was 0.47°C/10 years, although the global world values of this indicator increased by only 0.18°C/10 years [18]. Warming is also occurring in the steppe conditions of the Donbas. According to the Lugansk Meteorological Office, in comparison to the average long-term norm during 160 years (from 1838-1997), over the past 25 years (1997-2021), the average annual air temperature has increased by 1.7°C and reached 9.7°C, with an increase rate of 0.68°C/10 years. The frequency and duration of hot drought seasons have noticeably increased in summer. An urgent task in the conditions of increasing aridity of the climate is to increase the cultivation area of a promising, extremely drought, heat and salt tolerant, ecologically plastic and high-yielding crop – grain sorghum, which has a universal application for food, fodder and technical purposes [4]. According to the long-term research in the conditions of the Lugansk Region, this crop significantly exceeds the main spring sown cereals – barley, oats and corn in terms of yield [3, 4, 11], providing an average grain yield of 5-6 t/ha or more [12].

It is known that the more a variety produce in a wide range of growing conditions (i.e., the higher its average yield), the higher the level of its adaptability [21].

Frequently, weather conditions lead to a significant reduction in the yield of many grain and fodder crops, while sorghum is able to withstand air and soil droughts for a long time. It is necessary to introduce varieties in production that are characterized by responsiveness to improving of growing conditions and the stability of the grain yield. Therefore, for the zonal placement of sorghum varieties and hybrids, it is important to know their adaptive potential, which is estimated by the parameter value of ecological plasticity and stability, which show the adaptation characteristics of varieties to environmental conditions (genotype × environment interactions) [1, 2, 13, 15, 17].

In the grain production of the Lugansk Region, a high-yielding hybrid of grain sorghum Sprint W (production of "Richardson Seeds", USA) is widely used. Therefore, we set the task to establish the most optimal sowing time for this hybrid (the best hydrothermal environmental conditions), which ensure the maximum adaptability of this genotype.

MATERIALS AND METHODS

The research was carried out in 2008-2017 on the experimental field of the Lugansk National Agrarian University in the field crop rotation of the Department of Agriculture and Environmental Ecology. The soil was ordinary, thin, slightly eroded chernozem on loess-like loam with an average content of 3.3-3.4% humus in the arable layer (according to Tyurin); 113.2 mg/kg of hydrolysable nitrogen (according to Cornfield); 80.1 mg/kg of mobile phosphorus (according to Chirikov) and 156.2 mg/kg of exchangeable potassium (according to Chirikov) [8]. The reaction of the soil solution was weakly alkaline (7.7-8.6%).

Agricultural technique of sorghum cultivation in the field experiment was conventional for the zone. The studies were carried out in accordance with the methodology of the field experiment [8]. The preceding crop was winter wheat. The seeding rate was 250-300 thousand/ha of viable seeds with manually formed density at the level of 130-140 thousand/ha. We used the middle-early hybrid of grain sorghum, which was recommended for the region – Sprint W. It was a two-factor experiment. The replication of the experiment was fourfold. The area of the plot was 33.6 m^2. The registration plot was 28.0 m^2. Six sowing dates of sorghum were studied in the experiment: I – April 25; II – May 5; III – May 15; IV– May 25; V – June 5; VI – June 15.

According to the works of Rybas I.A., Marchenko D.M., Nekrasov E.I. et al. [19]; Biktimirov R.A., Nizaeva A.A. [6], in order to calculate the adaptability parameters, the coefficient of variation was used in accordance with the method of field experiment [8]; indicators of stress resistance (Y_{min}-Y_{max}) and genetic flexibility ((Y_{max}+Y_{min})/2) according to equations of Rosielle and Hamblin (1981) as expounded by Goncharenko A.A. (2005); indicators of plasticity (b_i) and stability (S_i^2) according to the method of S.A. Eberhart, W.A. Russell [9] as expounded by Zykin V.A., Belan I.A., Yusov V.S. et al. [22]; Pakudin V.Z., Lopatina L.M. [16]; Kilchevsky A.V., Khotyleva L.V. [14].

The weather conditions of the growing season during the years of the experiment were very contrasting (Table 1).

Despite the extremely uneven precipitation during the growing season, the most favorable hydrothermal conditions were in 2008, 2011, 2014, 2016 and 2017 (HTC was 0.94-1.14).

Due to the increased air temperature and the extreme lack of precipitation in the second half of the growing season of sorghum (July-August), in the most critical reproductive period of development, the most extremely dry conditions were in 2009, 2010, 2012, 2015.

Table 1. Weather conditions during the growing season of grain sorghum, 2008-2017 (Hydrometeorology Center data, Lugansk)

Measurements during the growing season (April-September)	Years										
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Normal value**
Mean air temperature, ºC	17.8	18.0	20.1	18.0	20.2	18.8	17.9	19.0	18.6	18.0	**17.3**
Precipitation amount, mm	292	162	252	318	196	202	310	274	335	283	**309**
Relative air humidity, %	67.0	61.1	62.6	67.6	61.7	61.3	65.7	61	64.2	62.5	**66.0**
Number of days with relative air humidity ≤ 30%	51	89	75	54	70	68	63	82	32	64	**45.2**
Sum of active (≥10ºC) temperatures, ºC	3,414	3,455	3,560	3,287	4,008	3,868	3,253	3,408	3,546	3,166	**3,148**
Hydro-thermal Coefficient of Selyaninov (HTC)	1.10	0.54	0.78	0.94	0.58	0.68	1.14	0.68	1.08	0.99	**1.00**

Source: developed by the authors based on [8, 18].

Moisture conditions of these years during this period corresponded to the natural zones of the semi-desert (HTC = 0.4-0.2), and in August of 2008, 2010, 2015, 2017 – the desert zone (HTC < 0.2). On average, for 2008-2017 years of the experiment, the hydrothermal coefficient (HTC) for July-August was 0.54 or decreased relative to the average long-term (average for 1986-2005) climatic norm by 32.5% [20] (Table 2).

Table 2. Conditions of water availability in July-August during 2008-2017

Measurements	Years										Normal value
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	
Precipitation amount, mm	65.7	60.2	52.8	87.2	49.1	91.4	105.5	41.6	129.6	98.8	108
HTC during July-August	0.46	0.44	0.32	0.61	0.32	0.66	0.76	0.29	0.88	0.69	0.80

Source: developed by the authors based on [8, 18].

Therefore, we set the task to establish the effect of the shift in the sowing time of the crop relative to the one, which is conventional in production (May 15) towards earlier or later dates.

RESULTS AND DISCUSSIONS

The sowing time of sorghum significantly influenced the length of the period "sowing – germination". In April sowing period, sorghum sprouts appeared only on the 15th day. On average, it was 5.5 days earlier. As for the late (May 15) date, it was almost 9 days earlier or 2.4 times faster (Table 3). An analysis of the duration of the sorghum growing season showed that with an earlier sowing time (April 25), the growing season of crop development (germination – flowering) was significantly longer than with medium (May 15) or late (June 15) sowing time. This difference, on average for 10 years, was 4.1 days in comparison with the average period (varied on an annual basis from 1 to 11 days) and 8.6 days (with fluctuations from 3 to 19 days). The exception was 2011, when with a late sowing time, this period was longer (by 5 days) than at an early one.

In particular years (2010, 2011, 2012, 2015, 2016), the total growing season of sorghum of late June sowing time was even longer than early (April) ones. This was due to the fact that during these years late-sown sorghum didn't have enough sum of active temperatures for ripening in proper time (2010), or it did not reach the stage of full ripeness at all (2011, 2012, 2013, 2014, 2015, 2016) due to air and soil frosts in October. Late-sown sorghum stopped growing and died in the stages of milk-wax and wax ripeness.

Thus, the lasting (average for 1991-2020) probability of air and soil frosts in the III ten-day period of September was 6.0 and 12.3%, in the I ten-day period of October – 7.4 and 17.0%, and in the II ten-day period of October – 16.7 and 25.7% [5].

Table 3. The duration of interstage periods in the cultivation of grain sorghum during 2008-2017 depending on the sowing time of crops

Sowing time	The duration of the interstage period during the years of the experiment, days										$\overline{X}$
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
	Period of sowing – germination										
I	16	20	15	22	9	10	13	15	16	15	15.1
II	11	16	11	15	9	9	11	12	9	13	11.6
III	10	11	9	11	8	8	9	10	8	12	9.6
IV	9	8	7	10	7	8	8	8	7	8	8.0
V	8	6	6	8	7	7	6	6	7	11	7.2
VI	7	6	5	7	6	6	6	6	7	7	6.3
	Period of germination – flowering										
I	82	72	65	65	68	66	69	63	67	78	69.5
II	85	70	63	64	62	62	68	61	65	75	67.5
III	79	68	59	64	63	63	68	62	61	67	65.4
IV	76	66	54	73	60	60	64	61	58	64	63.6
V	75	60	57	77	62	61	67	57	54	58	62.8
VI	70	55	59	70	59	59	66	57	55	59	60.9
	Period of germination – ripeness										
I	126	129	95	114	106	113	121	112	111	118	114.5
II	122	124	94	113	99	109	118	106	112	112	110.9
III	119	122	95	109	99	116	119	101	110	105	109.5
IV	114	121	90	121	98	119	119	100	111	104	109.7
V	112	120	92	122	128	109	111	118	120	105	113.7
VI	106	124	111	113	119	102	101	118	110	99	110.3

Source: developed by the authors based on [8, 18].

On average, during the years of the research (2008-2017), the yield of grain sorghum hybrid Sprint W varied in a very wide range (from 0.57-4.60 t/ha in dry 2010 to 6.56-8.82 t/ha in wet 2016). It was the highest at I and II sowing time and significantly exceeded this parameter with later dates (Table 4). The only exception was 2017, with a very cold and dry spring growing season, when the maximum crop yield was formed at III sowing period.

Table 4. Yield of grain sorghum hybrid Sprint W during 2008-2017

Sowing time	Crop yield during the years of the research, t/ha										$\overline{X}$
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
I (25.04)	7.21	5.62	4.60	6.55	4.50	7.34	6.51	7.29	8.82	4.34	**6.28**
II (5.05)	7.06	5.33	4.15	6.43	4.22	6.87	5.85	7.07	8.71	5.02	**6.07**
III (15.05)	5.73	4.90	4.08	6.20	4.20	5.67	4.99	6.52	7.98	5.28	**5.56**
IV (25.05)	4.96	4.79	3.15	6.14	3.71	5.84	4.02	6.18	7.02	5.00	**5.08**
V (5.06)	4.36	4.52	1.91	3.59	2.79	5.58	2.34	3.50	7.25	4.44	**4.03**
VI (15.05)	3.55	4.72	0.57	2.61	1.56	4.18	1.48	1.52	6.56	4.65	**3.14**
$\sum Y_j$	32.87	29.88	18.46	31.52	20.98	35.48	25.19	32.08	46.34	28.73	**30.15**
Y_j	**5.478**	**4.980**	**3.077**	**5.253**	**3.497**	**5.913**	**4.198**	**5.347**	**7.723**	**4.788**	**5.025**
J_j	0.453	-0.045	-1.948	0.228	-1.528	0.888	-0.827	0.322	2.698	-0.237	
$S\overline{\mathbf{x}}$	0.124	0.058	0.078	0.116	0.079	0.095	0.105	0.104	0.162	0.078	
LSD_{05}, t/ha	0.367	0.172	0.242	0.343	0.235	0.283	0.312	0.309	0.498	0.231	
$S\overline{\mathbf{x}}$, %	2.26	1.16	2.53	2.21	2.26	1.61	2.50	1.94	2.10	1.63	

Y_j– average yield per year for all periods of sowing time; J_j – year conditions index
Source: developed by the authors based on [8].

The results of the variance analysis of a two-factor experiment (Fig. 1) indicate that not only the conditions of the year (47.3%), but also the sowing time (38.8%), and to a much

lesser extent, their interaction (the contribution of the interaction influence of the factors “year conditions” × “sowing time” on the crop yield was only 13.9%).

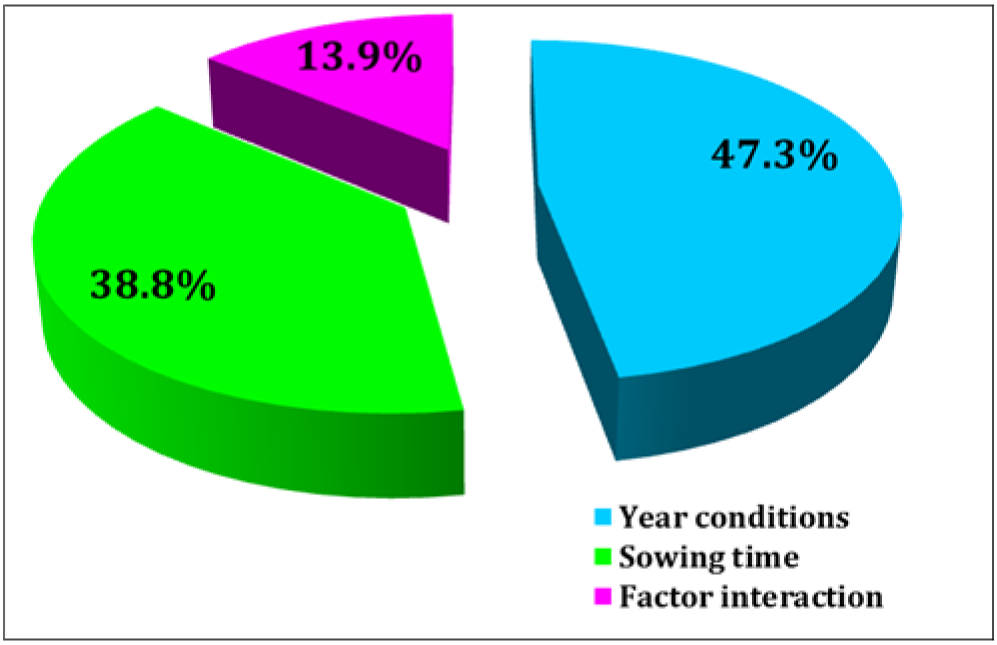

Fig. 1. Percentage of the contribution of factors in the formation of the yield of grain sorghum hybrid Sprint W on average for 2008-2017.
Source: developed by the authors based on [8].

The results of the variance analysis of a two-factor experiment (Fig. 1) indicate that not only the conditions of the year (47.3%), but also the sowing time (38.8%), and to a much lesser extent, their interaction (the contribution of the interaction influence of the factors “year conditions” × “sowing time” on the crop yield was only 13.9%).

As a result of calculations of the adaptive capacity indicators of grain sorghum of the studied hybrid Sprint W, it was found that the greatest responsiveness to improved moisture conditions during the growing season by optimizing the sowing time was the crop, which was sown at the earliest time – in the period from April 25 to May 5 (Table 5). This contributed to obtaining a linear regression coefficient (b_i) ≈ which is equal to 1.0 (under these conditions, this genotype behaves as highly plastic, and its yield corresponds to changes in environmental conditions). At these sowing dates, a greater stability of hybrid yield formation was also obtained since the measure (variance) of sample stability (S_i^2) has a decreasing tendency (0.67-0.30), which is not a sign of its intensity, but a factor of better adaptation of the genotype to deterioration of growing conditions. Sorghum crops of the latter sowing time (June 15) had the highest stability indicator (S_i^2= 1.39), which indicates the formation of a consistently low yield at this sowing time.

Sorghum crops of III and IV sowing time had the highest stress resistance (Y_{min}-Y_{max} ≤ -3.9 t/ha), i.e. the lowest negative values of the difference between the minimum and maximum yield of this variety. The maximum genetic flexibility of the hybrid (1/2 × (Y_{min} + Y_{max}) = 6.58-6.43 t/ha) was obtained at I and II sowing dates. The drought tolerance index of the hybrid (DTI = Y_{min}/Y_{max})×100%) was also the highest at the I sowing time (88.2%), which is 8.4% more than at the conventional sowing time of sorghum (May 15).

The highest adaptive capacity of the hybrid (GAC = the difference between the average yield of the hybrid at a specific sowing time and the average yield of the entire set of tests during all years of the experiment) was equal to +1.25 t/ha and was also obtained at the first, earliest April sowing time. The system index (SI = (Y_{max} – Y_{min}) / $\overline{Y}$ throughout the experiment × 100%) was the highest (106.2-

119.1%) at V and VI sowing dates, and the minimum was at III sowing time.

Table 5. Parameters of adaptability and stability of grain sorghum hybrid Sprint W based on the trait "crop yield" depending on the sowing time and year conditions during the growing season (2008-2017)

Sowing time	Grain yield, t/ha						Adaptivity parameters		DTI, %	GAC, t/ha	CV, %	System Index, %	SF	Stability Index	SLI, %	SLI, % to St
	Average Y_i	Inaccuracy Y_i	min-max	Range d		$\frac{min+max}{2}$										
				t/ha	%		b_i	S^2_d								
I (25.04)	6.28	0.47	4.34-8.82	4.48	50.8	6.58	0.968	0.667	88.2	+1.25	23.6	89.1	2.03	0.27	169.6	113.0
II (5.05)	6.07	0.45	4.15-8.71	4.56	52.4	6.43	1.022	0.304	59.0	+1.04	23.6	90.7	2.10	0.26	157.8	105.1
III (15.05)	5.56	0.37	4.08-7.98	3.90	48.9	6.03	0.824	0.204	79.8	+0.53	20.9	77.5	1.96	0.27	150.1	100.0
IV (25.05)	5.08	0.39	3.15-7.02	3.87	55.1	5.09	0.861	0.260	44.9	+0.05	24.1	76.9	2.23	0.21	106.7	71.1
V (5.06)	4.03	0.50	1.91-7.25	5.34	73.7	4.58	1.149	0.460	26.3	-1.00	39.4	106.2	3.80	0.10	40.3	26.8
VI (15.06)	3.14	0.60	0.57-6.56	5.99	91.3	3.57	1.177	1.390	8.7	-1.89	60.5	119.1	11.51	0.05	15.7	10.5

Source: developed by the authors based on [8].

The highest indicator of the stability factor ($SF = Y_{max} / Y_{min}$) was obtained precisely at V and especially at VI sowing dates, i.e. with the lowest hybrid yield. Stability index of sorghum grain yield ($SI = \overline{Y}_{\text{throughout the experiment}} / CV$, %) was the highest (0.26-0.27) at the first three sowing dates (April 25 through May 15). Also, the stability level indicator of the hybrid ($SLI = \overline{Y}_{hybrid} \times SI_{hybrid}$) was the highest at the first earliest sowing time (169.6%), which was higher by 13.0% in comparison to the conventional sowing time for sorghum in production (May 15).

CONCLUSIONS

On average, during 2008-2017 years of the research, the share of the contribution to the formation of the grain sorghum yield by optimizing the sowing time was 38.8%. According to the set of indicators of adaptive capacity and ecological plasticity, the first earliest (April 25) sowing time for grain sorghum of the middle-early hybrid Sprint W was identified as the most appropriate. This sowing time provides not only the highest yield for the hybrid, but also the most favorable combination of the main indicators of adaptive capacity. At this sowing time the hybrid behaves as a highly plastic genotype ($b_i \approx 1.0$), which simultaneously has a reduced stability ($S_i^2 = 0.67$). It indicates it has better adaptability to environmental deterioration. The earliest sowing time also provides the maximum indicators of genetic flexibility (6.58 t/ha), drought tolerance index (88.2%), general adaptive capacity (+1.25 t/ha), yield stability index (0.27) and stability level indicator of the hybrid (169.6%).

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MODERN DIGITALIZATION TRENDS OF GEORGIA AND UKRAINE

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Abstract

In today's turbulent and unstable environment, international companies, including Ukraine and Georgia, are forced to move to technologies they did not plan to implement for some time and reconsider their strategic priorities. "Become digital or die" is the reality of the COVID-19 epidemic. Companies that will survive in the long run - those that have the best tools that allow them to be flexible, agile, agile; those who are better than others will be able to respond to changes in the product range, control and monitor their factories, regulate supply chains and will be able to use their workforce really anywhere. Mixed research methods were used to analyse the data. The theoretical and methodological basis of the study were the dialectical method of cognition, a systematic approach to the use of general provisions of economic theory. According to the research results, despite the serious positive transformations in the field of digitalization, there are a number of current and significant unresolved issues in the industry. It is established that the digital economy in Ukraine and Georgia, despite a number of existing problems, is developing dynamically. Organizations in various sectors of the economy are beginning to actively implement digital solutions, taking into account the specifics of their activities. Innovation is the engine of economic development, so attempts are made to find and create the most appropriate forms of organizational associations of innovative enterprises, alliances, within which strong cooperative ties can be established. The need for large-scale cooperation and coordination in the form of networking of participants in the innovation process becomes quite obvious, which provides them with a beneficial effect and corresponding competitive advantages.

Key words*: *digitalization, turbulence, development, management, trend

INTRODUCTION

The development of information technologies and means of communication, primarily electronic networks, has created a powerful impetus for the formation of a new trend in the functioning of modern business – the digitalization of economic relations. Most information carriers are becoming digital, which determines the main trend in the development of both modern technology and business processes with a predominant share of the electronic component. The electronic form of communication raises the level and effectiveness of communication between buyers and sellers and creates new markets and opportunities for the reorganization of economic processes.

The creation of the Internet made it possible to reduce the cost of electronic communications due to the low cost of information transfer and significantly increase the speed of data exchange, which led to an increase in the turnover of financial and material resources of enterprises. Electronic communications based on Internet technologies create such opportunities for business as a) development of new markets; b) attracting new customers; c) reducing the time spent on doing business; d) prompt response to market changes. The practical experience of using e-commerce systems has shown that savings from using B2B schemes can reach 15% in the procurement process and 22% in the sales process due to logistics optimization, procurement consolidation, reduction of intermediary margin, and achievement of the optimal price [9, 10, 17].

Thus, the search for the most promising areas for the reorganization of business processes of enterprises in Ukraine for the next 5-10 years, the possibility of their adaptation to the realities of electronic communication is an urgent problem, the solution of which gives both enterprises and their partners many advantages. Prices as sellers of products – increasing the markets of presence, increasing sales volumes, increasing the turnover rate of working capital, reducing costs, increase the competitiveness and sustainability of the business in a dynamic business environment. For buyers, this is convenience, reliability, practicality, and shopping time-saving.

The authors conducted a study of world scientists in the field of electronic systems in business, studied e-business from the standpoint of marketing, studied the problems of management and effectiveness of business decisions in the context of "business - content - management".

Distinctive features of the development of world agriculture are the concentration and specialization of agricultural production, the widespread use of information technology, including navigation technology management of agricultural machinery while reducing specific energy costs and production costs.

Most of the agricultural machinery is equipped with electronics, and modern tractors or combines use many different electronic sensors and an on-board computer to monitor and control it. In recent years, navigation devices have become an indispensable tool for placing agricultural machinery in space and time. Various works are used not only in industry but also in agriculture.

Among the main aspects of research on this issue, scientists have focused on: electronic communications of current business structures: problems of corporate partnerships [17]; the state of development of digitalization in Ukraine [21]; matrix method of competitive analysis of the results of economic activity of enterprises in the conditions of strategization and digital transformation [8]; development of a system of effective use of enterprise resources by balancing the effectiveness of economic activity in terms of resource features [2]; the digital economy and business in the conditions of pandemic [4]; innovation processes and economic growth [22]; strategies of socio-Economic development and mechanisms of their implementation in the conditions of economic [1].

However, the issue of modern development of modern digitalization trends in Ukraine and Georgia is deeply needed. It is expedient to study and establish ways for business in mastering this area.

Digital business is modernity, which is sometimes difficult to give to entrepreneurs who do not know how to start this journey.

The article is for the purpose of defining modern trends in the introduction of digitalization in Georgia and Ukraine, and marks out problematic aspects and prospects, and identification of specific features of digitalization in the sphere of agrarian business.

MATERIALS AND METHODS

The used research methods include comparative and system analysis, expert assessment methods, modelling. At the initial stage, we analyzed the concept of technological revolution includes technological structures, four industrial revolutions and periodization of globalization. Further, the authors studied the dynamics of foreign direct investment in the economies of countries for 2015-2019. We have assessed the position of countries in terms of the components of the Global Innovation Index 2020 and Innovation achievers in 2020: income group, region, and years as an innovation achiever. At the next stage, the distribution of the permanent population of Ukraine and Georgia by age as of 2019 was carried out. Despite serious positive transformations in the field of digitalization, there are a number of relevant and significant unresolved industry problems. At the final stage, the obtained results were processed and analyzed and tasks for further research were formulated.

The information base of the study consisted of scientific works of domestic and foreign scientists on the problems of the research issue, laws and regulations of Ukraine and Georgia, materials of statistical services, sources of information and analytical materials of relevant organizations and

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periodicals.

RESULTS AND DISCUSSIONS

The transformation of socio-economic relations, associated with the widespread use of information and communications technologies (ICT), is interpreted differently in different scientific schools.

The most common is the technical-technological approach, which inextricably connects the development of human civilization with the progress of technique and technology. Its current stage, which is called the 4th industrial revolution in the United States, the EU, and other technologically advanced countries, is identified in the EAEA with the formation of the 6th technological order.

The concept of technological revolution is presented on Figure 1.

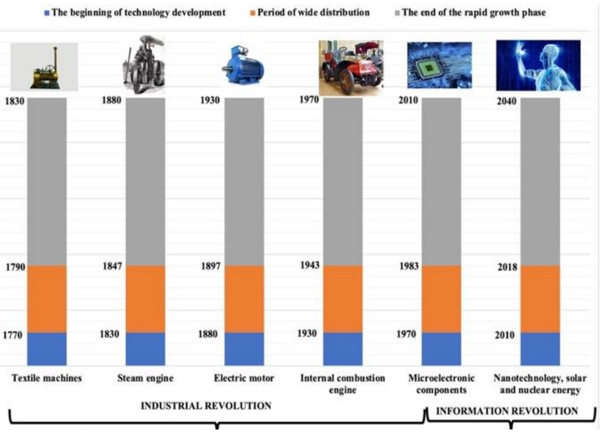

Fig. 1. The concept of technological revolution
Source: systematized by the author's based on research.

Technological structures are groups of technological units that stand out in the technological structure of the economy, and that are interconnected by the same type of technological chains and form reproductive integrity.

Each such method is a holistic and sustainable formation, within which the full macro-production cycle is, including the extraction and production of primary resources, all stages of their processing, and production of a set of final products that meet the appropriate type of public consumption.

At the moment, there are six technological orders (Table 1).

Table 1. Technological structures

Period of development	The core of the technological structure	Predominant infrastructure	Organization of production
1770-1830 The beginning of the industrial revolution	textile industry, textile engineering, iron smelting, iron processing, canal construction, water engine	roads, irrigation canals	factory production
1830-1880 Age of steam	steam engine, railway construction, transport, mechanical engineering, shipbuilding, coal industry, ferrous metallurgy	railways, shipping lines	mechanization of production, urbanization
1880-1930 The steel age	Electrical and heavy engineering, steel production and rolling, inorganic chemistry	power systems, post office, telegraph, radio, telephone, railways	standardization of production
1930-1970 The oil age	Auto and tractor building, non-ferrous metallurgy, production of durable goods, synthetic materials, organic chemistry, oil production and processing	expressways, power systems, pipelines, radio and television communications, shipping and airline	serial production, quality growth
1970-2010 Scientific and technological revolution	electronic industry, computer, fiber-optic technology, software, telecommunications, robotics, gas production and processing, information services	computer networks, satellite communications, Internet, global power systems, airlines	networking, logistics, clusters, outsourcing
2010-2050 The digital revolution	biotechnology based on advances in molecular biology and genetic engineering, nanotechnology, artificial intelligence systems	global information networks and integrated high-speed transport systems	virtual services, 3D printers, Internet of Things, cloud infrastructure

Source: systematized by the author's based on research.

Western publications do not use the concept of technological order, and, considering the fundamental changes in technology that lead to fundamental changes in economic relations and society as a whole, the authors speak of industrial revolutions (Table 2).

Table 2. Four industrial revolutions

Industrial revolution	The main source of growth
1770-1860: 1st Industrial Revolution – the era of steam and spinning production	Steam machines, spinning and weaving machines, metallurgy, lathe
1860-1900: 2nd Industrial Revolution – the era of steel and current production	Telegraph, railways, internal combustion engine, conveyor
1970-2010: 3rd Industrial Revolution – the age of computers	Computers, electronics, nuclear energy, robots
2010-2060: 4th Industrial Revolution - the era of cyberphysical systems, the Internet, the digital economy	NBIC-technologies, genetic engineering, 3D-printers, RES, drones, Internet of Things

Source: systematized by the author's based on research.

There are different periodization of the globalization process. Based on Maddison's E. study "Contours of the World Economy in 2030" [7], it is fair to say that human civilization in its development has gone through six stages of globalization (Table 3).

Table 3. Periodization of globalization

Stages of globalization	Average annual GDP growth,%	Average annual growth of world trade,%	Excess of trade growth over GDP (times)
Trade Capitalism, European Colonization of America, East India TC (1500-1820)	0.32	0.96	3.0
Industrial capitalism, the rise of European global empires (1820-1870)	0.94	4.18	4.4
The era of imperialism, financial globalization (1870-1914)	2.12	3.40	1.6
Stagnation of globalization – world wars, the Great Depression (1914-1945)	1.82	0.90	0.5
Bretton Woods Monetary System, GATT (1945-1973)	4.90	7.88	1.6
The Golden Age of Globalization: The Jamaican Monetary System, WTO (1973-2010)	3.17	5.38	1.7
Digital Globalization (2011-?)	3.14	10.44	3.3

Source: official data of the Contours of the World Economy in 2030 [7].

Under the influence of the fifth stage of globalization, international economic relations developed rapidly, trade unions and organizations were formed, stable interstate institutional ties were formed, and the mobility of people increased. The sixth stage of globalization began in the 1970s of the XX century and it is associated with the integration of the world economy and the emergence of multinational corporations. One of the most important achievements of the fifth and sixth stages were the GATT-WTO trade rules and the global payment systems SWIFT, VISA, and Europay.

The growing interest in big data technology over the past few years is due to two main factors. The first is the rapid expansion of the use of computers and various digital devices, not only in business but also in the daily lives of many people. Transport, industry, commerce, and healthcare are increasingly using detecting devices and sensors to collect and transmit data on freight traffic, transport, and patient status. As a result, a new space is created in which the objects of the real and virtual worlds communicate with each other through wired and wireless communication channels (the so-called Internet of Things). Secondly, the popularity of big data is due to the increase in information flows on the Internet, which includes tweets, social media posts, search queries, sensor data, and controllers of millions of smart devices.

The first companies that realized the hidden value of large amounts of information were Google, Amazon, Yahoo, Facebook, which developed tools for collecting, analysing, and storing large amounts of data. The development of cloud solutions has led to an increase in the number of data centres and a reduction in the cost of their services, which, in turn, has significantly reduced companies' storage costs.

The survey found that the most widely used big data technologies were found in telecommunications, as well as in mechanical engineering, insurance and finance. The leading areas of big data use are retail, finance, healthcare, and telecommunications.

Big data is now seen as an effective tool for government decision-making. One way to work with big data on the regulation of socio-economic and political processes is to compile and analyze official statistics solely on their basis and in combination with traditional sources: registers, surveys, etc.

In December 2019, the Verkhovna Rada of Ukraine passed a bill containing provisions on virtual assets that are considered property and can be used for payment and investment purposes. The bill proposes a tax rate at a reduced rate of 5% of profits for five years for individuals on cryptocurrency transactions, which is 13% lower than the current tax rate.

The experience of regulators around the world shows that cryptocurrency is difficult to classify as an existing asset class. The mechanical transfer of traditional regulations to cryptocurrency works poorly. More and more regulators are inclined to the obvious view that it should be considered as a unique alternative asset class, different from all others, with its own advantages, risks and its own legal framework. Taking into account that cryptocurrencies are very different from each other – as an example it is possible to consider at least decentralized and centralized projects – then, most likely, it needs to be divided into several categories. Ultimately, how cryptocurrencies are classified largely determines market share.

Countries with strong economies and currencies are introducing cryptocurrency as a

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means of payment or as a financial asset. Countries with weak economies and volatile currencies are trying to support the national currency by restricting cryptocurrencies as a means of payment but allowing cryptocurrencies as a means of exchange. Thus, the ambiguous approach to cryptocurrencies in different countries around the world creates additional problems for determining their legal status. This means that Ukraine needs to develop its own approach to the legal regulation of cryptocurrencies, giving them a special legal status, based on the current state of legislation and economic development of the country.

The term "business process" is commonly used to refer to a set of interrelated activities or tasks aimed at creating a specific product or service for consumers. The model of any enterprise consists of a combination of individual business processes, and the success and competitiveness of the enterprise depend on their efficiency. To date, there is no single definition of the term "business process". The founders of process management of the enterprise provided the following definitions of business process: a business process is a set of different activities in which "input" uses one or more types of resources, and as a result of this activity "output" creates a product which is valuable to consumers [10]. The purpose of the business process is to create a product or other useful result for the company's customers, management, owners, other employees or, departments of the company [17].

In the process of building a management system for an industrial enterprise based on business processes, attention is focused on developing mechanisms for interaction between internal structural units and their interaction with stakeholders. The authors identified four groups of entrepreneurial stakeholders: the state, the social environment, the educational environment, and the business environment. Each of the selected groups includes several participants (Figure 2). The social environment includes the population, public organizations, students; the group "state" includes public authorities and local governments; the educational environment is educational institutions and institutions of non-formal education and the business environment includes business associations and business structures.

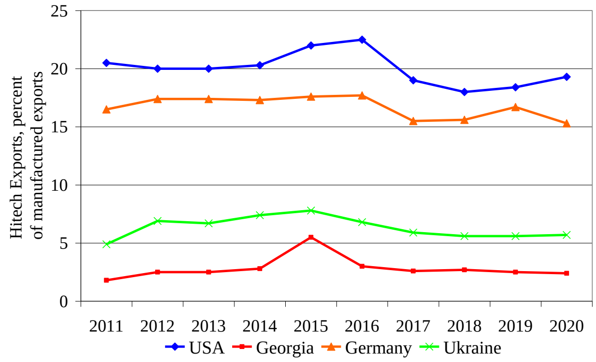

Fig. 2. Hitech Exports, percent of manufactured exports.
Source: official data of the United Nations; The GlobalEconomy.com [18, 20].

Each of the stakeholder groups has certain priority interests in several areas – interaction with each other when working with young entrepreneurs and directly with young entrepreneurs. Each of these groups of stakeholders influences the activities of the enterprise and has its own characteristics. It is proposed to compare some of the parameters that affect business processes, in particular in the context of modern digitalization trends, using the example of Ukraine, Georgia, Germany (as a European benchmark), and the USA.

The first of the parameters that contribute to business development is direct investment. The World Bank (World Bank) published an analytical report "Doing Business in 2015". Singapore ranks first in overall ease of doing business for the eighth year in a row, according to this study, and has consistently pursued reforms aimed at improving the business environment. The top ten countries also included New Zealand, Hong Kong (Special Administrative Region of China), Denmark, South Korea, Norway, the United States, Great Britain, Finland and Australia [12].

It should be emphasized that not only and not so much financial profitability affects the decision to invest in a particular region. A potential investor always takes into account the stability of not only political, socio-economic, geographical and cultural, but also organizational and legal factors.

For example, Singapore is a country with a favorable investment climate, not only due to low taxes, of which there are only five. Bureaucratic procedures for business have been reduced to a minimum; all reporting is done via the Internet (although there is very little of it).

The country has completely abolished the "permissive" practice and "licensing". There are no taxes on dividends, capital gains, bank interest, and investment income in Singapore.

The transformation of Hong Kong into one of the global financial centers is facilitated by especially liberal tax and currency legislation, which does not cause barriers to the movement of capital, both in terms of volumes and directions of transactions.

In Hong Kong, the process of creating a new company takes no more than four days, and registration takes half an hour, most of the communication with government agencies and the execution of basic documents, as well as in Singapore, are possible online.

Regions can serve not only as an object for investment, but also create conditions for opening and comfortable doing business.

For example, in Hong Kong, the process of business functioning is as convenient as possible.

Entrepreneurs regardless of nationality have access to a developed financial and legal industry, reliable and affordable utilities, advanced communications, and information infrastructure.

Moreover, the Hong Kong authorities provide for a number of grants and sponsorship programs, the purpose of which is financial and educational assistance to teams that work in the intellectual field [19].

In South Korea, the number of procedures required to open a business is kept to a minimum (three procedures on average). The procedure for opening a new company takes a maximum of two weeks.

Let us pay attention to the dynamics of investments over the past 5 years in the countries under study (Table 4).

Table 4. Foreign direct investment (share capital) in the economies of countries in 2016-2020

	Volumes in				
	2016	2017	2018	2019	2020
Georgia, million USD	1,660	1,921	1,270	1,366	534
Germany, million USD	64,708	109,506	158,515	67,619	112,617
The US, million USD	474,388	380,823	214,315	302,199	211,298
Ukraine, million USD	4,128	3,680	4,975	5,796	304

Source: official data of the World Bank [14].

Over the past 19 years, the number of FDIs in the United States has more than doubled. In 2000 the FDI was 1.26 billion USD USA, and in 2019 it increased to 4.46 billion USD USA. Foreign direct investment (FDI) is an investment from a company in one country to a company or organization located in another country. In this case, foreign direct investment is recorded for companies / organizations located in the United States.

However, while the United States receives huge sums of FDI annually, it also invests even larger sums in other countries. For example, in 2018, the United States invested over $ 866 billion in the Netherlands and another $ 758 billion in the UK.

Germany is considered as an attractive country for foreign direct investment (FDI), but the global recession and subsequent Eurozone crisis have hampered the influx of FDI in recent years. According to the 2020 World Investment Report by UNCTAD, FDI inflows in Germany decreased by almost 50% in 2019, reaching 36.6 USD billion compared to the 74 billion USD of the previous year. This is mainly due to uncertainty caused by the Brexit and US tax reforms, a tight labour market, as well as the stagnation in the automotive industry. FDI stock decreased slightly in 2019, reaching 953 billion USD (in general its level has remained constant over the last ten years and it amounted to $955 billion USD in 2010).

According to latest data by OECD, FDI flows to Germany increased by more than 20 billion USD in the first half of 2019. FDIs in Germany are mostly owned by the Netherlands, Luxembourg, the US and the

UK, which represent more than half of the total stock. Switzerland, France, Italy, Belgium, Austria, Japan, Spain and Denmark are also investing in the country. Investments are mainly oriented towards manufacturing and trade, finance and insurance, information and communication, real estate. In 2018, Germany Trade & Invest (GTAI) recorded a record of 2,062 foreign direct investment projects, with corporate and financial services representing 22% of all new projects, followed by ICT & software (16%) and the consumer goods industry (9%). Nevertheless, Germany remains a net capital exporter: in 2019 FDI outflows amounted to USD 99 billion.

It is to be noted that research and innovations play a critical role in ensuring the economic growth and effective use of the export potential in developing countries [6, 16]. (Scientific studies on innovative development and contemporary challenges of digital technologies in the context of Ukraine and Georgia, more detail, see, for example: [1, 2, 3, 4, 5, 6, 8, 11, 13, 15, 16, 17, 21, 22]. Ukraine and Georgia have challenges and considerable potential here.

Among the country's strengths are a highly powerful and diversified industrial network, a highly skilled workforce with a good command of English, reliable infrastructure, a favorable social climate, a stable legal framework, and a location at the heart of Europe. Their main weaknesses are a high tax rate (for both individuals and businesses) and rather inflexible labor laws. The World Bank ranked Germany 22nd out of 190 countries in its 2020 Doing Business report (gaining two positions compared to the previous year).

The volume of foreign direct investment in the Georgian economy in January-June 2019 amounted to $473.1 million, which is 34.9% less than in the same period in 2018, the National Statistical Service reports.

In the second quarter, the inflow of foreign investment amounted to $187 million – 34.6% less than in the previous quarter, and 2.2 times less than in the second quarter of 2018.

According to the statistical service, out of the total volume of foreign investments received in Georgia in the first half of 2019, $210.9 million was invested in the equity capital of enterprises, $161.5 million were reinvestments, and $100.7 million were debt obligations.

Over the six months of this year, the largest volume of foreign investment was attracted to the energy sector – $112.3 million (23.7% of the total). The hotel and restaurant sector received $86.7 million (18.3%) of foreign investment, the processing industry – $57.7 million (12.2%), the transport sector – $54.7 million (11.6%), the mining industry – $23.9 million (5.1%).

In terms of the number of investments invested in the Georgian economy, Ireland ranks first, from which $133 million (28.1% of the total) was received in January-June this year. Turkey is in second place – $104.1 million (22%), Panama is in third – $59.3 million (12.5%). The top five investors of the republic also include the USA – $50.4 million (10.7%) and the UK – $44.6 million (9.4%).

According to updated statistics, in 2018 the volume of foreign direct investment in the Georgian economy decreased by 35.5% compared to the previous year, to $1 billion 265.2 million (7.8% of GDP).

According to the State Statistics Service, in 2015 Ukraine received $4.3 billion in direct investment. In 2016, the volume of investments increased by almost 2% to $4.4 billion. In 2017, the flow of direct investment in Ukraine fell by 43% and amounted to just over $2.5 billion.

In 2018, the situation improved slightly and investments increased by 14.3% to almost $2.9 billion. In 2019, the amount of money invested in Ukraine decreased by 11.8% and amounted to $2.5 billion.

In 2015, the largest amount of money was invested in the development of finance and insurance ($2.7 billion). The second place in terms of the number of financial injections was taken by the IT industry ($ 0.5 billion). More than $0.3 billion was invested in wholesale and retail trade. Slightly fewer funds were received in the development of the industry. $0.1 billion was invested in real estate transactions.

In 2016, the number of investments increased in all these areas, in particular, in the industry

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– by 80%.

In 2017, there was a significant outflow of investments from the financial sector (-54.4%) to $1.3 billion and trade (-66%) – less than $0.2 billion.

In 2018, the financial sector lost another 6% of investments, which during the year amounted to $1.2 billion, the industry – $0.3 billion (-42%), IT industry – $0.1 billion (-22%). At the same time, real estate operations grew by 244% and received $0.4 billion in financial injections. Investments in trade and auto repair increased by 236%, which amounted to $0.6 billion.

In 2019, investment in the financial services sector sank by almost a quarter, but capital investment in the industry doubled. Investing in real estate began to invest 46% less ($0.2 billion), and trade and auto repair received 65% less investment than in the previous year, returning to the positions of 2017 ($0.2 billion).

The region can be not only an object for direct or indirect investment but also a place for the most daring innovations. As an example, we can cite not only the famous Silicon Valley but also other regions.

For example, having come to power in 2007, Sarkozy began to actively implement a policy aimed at the development of innovation, which resulted in support for high-tech industries, the creation of scientific and industrial clusters, the development of regional innovation networks, the modernization of the higher education system and scientific research. The most notable changes in the field of innovation policy were the poles of competitiveness (PC) and the poles of scientific research and higher education (PSRHE), as well as measures aimed at developing university autonomy (2007) [11]. Of course, France is not a pioneer in the implementation of industrial and innovation policy based on cluster principles, but it deserves attention. Competitiveness poles are an association of enterprises, research organizations and educational centers located on the same territory, included in joint activities and designed to accumulate synergy in innovative projects of young entrepreneurs [8]. Scientific, technical and innovative projects designed for the development of the national and regional economy became the basis of the PC's activity.

It is generally recognized that innovation and educational clusters are an effective mechanism for the development of a regional innovation system [2].

In Hong Kong, special attention is paid to the cultivation of skills to bring the achievements of the innovation process to the open commercial market [21].

At the service of companies engaged in scientific development, numerous and accessible high-tech specialized centers have been created, the purpose of which is to help develop promising ideas.

From the point of view of the impact of entrepreneurship on the development of the innovative activity, it should be noted that cooperation between universities, government agencies, public organizations and business makes it possible to establish and implement effective mechanisms to support youth innovative entrepreneurship through synergistic effects achieved in the course of such interaction. In addition, only based on such cooperation, conditions for the sustainable development of interuniversity Start-up centers and the promotion of youth entrepreneurship can be created.

At the same time, one of the main indicators, a generalizing indicator for measuring the level and results of the implementation of the country's innovative potential is the Global Innovation Index, which reflects the main components of the countries' innovative potential [12].

The results of the study of the position of countries in 2020 for the components of the Global Innovation Index are given in Table 5 and Table 6.

Table 5. Assessment of the position of countries by the components of the Global Innovation Index 2020

Country	Global Inno-vation Index	Insti-tu-tions	Human capital & re-search	Infra-struc-ture	Market sophi-stica-tion	Busi-ness sophi-stica-tion	Know-ledge sophi-stication & tech-nology	Crea-tive out-puts
Georgia	63	36	61	81	39	79	67	68
Germany	9	18	5	12	24	12	10	9
USA	3	9	12	24	2	5	3	11
Ukraine	45	93	39	94	99	54	25	44

Source: official data of the Global Innovation Index Database [9].

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Table 6. Innovation achievers in 2020: income group, region, and years as an innovation achiever

Economy	Income group	Region	Years as an innovation achiever (total)
Ukraine	Lower-middle income	Europe	2020, 2019, 2018, 2017, 2016, 2015, 2014, 2012 (8)
Georgia	Upper-middle income	Northern Africa and Western Asia	2020, 2019, 2018, 2014, 2013, 2012 (6)

Source: official data of the Global Innovation Index Database [9].

After analyzing the state of development of innovation activity based on the Global Innovation Index, it should be noted that the undisputed leaders are the USA (3rd place) and Germany (9th place). At the same time, these countries consistently occupy such leading positions.

Georgia and Ukraine are relative newcomers to this indicator. For Ukraine, the GII indicator is calculated over the period of 10 years, for Georgia – 6 years. These countries managed to win 45th and 63rd place respectively.

It is noteworthy that the leading countries under study have the lowest results in two components, which coincide in pairs with Ukraine and Georgia. Thus, the USA has the worst result (24th place) in the Infrastructure component, for Georgia it is also the worst result – 81st place. Germany ranks 24th in the "Market sophistication" component, in Ukraine it is 99 th.

If we analyze all the components of the GII, it becomes obvious that one of all stimulates the development of the others. Such a component is Human capital & research.

Not just residents are important, but taxpayers will replenish regional and local budgets. The quality of life is one of the most important factors in the innovative development of the economy [14].

In this regard, the experience of Tallinn with the idea of "free travel in exchange for registration" is interesting. All residents of the city who have an official residence permit are exempted from paying fares in public transport. Many called this event "populist". Of course, it required additional investments from the municipal budget. However, the benefits are obvious: the city's tax revenues have increased, people have become more mobile, retail sales have increased, the number of cars on the city's streets has decreased, the environmental situation has improved, and the need to build new parking lots and maintain old ones has disappeared.

It must be said that the city of Tallinn was far from being a pioneer, its experience is interesting because it is the first European capital that began to use this tool to increase the attractiveness of the city for its residents. In 1997 in the Belgian city of Hasselt, in 2009 in the city of Ambage in the south of France, public transport became free. Some cities in Germany and Sweden have also eliminated tolls. Many cities in Europe run free buses, or municipalities are taking steps to reduce ticket prices.

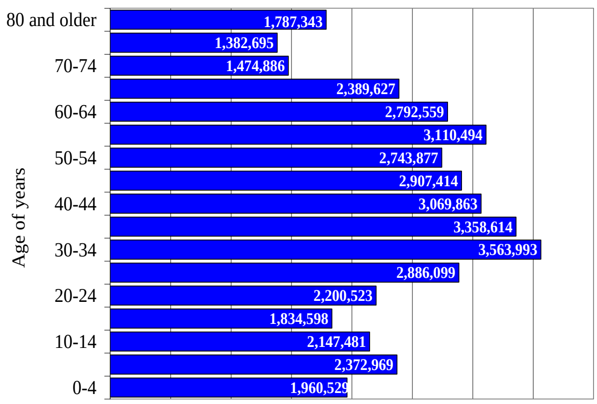

Fig. 3. Distribution of the resident population of Ukraine by age as of January 1, 2019.
Source: official data of the State Statistics Service of Ukraine [13].

Regarding the population of Ukraine as of January 1, 2019 (Figure 3), the largest number of citizens, namely 3,563,993 men, falls on the age category of 30-34 years.

This is the age at which the vast majority of young entrepreneurs operate. In general, citizens aged 15-34 in Ukraine are 24.97%, which is a quarter of the total population and 36.83% of the economically active population of the country.

This statistic shows the distribution of the population of Georgia by age group in 2019. In 2019, about 13.7 percent of the population in Georgia was between 25 and 34 years old (Figure 4).

The US population (Figure 5) was estimated at approximately 328.2 million in 2019, with the largest age group being adults aged 25 to 29. There were 12 million men and about 11.5 million women in this age group.

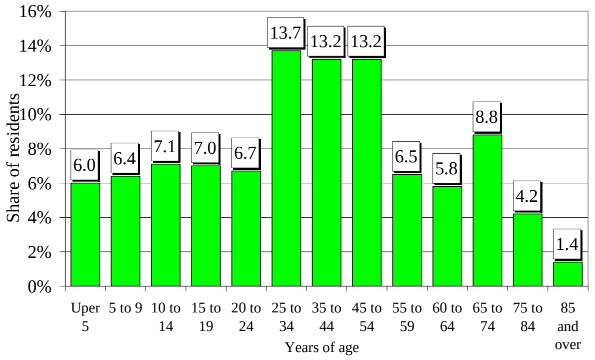

Fig. 4. Distribution of resident population of Georgia in 2019, by age group, %.
Source: official data of the Global Innovation Index Database [9].

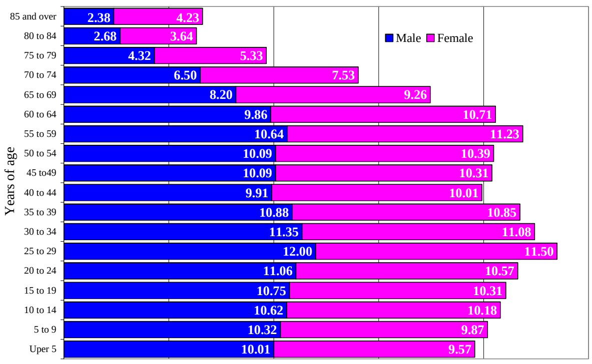

Fig. 5. The resident population of the United States by sex and age in 2019 (in millions).
Source: official data of the Global Innovation Index Database [9].

The population of the United States continues to grow, and the country ranks third in the world in terms of population after China and India. The gender distribution remained unchanged for many years, with the number of women slightly exceeding the number of men. In terms of where the residents live, California was the state with the highest population in 2019.

The United States is known worldwide for its diverse population. In 2019, the number of blacks or African Americans was estimated at 44 million, which is four million more than in the 2010 census. The population of Asia has also increased at the same rate over the same period of time. The Latin American population in the United States continues to grow, and in 2019, approximately 18.5% of the total population belonged to this ethnic group.

People aged 40-59 are the largest age group in Germany - 23.6 million people. The latest data for 2019 confirm that the next largest age group was 65 years and older - 18.09 million people (Figure 6).

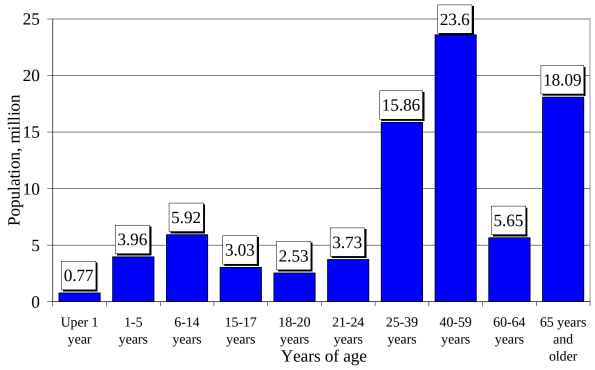

Fig. 6. Population of Germany in 2019, by age group (in millions).
Source: official data of the Global Innovation Index Database [9].

As the number of older people is significantly higher than the number of young people, in recent years it has become clear that Germany's population is aging faster than it is developing. In fact, data on the age structure in Germany for the decade ended 2017 show a steady trend towards a slow increase in the proportion of the population over the age of 65. Meanwhile, the share of the population aged 0 to 14 is declining, which is also reflected in fluctuations in the national birth rate in recent years.

Currently, the total population of Germany is 82.79 million people. Although an increase in this number is projected, the same applies to the age group of 65 years and older. This means that the country's population will continue to age.

The second part of the GII Human capital & research component is research. Therefore, the educational aspect should be considered.

In France, in order to reform research and educational institutions, a policy was pursued to develop cooperation between higher educational institutions – universities and research structures (Poles of Scientific Research and Higher Education – PSRHE), located in the same geographical area, in order to combine efforts in certain scientific areas and efficient use of the resources at their disposal. In this way the PSRHE “Sorbonne – Universities”, “Paris – science and literature of Latin Quarter” appeared. Much attention was paid to the integration of universities in the life of the territory where they are located. Representatives of territorial authorities sit on the administrative boards of universities, influence the development of university policy, participate in the reconstruction of university buildings and dormitories, allocate scholarships, and finance research. In turn, the university seeks to adapt the education it provides to the needs of the local labor market [10].

All living conditions for a comfortable stay have been created for students, from hostels to fares. For example, in the city of Grenoble and its district, where are, according to various estimates, from 80 to 100 thousand students per year, mostly foreigners, a system of affordable hostels has been created: these are not only traditional hostels in our understanding, but also modern residence apartments in which are rented only to university students. A public transport ticket for students is cheaper than for young children.

Higher education in Ukraine is the choice not only of promising Ukrainian youth, but also of many students from neighboring countries and Asian countries. Most of all students come to Ukrainian universities from Turkmenistan, Azerbaijan, India, Nigeria, China, Iraq and Russia. And the most demanded areas of training in Ukraine for foreigners are medicine, economics, law, engineering and aviation.

Despite the fact that European universities are traditionally considered an indicative example of the high quality of education, in recent decades there has been a tendency to strengthen the position of Ukrainian universities in the list of the best educational institutions in Europe. And although there are only 6 of them so far, while 203 universities have been issued a license to accept foreigners, there are prospects for getting an education in Ukraine, but there is already a European level, which is used by the majority.

At the moment, the education system of Ukraine is undergoing significant changes, which contributes to an increase in its prestige and demand for knowledge gained during training. In addition, education received in Ukrainian universities is recognized today in many countries of the near abroad, where specialists with knowledge of Ukrainian and Russian, in addition to their state language, are in great demand in the labor market.

There are also a number of more prosaic advantages that higher education in Ukraine offers, namely:

- having your own home saves costs;
- the familiar environment and language of teaching, as well as the absence of the need for a break;
- social contacts reduce stress from the transition to a new stage of life;
- lower study fees than in foreign Universities makes higher education more accessible;
- double degree programs offered by some universities help to obtain an international diploma without going abroad.

The headcount enrollment for the 26 institutions of the University System of Georgia (USG) in Fall 2019 was 333,507, representing an increase of 1.5 percent – or 4,795 students – over the Fall 2018 enrollment of 328,712, according to USG’s Fall 2019 Semester Enrollment Report. This continues a six-year trend of modest increases in student enrollment within USG. This fall also marks the fifth consecutive year of growth to reach an all-time high in the number of students enrolled in USG institutions (Figure 8).

Meanwhile, enrollment patterns varied by institution across the USG. Headcount enrollment grew by 3.8 percent in research universities and 1.8 percent in comprehensive universities. Enrollment declined by 1.2 percent at state universities and 2.5 percent at state colleges. Enrollment increased at 11 institutions, while 13 had a decline and 2 were relatively flat.

Dual enrollment increased by 203 from 12,394 in Fall 2018 to 12,597 in Fall 2019, an increase of 1.6 percent. Most of this growth occurred at the comprehensive and state universities. This is the smallest fall-to-fall increase in dual enrollment since Fall 2015.

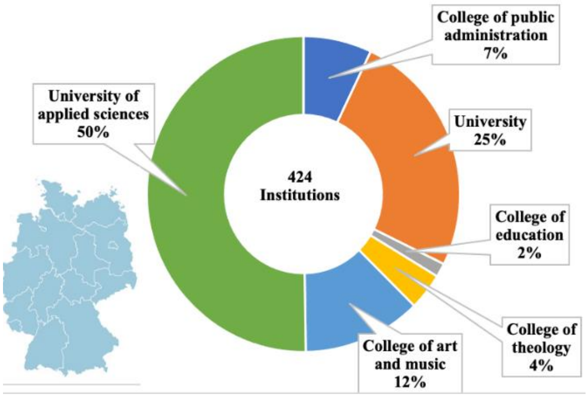

Fig. 7. Higher education institutions, by types and Länder (Germany)
Source: official data of the Global Innovation Index Database [9].

Taking into account the low percentage of young people, Germany is open to international students. Germany is becoming a very popular study destination standing alongside the US, the UK, Canada and Australia. Consequent to this high attractiveness the country has reached its long-term of welcoming 350,000 international students, by 2020, three years earlier in 2017.
In 2017, there were 4,313 higher education institutions in the United States. This is less than in 2015, when there were 4,583 higher education institutions in the country. In the United States in 2019, there are about 5,300 colleges and universities (Figure 8).

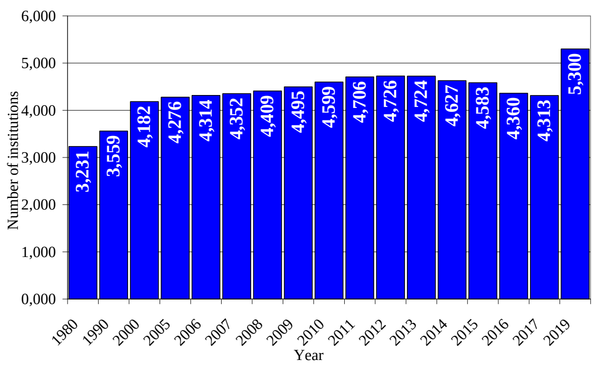

Fig. 8. Number of higher education institutions in the U.S.
Source: official data of the Global Innovation Index Database [9].

Higher education in the United States refers to the country's colleges and universities. The United States has some notable differences in higher education compared to the rest of the world, including NCAA sports, Greek living, and high attendance costs. However, the vast majority of the world's best universities are located in the United States. Some of these universities include eight Ivy League schools, the Massachusetts Institute of Technology and Stanford University.
The cost of universities in the United States has risen significantly over the past few decades. As a result of such a high cost of education, students began to take exorbitant student loans. Both the federal and state governments have reduced funding for public schools, but compulsory spending on higher education is expected to increase in the next few years. In 2017, California had the highest level of higher education spending by state and local governments. California also has the largest number of higher education institutions in the country.
Comparative data on the level of digitalization of the economy and society as a whole in different countries, which are contained, in particular, in the global digital competitiveness rating are also of great interest [10]. The comparative assessment of countries in this ranking is carried out by their ability to perceive and effectively use digital technologies as a means of ensuring the transformation of regulatory practices, business models and society as a whole. The comparative assessment of countries in this ranking is carried out by their ability to perceive and effectively use digital technologies as a means of ensuring the transformation of regulatory practices, business models and society as a whole. This assessment is carried out on the basis of three complex factors that have received such generalized names: knowledge, technological environment, openness to the future. Each of these factors is further broken down into three sub-factors, which, in turn, are detailed using six indicators. The knowledge factor is understood as a system of knowledge necessary for the discovery, understanding and creation of new technologies and which are divided into the following three sub-factors: talent, education and retraining, scientific concentration. The technological environment factor is subdivided as a sub-factor into regulatory framework conditions, capital and technological framework

conditions. The openness of the future is detailed using the sub-factors of adaptability, business agility and IT integration.

In 2019, the United States held the number one spot in the rankings, with all five of the country's top economies unchanged: the US, Singapore, Sweden, Denmark and Switzerland. The top 5 share a common thread of terms with their focus on knowledge generation, but they all had different approach to digital competitiveness. The US and Sweden take a balanced approach between generating knowledge, creating a supportive environment for technology development and a willingness to do so to embrace innovation. Singapore, Denmark and Switzerland give priority to one or two factors. In the Top 10, the Netherlands, Hong Kong South Africa and South Korea moved up (to 6th, 8th and 10th respectively), while Norway dropped to 9th and Canada fell from 8th to 11th.

The IMD World Digital Competitiveness Ranking presents the 2020 overall rankings for the 63 economies covered by the WCY. The rankings are calculated on the basis of the 52 ranked criteria: 32 Hard and 20 Surveydata. The countries are ranked from the most to the least digital competitive and the results from the previous year's scoreboard (2019) are shown in brackets. The index value or "score" is also indicated for each country.

Among the studied countries, the United States consistently ranks 1st place, Germany is in 18th. Ukraine improved its performance by 2 positions and took 48th place in 2020. Georgia is not yet included in this rating, which indicates the need to improve and develop the direction of digitalization.

Fig, 9. Digital competitiveness ranking
Source: official data of the IMD World Digital Competitiveness Ranking [19].

In 2020, USA held the top position for the third consecutive year. Singapore held the 2nd spot, while Denmark overtook Sweden to claim 3rd place. Hong Kong climbed three ranks to 5th, and Switzerland dropped one place to claim the 6th spot. 2020 has been a challenging year for the world. Every aspect of our lives has been affected by COVID-19 and technology has been incorporated to address the pandemic in different dimensions from communication to monitoring, assessing and, hopefully in the non-distant future, finding a cure for the virus.

Digitalisation in agriculture

New electronic equipment and information technology open up opportunities for the broad development of smart agriculture, which is understood as the use of strategic management using information technology, obtaining data from various sources for decision-making related to agricultural production, market, finance and people.

Smart agriculture is a modern concept of agricultural production, based on the introduction of new technologies: geographic information systems, satellite navigation, digitalization of agricultural production processes that increase productivity and quality while reducing costs.

An example of the digitalization of the agricultural sector in Ukraine is the digital agribusiness transformation project #DigitalAgriBusiness, launched by Kernel Company in 2016 to ensure growth and efficiency by digitizing crop production based on BigData. It was noted that if the digitalization of grain growing is a project for the whole country, it will increase production in Ukraine from the current 60 to 85 million tons and increase exports from 36 to 63 million tons (ROI=30-90%).

Farmers and producers must have effective adapted technologies, calculate the costs of growing crops and raising livestock in advance, program the level of yield and calculate the cost of production. Only in this case they will be competitive with other domestic and foreign manufacturers.

Smart agriculture has been practiced in the United States, Japan, Western Europe (Germany, England, Holland, Denmark) and China since the 1980s, while in Eastern

Europe since 1990. It is currently experiencing a real boom in South America, particularly in Brazil, due to rapid economic growth and the desire to reduce production costs.

Digitalization and mechanization are becoming part of Georgia's agriculture as more and more producers invest in precision farming technology. Georgian companies are contributing to this process by building an agricultural business, where almost every decision is based on the analysis of data obtained using digital tools directly from the field. In the next few years, the companies plan to develop the entire value chain and become a provider of consulting services for others.

Smart agriculture has become possible in those countries where the material, technical and economic base has been formed, as well as trained specialists in the field of information technology. World experience shows that work on the introduction of new technologies is successful where groups of scientists and practitioners of various specialties are created: soil scientists, agronomists, livestock breeders, engineers, economists and programmers (Table 7).

Table 7. The use of smart agriculture in advanced countries

Used forms of smart agricultural				
USA: 80% of American farmers use various precision farming technologies with high efficiency and profit	Germany: More than 60% of farms use this technology, both small farms and large enterprises	The Netherlands and Denmark: Precision farming is used to reduce feed costs for the livestock industry	Japan: plant growth models are used, as well as combines with automatic control, robots are operating	Brazil: Precision farming introduced 60% of agricultural land, with 11% increase in sown area, 10% increase in grain yield

Source: systematized by the author's based on research.

Smart farming, or precision farming, was originally associated only with precision farming, but in recent years precision farming has evolved into dynamic livestock – precision farming and its industries: precision dairy farming, precision pig farming and precision poultry farming.

Precision farming is a differentiated management of agricultural operations that provides constant control, reliability and reproducibility in agricultural production, which helps reduce costs, variability and increase predictability of results.

If we collected the top 10 innovations without which there could be no precision farming, it would look like this: satellite navigation systems, mobile devices, robotics, irrigation systems, Internet of Things, sensors, variable seeding rate, weather change monitoring, nitrogen monitoring in the soil, standardization.

Integrated precision farming is based on three components: informational, technological and scientific (Table 8).

Table 8. The main elements of precision farming

Basic elements of precision farming		
Information: yield characteristics, soil properties, requirements for fertilizers and plant protection products, yield data	Technology: traditional, intensive and innovative	Scientific management: combining the received information and available technologies into a holistic system

Source: systematized by the author's based on research.

Only through the use of precision farming did they become broader, more detailed and take into account all the many factors that affect crop yields: weather conditions, soil, its characteristics, including acidity, fertilizers, terrain, landscape, seeds, soil preparation technology sowing, sowing, planting and harvesting, differential fertilization, pest, weed and disease control chemicals and other factors. In general, the technology of precision farming includes the following stages of work:

- creation of an electronic field map;
- formation of a database by fields by area size, yield, agrochemical and agrophysical properties, level of plant development, etc.;
- conducting analysis using applications and issuing recommendations for decision development;
- download commands for decisions in the device on agricultural units for differentiated agricultural operations.

Appropriate technical means are required for the introduction of precision farming

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technology:
- satellite navigation system that allows getting accurate information about the location and speed of any object;
- electromagnetic, infrared, ultrasonic sensors used to determine various parameters: grain yield, mineral content in the soil, its moisture, density, hardness, amount of biomass and type of weeds;
- modern on-board computer as a multifunctional information and control system that collects information recorded by sensors and stores it on a memory card, combined with electronic processors of agricultural machinery and implements;
- geographic information system (GIS) that serves to output information collected by sensors in a readable form.

GIS provides a cartographic component of the system of precision farming. GIS is based on multilayer terrain maps with the possibility of rasters (images, scanned maps, etc.) of vector maps (topographic base, field maps, thematic maps, etc.) and matrices (relief surface, soil quality, productivity, etc.). The maps are used to record agricultural land, agrochemical monitoring, visualize the movement of equipment and display the status of monitoring objects.

Precision farming system ensures safety, speed limits and targeted transport, optimize routes, control fuel consumption, improve the quality of technological operations, reduce operator fatigue, increase operator speed, reduce overlap and reduce production costs, operational collection and analysis of weather data, reduction the cost of mineral fertilizers and their rational use, as well as improving product quality.

In the new economic environment, increasing agricultural production and improving its quality can and should be ensured through lower specific consumption of resources. That is why saving resources and energy is considered one of the most effective ways to increase the efficiency of agricultural production. In this case, the most significant effect can be achieved by saving resources (fertilizers, pesticides, seeds, fuels and lubricants), reducing or replacing technological operations. As the analysis of the conducted researches shows, the maximum efficiency from realization of exact agriculture is reached at differentiated performance of all basic technological operations: tillage, sowing, fertilization, care of plants, harvesting.

In addition to reducing costs and increasing yields, precision farming allows equalizing the physical and agrochemical properties of the soil, the field acquires the correct shape, convenient for agronomic operations. In addition, differentiated feeding, where necessary, minimizes the impact on the environment. This is why the technology has become so widespread, especially in Europe.

A separate issue for identifying and obtaining efficiency, as well as benefits, should be considered a new system of production management when using technology with navigation equipment. Space and aerial photography opens up many new things for production management and not only provides an opportunity to increase crop yields. They present a visual picture of the condition of plants, field boundaries, operation of equipment, it's movement and show other important data. Precision farming technologies allow obtaining reliable information with the help of various remote sensors, for example, on the moisture content in the soil, the distribution of nitrogen fertilizers. The color of the plant mass and its condition can predict the yield of agricultural plants, determine the weediness of fields. Aerospace photography is especially important during periods of intensive sowing and harvesting. New technologies of precision agriculture allow managing production in a different way (Figure 10).

Fig. 10. Example of a cyberphysical system.
Source: systematized by the author's based on research.

If the digitalization of grain growing is a project for the whole country, it will increase production in Ukraine and Georgia by about 50% and increase exports by 53%.

Agricultural science and practice of agriculture, agricultural engineering should take into account global trends and achievements in agricultural engineering, which aim to reduce the specific energy costs of agricultural production and its costs (Figure 11.).

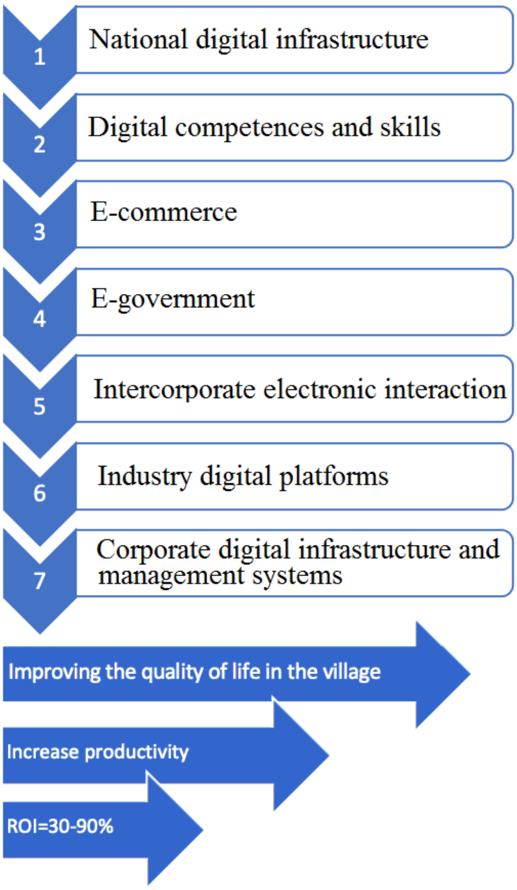

Fig. 11. The scheme of the process from the transformation of the object to the digitalization of the industry, related industries and the economy.
Source: systematized by the author's based on research.

Smart dairy farming is the use of technology to measure the physiological characteristics of the behavior and productivity of individual animals to improve farm management. In animal husbandry, there are RFID tags introduced to animals ensure the implementation of veterinary protocols, automatic collection of information about the work with livestock, while providing an individual approach to each unit of livestock.

Examples of precision or so-called smart dairy farming technologies include automatic milking machines, automatic calf feeding stations (feeders), automatic health monitoring for signs of illness, prevention of calving time and lameness. The use of these technologies is a great opportunity for dairy farming to improve farm management. Technological advances provide comfort and health to cows and improve the quality of life of farmers.

Autodrinker. Assessment of environmental conditions automatically allows determining the required amount of water. An automated drinking system frees up a significant amount of staff for more important work.

Automatic supply lines. It is possible to calculate the individual need for food for an individual. The feeding process can be increased to the recommended 6-8 times. In case of refusal of manual feeding, additional costs are not included in the cost of milk.

Integrated herd management system. Wi-Fi or 3G is used to monitor the herd. If something happens to the animal, the breeder receives an email with a recommended list of procedures for the animal within a month. In the near future, it is planned to switch to NFC tags to identify the animal and find out all the information without expensive scanners using tablets and smartphones.

Health and reproduction monitoring system. It is able to detect decreased appetite in individuals and reduce possible losses. It is also able to detect the onset of heating in cows for which acceleration sensors are used.

Shepherd robot. A team of engineers from the University of Sydney has created a four-wheeled semi-autonomous car that will be able to control its actions in the future. Thanks to 2D and 3D sensors, as well as GPS, the device determines where animals need to graze. One of the important qualities of a shepherd robot is speed: it is designed to move at the same pace as cows. The price of this work was announced at 1 million Australian dollars.

Precision farming, with the use of geographic information systems equipped with global positioning sensors, on-board computers, control mechanisms capable of differentiating agricultural technologies depending on the soil cover, is a new stage in the development of agriculture. Precise animal husbandry is a new direction in animal husbandry, based on the introduction of digital technologies that allow individual care of animals based on the latest technologies for measuring the biological condition of animals.

CONCLUSIONS

For most countries the responses of our survey were acquired during the first wave of COVID-19. To be clear, the questions we ask do not refer specifically to issues related to the pandemic. Still, if technology is the most important tool in our battle against the pandemic, some of the trends we identify have an added significance. For 2020, economies that top our ranking focus on building their talent pool and thus strengthen the knowledge infrastructure necessary to develop and employ digital technology with Singapore, Switzerland, and the Netherlands holding the top three positions respectively.

In addition, most leading economies in our ranking provide an effective regulatory framework that enables the development and introduction of technologies. Singapore, Norway, UAE and Denmark capture the top four places in this sub-factor.

Finally, top performers in digital competitiveness also combine individual adaptability with business agility in their economies. The Republic of Korea, Denmark and the USA excel in the dimension of individual adaptive attitudes while Taiwan-China, the USA, the Republic of Korea and China capture the four highest places in the area of business agility. The traditional economy is strongly influenced by the electronic component of business relations, generates progressive forms of business processes, under the influence of which not only the structure of market entities changes, but also the technology for managing them. However, in the process of optimizing business processes, it is important to adequately assess the specifics of the introduction of digital technologies into business processes, and the current level of efficiency of their application is also potentially possible. The development of digital business processes at enterprises in Georgia and Ukraine will be facilitated, firstly, by the training of qualified personnel specializing in electronic communications; secondly, the development of new services for convenient delivery of online orders covering regions; thirdly, the development and improvement of electronic payment systems; fourthly, optimization of business processes in the field of logistics and sales.

Despite serious positive transformations in the field of digitalization, there are a number of relevant and significant unresolved industry problems:

- high costs at an early stage of information systems operation;
- high transaction and transformation costs associated with the transition to the use of digital technologies by all economic agents;
- disproportions between the industry's demand for highly qualified specialists and the training of relevant educational institutions that form professional competencies, which causes a shortage of professional personnel;
- lack of unified standards, technical regulations and relevant legal norms governing relations in the field of digital technologies;
- insufficient level of protection of digital technologies from unlawful encroachments.

Summing up the study, we can conclude that the digital economy in Ukraine and Georgia, despite a number of existing problems, is developing dynamically. Organizations in various sectors of the economy are beginning to actively implement digital solutions, taking into account the specifics of their activities. Innovations act as an engine of economic development, therefore, attempts are being made to find and create the most appropriate forms of organizational associations of innovatively active enterprises, alliances within which strong cooperative ties can be created. It becomes quite obvious the need for large-scale cooperation and coordination in the form of network interaction by participants in the innovation process, which provides them with a useful effect and corresponding competitive advantages.

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OPTIMIZATION OF SOIL POLLUTION MONITORING METHODS BY USE OF BIOLOGICAL TESTS

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Abstract

Among all the environmental factors, soil is the most stable component, due to its solid physical state. Soil is the basis of all food chains and terrestrial biodiversity. Therefore, a clean, unpolluted soil means reversing the decline of biodiversity, providing healthy agricultural raw materials, protecting human and animal health, etc. Pesticides are a broad group of chemicals commonly used in agriculture. Even though the impact on crop production is obviously profitable, pesticide residues are a common cause of soil pollution, especially in developing countries. Higher plants are recognized as excellent genetic models to detect environmental mutagens and are frequently used in environmental pollution monitoring studies. The objective of this paper was to determine the potential of the species Allium cepa to be used in biological tests for monitoring environmental pollution with herbicides. For this purpose, the biological material consisting of meristematic roots of A. cepa was exposed for 24 hours to the treatment with different doses of two types of herbicides, namely: 0.125, 0.200, 0.250 g/L for Pendimethalin and 0.225, 0.250 and 0,300 g/L for Aclonifen respectively. The obtained results show the sensitivity of the species A. cepa to the tested herbicides by the drastic reduction of the mitotic activity in the cell cycle and by the appearance of a large number of chromosomal aberrations in the mitotic cells. From this point of view, the use of the Allium biological test can contribute to optimization of the methods of monitoring the chemical pollution of soil with herbicides.

Key words**:** *pesticides, toxicity, soil, A. cepa, monitoring*

INTRODUCTION

The agri-food strategy of any country is determined by the need to establish guidelines for the sustainable biotechnological development of the agricultural system and the rural area, as a guarantee of achieving the objective of the population well-being [7, 8].
In the context of current climate changes, the increase in agricultural productivity, the sustainable protection of crops, but also the reduction of food waste represents important elements of ensuring sustainable food security [5, 6, 13, 14, 21].
In agriculture, pesticides are commonly used to obtain higher quality products and increase the production rate. Pesticides used in agriculture are organic compounds with low molecular weight and different solubility in water. The chemical character, shape and molecular configuration, solubility in water and polarity of the molecule can greatly influence the adsorption-desorption processes on soil colloids.
Apart from their beneficial effects, the pesticides are toxic substances. They residues remain in the atmosphere, being dangerous at the local and global level, for the health of ecosystems and the human population. Many studies using different biological tests have demonstrated the strong cytotoxic and genotoxic effects of herbicides, insecticides and fungicides [9, 17, 19, 20].
Pesticides lead to the generation of reactive oxygen species, such as hydrogen peroxide, superoxide and hydroxyl radicals. Since pesticides, which are widely used in agriculture are potentially carcinogenic, the need to expand the genotoxic evaluation of these chemicals by using different test systems becomes crucial.
The intensive use of pesticides has many side effects: environmental pollution, biological imbalances and even affecting the health of

consumers, as a consequence of the pollution of soil, water and agricultural products. In genetics, genotoxicity describes the property of chemical agents (including pesticides) to produce various nuclear and chromosomal aberrations in cells and the production of mutations.

The pesticides are usually metabolically activated by plant peroxidases [11]. In soil, pesticides undergo some chemical transformations following the reactions with organo-mineral compounds of the soil. The physical and chemical properties of the soil are the most important factors that influence the chemical transformation of pesticides in soil. Numerous studies emphasize the role of soil microorganisms in the decomposition of pesticides, as well as the fact that there are few active substances that are not biologically degraded. Many pesticides are degraded in soil if a certain microbial culture medium or certain adjuvants, products that retain or degrade pesticides, are administered. There are also agricultural plants, such as sorghum and sugar cane which have the ability to decontamination the soil of pesticide residues through absorption and metabolic degradation. The EU has a complex legislation on chemicals, which has created the most advanced knowledge base in this field worldwide, and has established scientific organisms that carry out risk and hazard assessments of chemicals. The biomonitoring studies of the soils in EU indicate the presence of an increasing number of different dangerous chemical substances and therefore, the optimization of soil but also water and air monitoring methods is a very topical objective. One of these methods is the use of biological tests to determine the degree of soil pollution with chemical substances, such as the herbicides used to weeds control in agriculture. Plants are effective indicators for the detection of genotoxicity of chemical compounds and for in situ monitoring of genotoxic environmental contaminants.

The use of plants as test systems to assess the effects of pesticide soil pollution has many advantages related to: reproductive nature, the possibility of being applied in vivo, in vitro and in situ; standardization of the controlled method under laboratory conditions, which does not require large sample volume, extraction procedure or previous isolation, ethically suitable compared to animal tests and low cost, especially valuable in developing countries [4, 12]. From this point of view, the *Allium cepa* species is one of the most used in cytogenotoxicity tests of various pesticides or heavy metals in plant and animal systems [16, 18].

MATERIALS AND METHODS

For this experiment, we used onion bulbs as biological material, which were processed in according of the cytogenetic protocol, to obtain meristematic roots. Also, two herbicides were used for testing: Pendimethalin and Aclonifen respectively (Figure 1 and Figure 2).

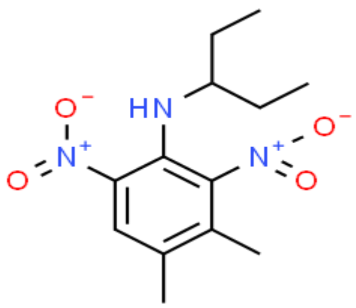

Fig. 1. Pendimethalin chemical structure
Source: [15].

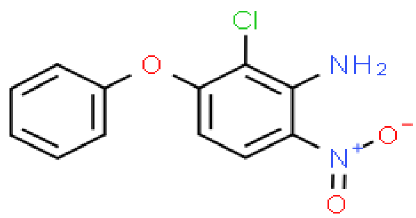

Fig. 2. Aclonifen chemical structure
Source: [1].

Pendimethalin is an herbicide of the dinitroaniline class used in premergence and postemergence applications to control annual grasses and certain broadleaf weeds. Its cytotoxicity has been demonstrated in many studies, both in plants and in animals [2, 3].

Aclonifen is a diphenyl ether herbicide which has been used in agriculture since the 1980s. Its mode of action has been uncertain, with

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evidence suggesting it might interfere with carotenoid biosynthesis or inhibit the enzyme protoporphyrinogen oxidase. This herbicide causes a bleaching phenotype to plants [10].
For this experiment, 10 healthy medium-size white onion bulbs were germinated in tap water for 72 hours, until the meristematic roots reached a length of 1-1.5 cm. The vegetal material was then transferred for 24 hours postincubation in the herbicides solutions, consisting of 3 experimental doses for each of the two herbicides, together with an untreated control, namely: 0.125, 0.200, 0.250 g/L for Pendimethalin and 0.225, 0.250 and 0.300 g/L for Aclonifen respectively.
After expiration of the treatment time, the meristematic roots were measured for the growth inhibition test and then, the biological material went through the stages of fixation, hydrolysis and staining with Schiff's reagent, after which the temporary microscopic preparations were prepared (according to the squash method) for microscopical analysis. The cytogenetic determinations concerned the mitotic index (MI) and the percentage of chromosomal aberrations (CA). The MI, characterized by the total number of cells in mitotic division in the cell cycle, has been used as a parameter to evaluate the cytotoxicity of different chemicals. Cytotoxicity levels of chemical stressors (such as pesticides) can be determined by increasing or decreasing MI. The percentage of chromosomal aberrations results from the total number of cells with aberrant chromosomes compared to the total number of cells in division. During the experiment, 500 cells were counted for each variant. The used microscope was Optika B-383 PL, equipped with photo camera. For the statistical comparison of the results, ANOVA analysis of variance and Duncan test were used ($P < 0.05$).

RESULTS AND DISCUSSIONS

The treatment of the biological material with three doses of the herbicides for 24 hours had different effects on meristematic growth as well as on the mitotic index to *A. cepa* (Table 1).

Table 1. Results regarding the mitotic index and root growth to *A. cepa* exposed to some herbicides

Herbicide/ Doses (g/L)		Mitotic index (%)±SD	Average length (cm) ± SD
Pendi-methalin	Ct	59.6±0.7a	2.3±0.05a
	0.125	43.2±0.5a	2.1±0.07b
	0.200	36.4±0.8b	1.9±0.09c
	0.250	21.5±0.4c	1.5±0.03d
Aclonifen	Ct	48.1±0.2a	2.1±0.05a
	0.225	33.2±0.5b	1.7±0.08b
	0.250	25.4±0.3c	1.5±0.04c
	0.300	11.3±0.1d	1.3±0.02d

Note: Means with the same letter do not differ statistically at the level of 0.05.
SD=Standard deviation
Source: Own calculation.

The sensitivity of *A. cepa* to Pendimethalin herbicide action can be observed through the effects of inhibiting meristematic growth, compared to the untreated control, respectively reduced of the mitotic activity, through the decrease of MI, in direct correlation with the Pendimethalin concentration.

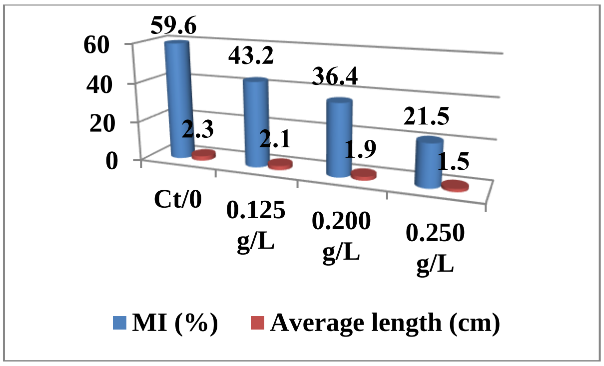

Fig. 3. The decrease of the mitotic index and the inhibition of meristematic growth in *A. cepa* roots exposed to different doses of Pendimethalin
Source: Own design and calculation

The MI value was between the limits of 59.6% (Ct) and 21.5% in the case of the variant exposed to dose of 0.250 g/L herbicide. Regarding the meristematic growth, the average length value was between the limits of 2.3 cm (Ct) and 1.5 cm in the case of the variant exposed to dose of 0.250 g/L herbicide (Figure 3).
The effect of Aclonifen on mitotic activity and meristematic growth in *A. cepa* was somewhat similar to that produced by Pendimethalin. It can be observed, however, that the effect of mitodepression as well as that of marked inhibition of meristematic

growth, compared to the control variant, were more pronounced in the case of this herbicide, but the treatment doses were also higher.

As can be seen in Figure 4, the MI value was between the limits of 48.1% (Ct) and 11.3% in the case of the variant exposed to dose of 0.300 g/L Aclonifen.

Regarding the meristematic growth, the average length value was between 2.1 cm (Ct) and 1.3 cm in the case of the variant exposed to dose of 0.300 g/L herbicide.

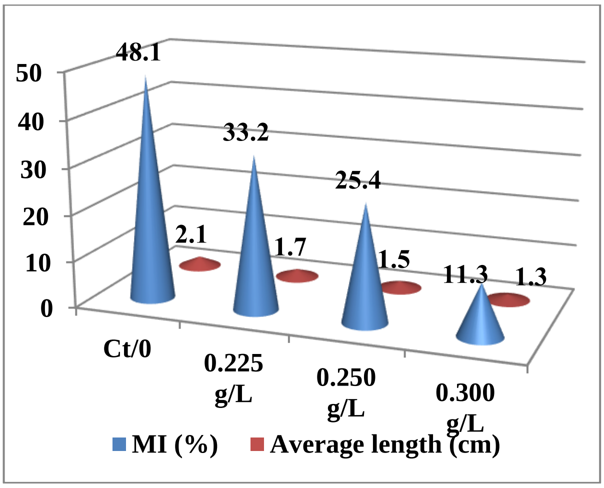

Fig. 4. The decrease of the mitotic index and the inhibition of meristematic growth in *A. cepa* roots exposed to different doses of Aclonifen
Source: Own design and calculation.

To quantify chromosomal aberrations, all phases of the mitotic division were evaluated: prophase, metaphase, anaphase and telophase. This analysis allows a much more precise assessment of cell damages, as a result of clastogenic or aneugenic effects on the tested biological material.

The cytogenetic results regarding the evaluation of the types and frequency of chromosomal aberrations identified in the meristematic cells of *A. cepa* exposed to the action of the Pendimethalin and Aclonifen herbicides are highlighted in Table 2.

Several types of chromosomal aberrations were identified through microscopic analysis, the most common being stickiness, vagrant, laggard and ring chromosomes. Sticky type aberrant chromosomes had the highest frequency and ring type chromosomes had the lowest frequency (Fig. 5).

Table 2. Results regarding the chromosomal aberrations to *A. cepa* exposed to some herbicides

Herbicide/ Doses (g/L)		**CA (%)**				
		S	**V**	**L**	**R**	Total CA± **SD**
Pendi-methalin	Ct	1.4	0.3	0.3	0.1	2.1±0.55a
	0.125	3.2	1.8	3.9	0.9	9.8±0.25b
	0.200	4.8	2.1	3.3	2.5	12.7±0.11c
	0.250	6.1	3.2	3.4	3.6	16.3±0.31d
Aclonifen	Ct	1.7	0.5	0.4	0.3	2.9±0.55a
	0.225	4.1	2.1	3.4	1.2	10.8±0.35b
	0.250	5.8	3.2	3.3	1.9	14.2±0.54c
	0.300	7.1	2,6	4.8	4.1	18.6±0.26d

Note: Means with the same letter do not differ statistically at the level of 0.05.
CA=Chromosomal aberrations; S=Sticky chromosomes; V=Vagrant chromosomes; L=Laggards chromosomes; R=Ring chromosomes; SD=Standard deviation
Source: Own calculation.

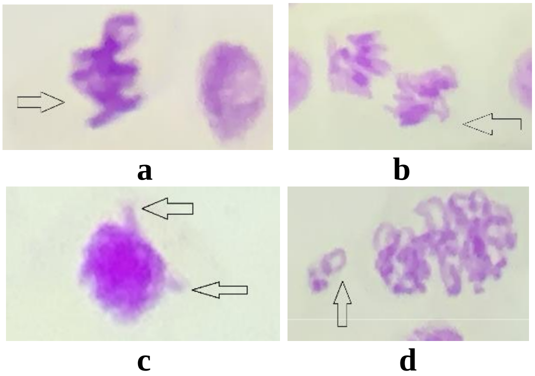

Fig. 5. Some chromosomal aberrations induced by Pendimethalin and Aclonifen herbicides in *A. cepa* cells: sticky chromosomes (a); vagrant chromosomes (b, c); ring chromosome (c)
Source: Own cytogenetic pictures

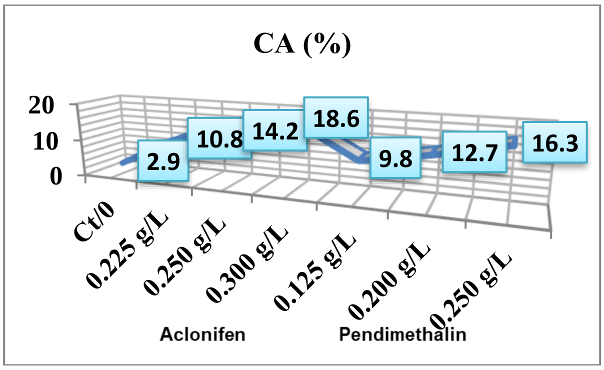

Fig. 6. Total chromosomal aberrations (CA %) induced in *A. cepa* roots after exposure to different doses of Aclonifen and Pendimethalin herbicides
Source: Own design and calculation.

The frequency of total chromosomal aberrations (CA%) recorded values between 2.1 and 2.9% in case of the control variants and respectively 16.3% and 18.6% in case of the highest doses of Pendimethalin and Aclonifen herbicides (Figure 6).

CONCLUSIONS

Higher plants are recognized as excellent genetic models to detect environmental mutagens and are frequently used in environmental pollution monitoring studies. In this context, *A. cepa* can be used to evaluate chromosomal aberrations and mitotic cycle disorders but also to evaluate the toxicity of many chemical agents.

The sensitivity of *A. cepa* to tested herbicides action was suggested through the inhibition of the meristematic growth, reduction of the mitotic activity by the decrease of mitotic index and appearance of several chromosomal aberrations respectively.

Reduction of the mitotic index and chromosomal aberrations appearance in the meristematic cells is an important indicator in environmental pollution monitoring, especially for the assessment of contaminants with toxic and cytotoxic potential. Therefore, the biological *Allium* test has potential for estimating, to a certain degree, the chemical pollution level of the soil.

The aneugenic and clastogenic effects of the tested herbicides can be much more significant, but not noticeable with the means of study in this case.

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TRENDS IN THE EVOLUTION OF ORGANIC AGRICULTURE AT THE GLOBAL LEVEL - A BRIEF REVIEW

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Abstract

Organic agriculture is a production system that supports the health of soil, ecosystems and consumers, combining tradition, scientific research and innovation, promoting fair relationships and a better quality of life, in a way that ensures equity at all levels and for all involved in the agri-food chain: farmers, processors, distributors, traders and consumers. Therefore, ecological agriculture means respect for people and for nature. In this context, the objective of this paper was to briefly evaluate the trends of organic agriculture sector at global level, in the context where the development of this system is motivated by the increasing demand of consumers for food quality and safety in consumption. Recent statistics published by the Research Institute of Organic Agriculture (FiBL), show the upward trend of organic agriculture. Thus, at the level of 2020, organically cultivated surfaces were 74.9 million hectares (with an increase of over 4% compared to 2019) and over 3.4 million producers, their number increasing with 7.6% compared to 2019. The organic food market is also continuously growing, exceeding 120 billion euros. From this point of view, USA, Germany and France are the countries with the largest organic market. Europe is the second largest and most developed organic market (52 billion euros), after Northern America 53.7 billion euros). The current decade is an organic decade, in which more and more organic food products are winning over consumers. Taking into account the upward trend of global organic agriculture, taking into account the surfaces, the number of producers and processors but also the number of consumers, it can be concluded that organic agriculture is emerging as a viable alternative for the third millennium, because, eventually, the organic agriculture means respect for people and for nature.

Key words*:* *organic agriculture, trends, surfaces, producers, organic market*

INTRODUCTION

Concerns regarding the risks of chemicals in agriculture, both in terms of consumer health and in terms of ecological effects have been manifested since the 1950s. Ensuring the food security of the population is the obligation of each state and for this, conventional agriculture is the one that takes precedence, for now in the vast majority of the world's states [8, 10]. However, this agricultural system seriously pollutes the environment and can affect the health of consumers, if some measures are not quickly taken to transition to a sustainable type of agriculture, in which new biotechnological technologies ensure food security and safety in consumption [7].

In this context, the global research is starting to find the technological options to reduce this negative impact, their results materializing in alternative agricultural systems, such as: organic agriculture, sustainable agriculture, biodynamic agriculture and permaculture, which eliminate or substantially reduce the consumption of chemical fertilizers and pesticides.

The definition of the concept of organic agriculture cannot be separated from that of agricultural ecology. Organic agriculture is a method of agricultural production with the main purpose of protecting the biosphere and the natural resources of the planet.

The techniques used in organic agriculture are based on specific objectives and principles, which ensure the harmony between the farmer and nature by maintaining and improving the flora and fauna of the soil, its natural fertility, its stability and diversity [10].

The climate changes that characterize the last decades, sometimes modify the natural conditions, and, indirectly, affect the agro-climatic requirements of the crops [18]. In this context, the sustainable management of crops and the rational use of land, the increase in agricultural productivity, the sustainable protection of crops [5, 6], but also the reduction of food waste [4, 16] become very important in maintaining agricultural potential, respecting the condition of not increasing the impact of agricultural practices on the environment and climate [17].

The alternative agricultural systems aim to maintain the productive potential of the ecosystems for as long as possible and accepting the ecological conditions, but this reduces the amount of products obtained. Currently, there are two large systems applied in agriculture that solve each separately the two variables of the food equation: quantity and permanence, but there is no system that solves both simultaneously. In these systems, the quantity of production is no longer a priority, this position being occupied by maintaining the productive potential for an unlimited duration, a fact for which they can be approached through the broader concept of sustainable agriculture.

Organic agriculture, unlike the conventional one, aims to preserve and even improve the health of consumers along with the unaltered preservation of the environment through the use of friendly technologies, which conserve soil fertility, biodiversity and also minimize global environmental issues [1, 2, 11, 14].

In every region of the globe, the action plans regarding organic agriculture aim to develop this sector by increasing production, demand and sustainability [3, 13, 15, 19].

On a global level, but especially in Europe, a strong demand has emerged for obtaining agro-food products through non-polluting technologies. The ecological sector began to develop rapidly in the world, with consumers showing a real interest in reducing the risks that agricultural practices could cause to human health and the environment [9].

Farmers from organic agriculture have as their main objective that, through agricultural friendly to the environment practices, they produce food of superior quality, with a special nutritional value and, above all, free from any danger to the health of consumers [8, 10]. However, sometime, the high distribution costs cause organic farmers to look for new strategies to maintain their economic viability. Therefore, the direct contact between the consumer and the producer, through sales at the farm gate, represents a considerable advantage for both parties, in terms of the price and the improvement of the cultural level. The creation of this perspective can contribute to the development of organic agriculture as an innovative system and model of sustainability.

According to the regulations on the packaging, labelling and free movement of organic products, the packaging of an ecological product must have a minimal adverse impact on the product itself or on the environment. The packaging of ecological products is made of biodegradable materials, which do not contaminate either the products or the environment [9].

Organic farming standards require that organic produce is not packaged in reusable bags or containers that have been in contact with any substance suspected of compromising the ecological integrity of the product or ingredient contained in those containers [8, 9, 10].

MATERIALS AND METHODS

The objective of this study was to evaluate the evolution trends of the organic agriculture sector at global level, in the context where the development of this system is motivated by the increasing demand of consumers for food quality and safety in consumption.

The topics followed were: numbers of globally countries with organic activities; organic surfaces, number of organic producers and organic market, with examples presented in graphics.

The used methods included searching of the main databases: Web of Science and Google Scholar as well as Fibl (*Research Institute of Organic Agriculture*) FAO (*Food and Agriculture Organization of the United Nations*) and IFOAM (*The International Federation of Organic Agriculture Movements*). The relevant data was transposed in graphs.

RESULTS AND DISCUSSIONS

Against the background of the some crisis regarding the contamination of food with dioxins, the mad-cow disease, the avian and swine flu, the infection of some vegetables with the enterohemorrhagic strain of the bacterium *E. coli*, as well as the fears regarding the use of genetically modified organisms, the request of agricultural products and ecological food has increased constantly.

Even if organic agriculture is currently present in most countries, the greatest demand for organic products is in Europe and North America [12].

According to FiBL data from 2022, with reference to the situation of organic agriculture in 2020, the largest areas for organic agriculture worldwide are found in Oceania, Europe, Latin America, Asia, North America and Africa, totalling 74.9 million hectares (Figure 1).

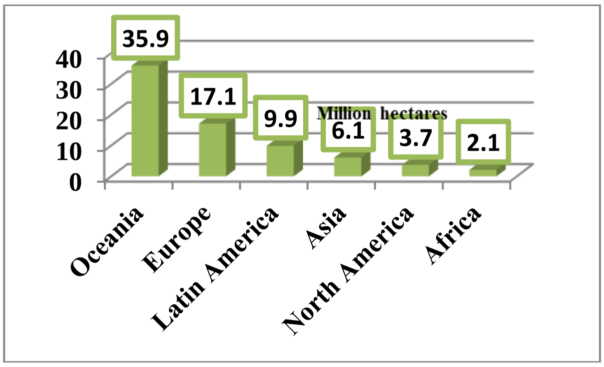

Fig. 1. The worldwide situation of organic agriculture
Source: Own design based on [9, 10].

This healthy farming system is practiced in 190 countries globally. The largest organically cultivated areas are owned by the following countries: Australia, Argentina, Uruguay, India, France, Spain, China, USA, Italy and Germany (Figure 2).

The increase in organically cultivated areas in 2020 was +4.1%, the highest values from this point of view being held by Uruguay (+28%), Argentina (+21%) and India (+16%) (Figure 3).

The number of organic producers increased by 7.6%, reaching a total of 3.4 million worldwide. The largest number of producers is in India, Ethiopia and Tanzania (Figure 4).

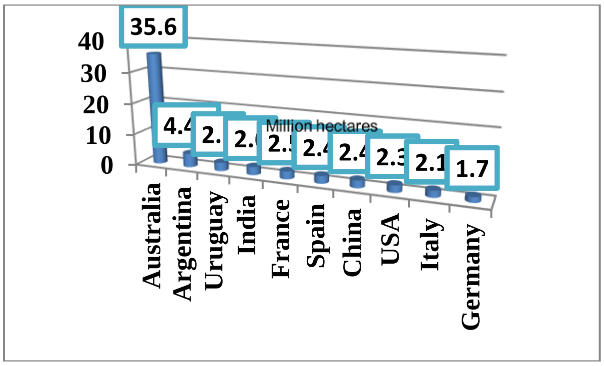

Fig. 2. Trends in the evolution of organic farmland areas at the global level
Source: Own design based on [8, 9].

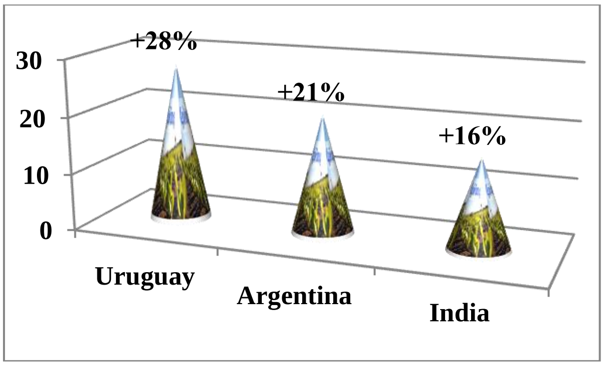

Fig. 3. Increase of organic agricultural land (2019/2020) at the global level
Source: Own design based on [9].

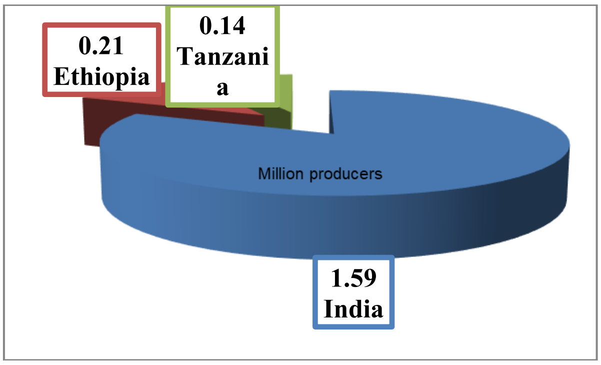

Fig. 4. The largest number of organic producers at the global level
Source: Own design based on [9].

Organic agriculture, concerned with both environmental protection and consumer health becomes more than an option; it is even a necessity, becoming a contributor to sustainable development. The area of manifestation of the consumer of organic products is represented by the contour of their specific market. The consumption needs for organic agricultural products evolve along with the economic and social development.

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The worldwide organic food market is continuously growing, exceeding 120 billion euros. From this point of view, USA, Germany and France are the countries with the largest organic market (Figure 5). This trend suggests the excellent relationship of European consumers with the organic food market. Actually, Europe is the second largest and most developed organic market (52 billion euros), after Northern America 53.7 billion euros).

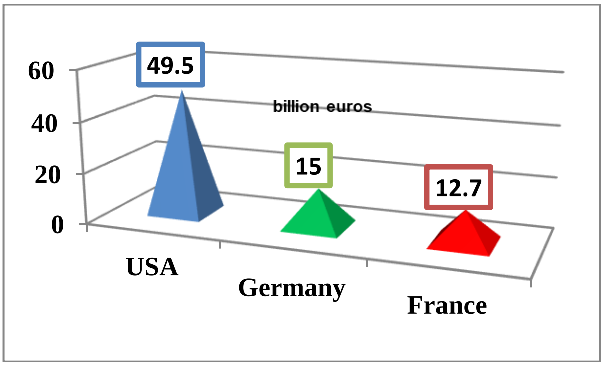

Fig. 5. Top 3 countries with the largest organic markets at the global level
Source: Own design based on [9, 10].

However, the most significant increase in the organic market was in Canada, China and Germany with percentages ranging from 22 to 26.1% (Figure 6).

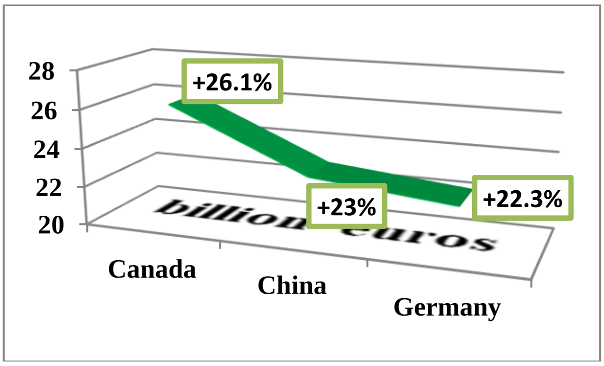

Fig. 6. The countries with the largest organic market growth at the global level
Source: Own design based on [9].

Globally, sales of organic products are concentrated in industrialized areas, due to the support received from the governments of the respective countries. At the same time, the population of many developing countries is below the poverty line, making it difficult to develop organic markets.

As of June 1, 2012, organic products certified in the EU or the US can be marketed as organic in either of these two regions. The agreement between the EU and the US means reduced taxes and red tape for companies that market the respective products. Romanian producers can export ecological products to the United States of America only with the certification obtained in Romania, which is also recognized overseas. Until this date, a Romanian producer who wanted to sell ecological products in the USA also needed the certification of an organization on the American market, i.e. a supplementary certification in addition to the one obtained in Romania.

From the point of view of the main ecological agricultural crops, the cereal crop worldwide has registered an upward trend in the last 10 years. Thus, if in 2005 1.4 million hectares were cultivated with organic cereals, in 2010 the area almost doubled (2.4 million hectares), while, at the level of 2020, the area increased to 5.1 million hectares (Figure 7).

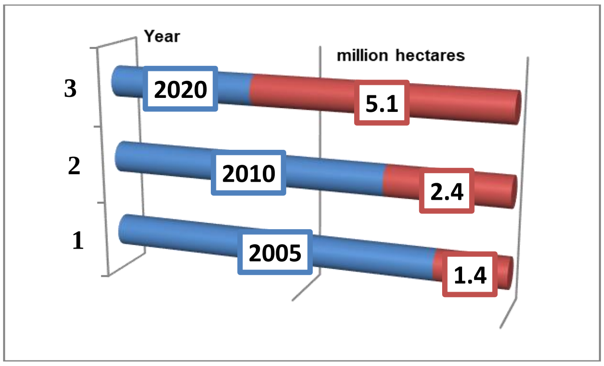

Fig. 7. Global organic grain area upward trend 2005 - 2010 - 2020
Source: Own design and calculation based on [9].

The top 10 countries with the largest areas cultivated with organic cereals are China, Germany, France, Italy, USA, Canada, Spain, Russia, Ukraine and Poland.

As far as consumers are concerned, health-related issues seem to assume greater importance than environmental protection concerns and are related to ensuring healthy nutrition, motivated by ecological and hygienic-sanitary arguments, imposed by the radical change in consumer demand and the increasingly insistent concerns for food biosecurity.

CONCLUSIONS

Organic agriculture at global level has experienced a rapid expansion, thanks to some favorable economic factors: the choice of consumers for the most natural and healthy food, the care for the environment and for the unaltered preservation of biodiversity, etc., along with economic benefits for farmers. The preference for organic food reflects an increase in the interest of consumers all over the world both for personal health and for the protection of the environment.

The largest areas for organic agriculture worldwide are found in Oceania, Europe, and Latin America. In developed countries, the organic share is quite high and growing at a double-digit rate, with demand exceeding supply.

The number of organic producers steadily increased worldwide; the largest number of producers is in India, Ethiopia and Tanzania

USA, Germany and France are the countries with the largest organic market. Europe is the second largest and most developed organic market, after Northern America.

The growth of the ecological sector also involves the concept of sustainable development, the only way to solve environmental issues that require urgent solutions.

Organic food must satisfy both quantitatively and qualitatively. Currently, although the quantity is very important, the basis is increasingly placed on the quality; consumers are oriented towards foods that contribute to the increase of the standard of living through a healthy diet, made in an ecological system. Taking into account the trends, lately the producers are moving more and more towards the practice of the organic farming system, which meets the requirements of the consumers.

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THE YIELD OF A 11 YEARS OLD SASKATOON BERRY (*AMELANCHIER ALNIFOLIA* NUTT.) CULTURE FROM ARAD COUNTY, WESTERN ROMANIA

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Abstract

Recently, in Romania special attention was given to the culture of Saskatoon berry (Amelanchier alnifolia Nutt.), a species originating from North America, whose berries are very appreciated both for their nutritional and medicinal values. The aim of this study was to highlight the yield of a culture installed in Bărzani Farm, Arad county, Romania.. The plants were produced in 2012 from seeds originating from Alberta (Canada). In the first two growing seasons the plants were kept into a nursery and specific treatments were applied. In Autumn 2013, the plants were transferred to two experimental plots, with a total area of 0.74 hectares, and a 3 m x 1 m planting scheme was adopted (i.e. 3 meters between the rows and 1 meter between the plants in the same row). Starting with 2018 different fertilizers were applied and soil analysis were performed. In most of the cases as regards the main micro- and macro-elements from the soil increasing trends were recorded thanks to the applied fertilizers. As regards the harvested quantities in the last five growing seasons, they grew from 1,250 kg (in 2018) to 6,800 kg (in 2022), meaning that, on average, each plant produced from 0.5 kg (in 2018) up to 2.7 kg (in 2022). The results recorded in the two experimental plots from Bărzani Farmrepresent an important step in the breeding program of this species in Romania.

Key words: *Amelanchier alnifolia, fruit, saskatoon, yield*

INTRODUCTION

Genus *Amelanchier* (*Rosaceae*) has a very complicated taxonomy, with about 25 species distributed across North America, Asia and Europe, cultivated for their fruits and/or thanks to their ornamental value [1], [15], [19], [27]. It includes diploids, triploids, and even tetraploids [7], and the most common species are represented by: Canadian serviceberry [*Amelanchier canadensis*(L). Medik.], snowy mespilus (*A. ovalis*Medik.), juneberry (*A.lamarckii* F. G. Schroed) and saskatoon berry (*A. alnifolia* Nutt.) [25].
Canadian serviceberrywas introduced into Europe almost 400 years ago, while *A. lamarckii* was brought in Europe around 1850, while at the end of the previous century, saskatoon berry was reported in the Baltic Region [13]. Regarding the latter species, in some regions, such as in the case of the suburban forests from Kambarka (Western Rusia), it was reported that *A. alnifolia* was an invasive species [3].
Saskatoon berry is very tolerant to site conditions, being able to grow in several soil types, with a broad range of soil reaction, starting from 5.6 up to 8.0 [24]. Thanks to its relative rusticity and its berries and beauty, *A. alnifolia* was also used in the composition of several hedgerows across Central Alberta (Canada), together with Virginia bird berry (*Prunus virginiana* L.) and two representatives of genus *Populus*, namely eastern balsam-poplar (*P. balsamifera* L.) and trembling aspen (*P. tremuloides* Michx.) [2].
Saskatoon berry can be propagated both by seeds and vegetatively, by cuttings, which is difficult, or in vitro [12]. In some cases, no differences were reported between the yields of seed propagated plants versus micropropagated plants [20]. As regards its

berries, its fruit is a small pome, 1.0 to 1.5 in diameter [21], with several uses, like its related species Canadian serviceberry [8]. The berries of both species are very rich in sugar, with an average content of 8% [14].

Moreover, it was reported that the berries of *A. alnifolia* represent a good source of bioactive components, nutrients, vitamins and other micro- and macro-elements [6], [10], [16], [17], [23], being considered to be a very healthy and useful supplement in human nutrition and medicine [4], [11], [18], [22].

As regards its fruit production, it was reported that an adult shrub is able to produce between 4,500 and almost 10,000 berries [13].

In the next years, it is expected that saskatoon berries to become an important source of organic products across Europe. In this context, both at local and regional level, professional associations expressed their need to work together to obtain as many organic products as possible. The EU actively supports the fruit and vegetable sector through its market management system. An EU Member State may also require compliance with the rules agreed within a professional organization to stimulate sustainable production [9]. However, effective regulation at European level must be uniform [26].

The aim of this research was to highlight the yield of a 11 years old saskatoon berry culture from Arad County.

MATERIALS AND METHODS

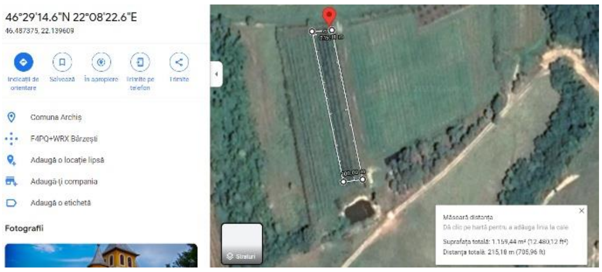
In spring 2012, seeds of Saskatoon berry originating from Alberta (Canada) were sown in the nursery of Bărzani Farm (Arad County) [5].

The young plants obtained from the seeds were kept in a nursery for two years and specific works (*i.e.* weed control works, fertilization, disease and pest control) were applied [5].

At the end of the second growing season (*i.e.* October 2013), the young plants were transferred from the nursery into two experimental plantations (Figure 1), both situated in Bărzani Farm, plot 1 being very close the nearby forest. The first planting plot had an area of 0.11 hectares (Map 1;46°29'12.6"N 22°08'22.9"E), while the second one had an area of 0.63 hectares (Map 2; 46°28'56.6"N 22°07'04.1"E), respectively.

Photo 1. Transferring the young plants from the nursery into the two experimental plots (October 2013)
Source: original.

The planting scheme was 3 x 1, meaning 3 m between the rows and 1 m between the plants on the same row. A total of 367saplings were planted in the first plot and 2,467 saplings were introduced in the second one.



Map 1. Planting plot no. 1
Source: Google Maps, Accessed on 8th of July 2022.

Before planting, the soil was prepared, and a 0.4 m deep plowing was applied and a quantity of 18.5 tones of manure were administrated in the two plots [5].

Map 2. Planting plot no. 2
Source: Google Maps, Accessed on 8th of July 2022.

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During the first two growing seasons (*i.e.* 2012 and 2013), special attention was given to the maintenance of the culture, by transforming the vegetal layer within the rows into mulch and by pest and disease monitoring (Photo 2).

Photo 2. Mulching applied on 8th of August 2014 in the two experimental plots
Source: original.

Starting with 2018, fertilizers were simultaneous applied in the two experimental plots, as follows:
-on 7th of April 2018: NPK Complex fertilizer (16-16-16), with doses of 80 kg/ha, being manually (granulated) applied;
-on 5th of May 2018: Nitrocalcar fertilizer (27%Total N 7%CaO 5% MgO), with doses of 100 kg/ha, being manually (granulated) applied;
-on 7th of March 2019: Doloflor fertilizer [33%CaMg(20%Co_3)$_2$], with doses of 3,000 kg/ha, being manually (powder) applied;
-on 16th of March 2019: NPK Complex fertilizer (16-16-16), with doses of 100 kg/ha, being manually (powder) applied;
-on 24th of March 2020: DAP fertilizer (18%N 46%P_2O_5, with doses of 150 kg/ha, being manually (powder) applied.
No fertilizers were applied in 2021, nor in 2022.
Moreover, for the timeframe 2018-2022, yearly soil analysis were done at Alchimex Laboratory, several parameters of the main and secondary macro-elements, soil reaction, micro-elements, salinity and organic matter being assessed.

The soil samples were collected from the two plots on 20th of April 2018, 24th of April 2019, 6th of March 2020, 23rd of April 2021 and 5th of April 2022, respectively.

RESULTS AND DISCUSSIONS

Since the values of the assessed soil parameters were similar in the two planting plots and since the same treatments were applied, their average values were considered in the followings.
Thanks to the applied fertilizers an increasing trend as regards the nitrogen supply (N index) was observed (Figure 1).

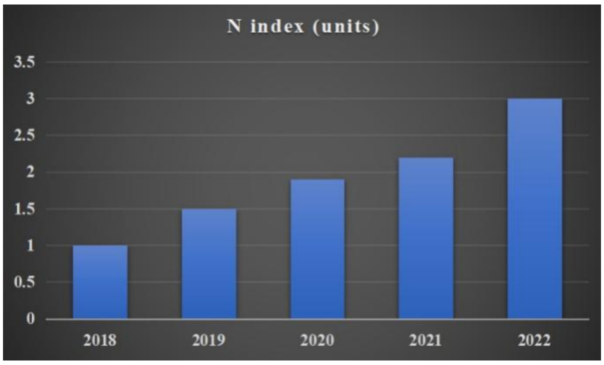

Fig. 1. N index evolution in the timeframe 2018-2022
Source: original.

N index is a synthetic indicator that expresses the capacity of the soil to make available to the crop, during the vegetation period, quantities of nitrogen by mineralizing the soil. According to the recorded values, between 2018 and 2020, the soil had a poor nitrogen supply, while in 2021 and 2022, the soil benefited from a medium supply of nitrogen.
As regards the main assessed macroelements from the soil, in general, their content increased in the considered timeframe (Figure 2).
The most significant increasing trend was recorded for Phosphorous [P] content, which grew from 24.3 mg/kg of soil (in 2018) up to 241.7 mg/kg of soil (in 2022).
A similar trend was also observed in the case of the Potassium [K] content, which grew from 78.1 mg/kg of soil (in 2018) to 247.4 mg/kg of soil (in 2022).

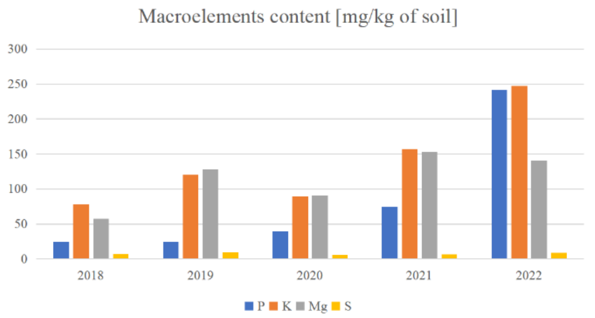

Fig. 2. Macroelements content [mg/kg of soil]
Source: original.

In the case of Magnesium [Mg] content, with the exception of the year 2018, when the soil was medium supplied with this macroelement, in the timeframe 2019-2022, the soil benefited of a good supply.

A variable trend was recorded for Sulfur [S] content, namely 7.2 mg/kg of soil (in 2018), 9.6 mg/kg of soil (in 2019), 5.4 mg/kg of soil (in 2020), 6.3 mg/kg of soil (in 2021) and 8.8 mg/kg of soil (in 2022), respectively.

The soil reaction (*i.e.* pH) recorded the lowest value (5.09) in 2019 and the highest one (6.26) in 2021. Thus, the soil reaction varied from moderately acid to slightly acid (Figure 3).

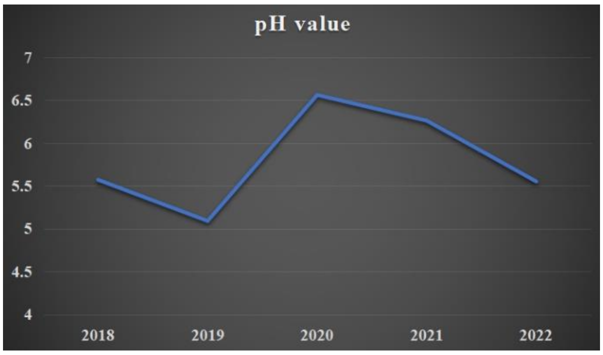

Fig. 3. pH values across the considered timeframe
Source: Original.

It is well known that the pH value influences the entire nutritional dynamics of the soil and therefore the knowledge and improvement of the soil reaction (pH) is of prime agrochemical importance.

A very low value of the pH usually indicates a deficiency of calcium [Ca], magnesium [Mg] and especially phosphorus [K]. This low value can sometimes be associated with a risk of toxicity of aluminum [Al], manganese [Mn] and iron [Fe].

Such a situation requires measures to improve and avoid certain types of fertilizers that can further acidify the soil.

As regards the content of the microelements, the soil had a good Iron [Fe] and Manganese [Mn] supply, ranging from 51.2 mg/kg of soil (in 2020) to 198.0 mg/kg of soil (in 2018), in the case of the Iron, and from from 36.4 mg/kg of soil (in 2020) to 354.9 mg/kg of soil (in 2018), in the case of the Manganese, respectively (Figure 4).

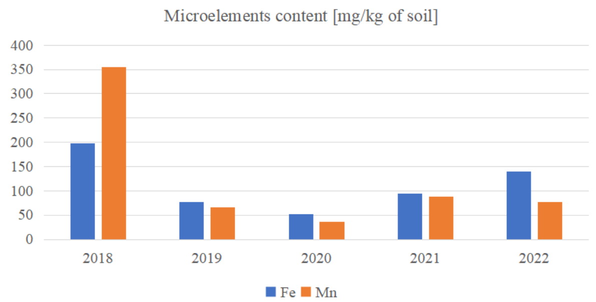

Fig. 4. Iron [Fe] and Manganese [Mn] content
Source: original.

In the case of the other two assessed microelements (Copper and Zinc), their shares were lower, namely ranging from 0.9 mg/kg of soil (in 2019) to 2.6 mg/kg of soil (in 2018) in the case of Copper [Cu], and from 1.0 mg/kg of soil (in 2019) to 3.5 mg/kg of soil (in 2018) in the case of Zinc [Zn], respectively (Figure 5).

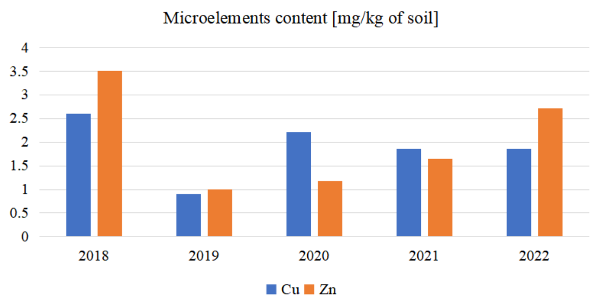

Fig. 5. Copper [Cu] and Zinc [Zn] content
Source: Original.

According to the soil analysis, during the studied timeframe, the soil was unsalted, the values of the salinity ranging from 12.5 mg/100g of soil (in 2018) to 33.1 mg/100g of soil (in 2019), being suitable for planting Saskatoon berry.

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As regards the organic matter content [%], an increasing trend was recorded both for organic carbon and total humus (Figure 6).

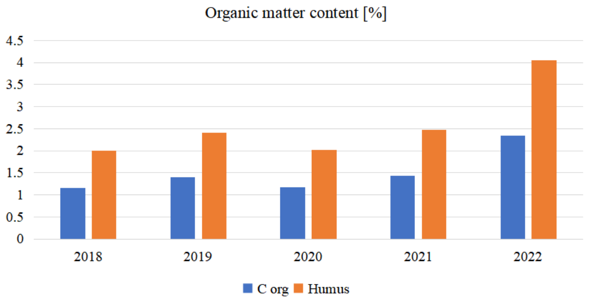

Fig. 6. Organic Carbon and total humus content
Source: original.

During the considered timeframe (2018-2022), the berries harvesting was done in June, with a 4-5 days delay between the two experimental plots, since the small one being placed nearby the forest, the flower blooming started 4-5 days later.
The total quantities of the harvested berries from the two plots were the following ones: 1,250 kg (in 2018), 2,370 kg (in 2019), 4,880 kg (in 2020), 6,290 kg (in 2021) and 6,800 kg (in 2022), respectively. This means that, on average, each plant produced 0.5 kg (in 2018, in their seven growing season), and 2.7 kg (in 2022, in their eleventh growing season) (Photo 3).

Photo 3. Berries of *Amelanchier alnifolia* from Bărzani Farm
Source: Original.

CONCLUSIONS

Based on the obtained results, it can be concluded that Saskatoon berry represents a good option for producing high and valuable quantities of berries, which are very appreciated both for their nutritional and medicinal values.
The results recorded in the two experimental plots from Bărzani Farm (Arad County) represent an important step in the breeding program of this species in Romania. Future research should be focus also on assessing both the morphological variability (especially regarding the fruit traits), genetic variation by the aid of the molecular markers and the flowering phenology. By doing so, it is expected to increase the number of varieties that can be introduced in several sites across Romania.

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DETERMINANTS OF COCOA EXPORT EARNINGS IN NIGERIA (1980-2019)

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Abstract

This study investigated the determinants of cocoa export earnings in Nigeria between 1980 and 2019. Secondary data spanning between 1980 and 2019 were collected from reputable sources such as Food and Agriculture Organisation Statistical Database (FAOSTAT), National Bureau of Statistics (NBS) and Central bank of Nigeria (CBN). Descriptive Statistics, Augment Dickey Fuller Johnson co- integration, and vector error correction (VECM) were the analytical tools employed in the study. Results indicated that variables of the model were stationary after first difference and were co- integrated. VECM results shows that domestic production of cocoa negatively influences cocoa export earnings in the short run, while cocoa output and gross domestic product (GDP) had direct relationship with cocoa export values in the long run, but exchange and interest rates had negative effect on cocoa export values over the study period. It is concluded that domestic production, GDP, exchange and interest rates were the variables determining the cocoa export earnings over the study period. It is recommended that policy reforms on coco production and value chain, flexible exchange and a single digit interest rates would improve cocoa earnings and its contribution to GDP.

Key words: *factors, trend, cocoa, output, vector error correction (VECM)*

INTRODUCTION

The role of agricultural exports is so significant in its contribution to economic growth in Nigeria [5]. Cocoa (*Theobroma cacao*) is crucial in its immense values to the world economy at large. In West Africa, cocoa has features of smallholder cultivation; planted on farm population of about 1.5 million with an average farm size ranging from 1.2 to 2.8 hectares and employment capacity of about 10 million labour force [4]; [10]. In Nigeria, cocoa has been a major export crop in the years back, contributing about 37.9% of agricultural volume of exports [12]; [15]. Cocoa is the main agricultural subsector in its great contribution to Nigeria's Gross Domestic Product (GDP) of about 15% to the total Nigerian export [15] prior oil discovery. At the inception of crude oil discovery and exploration in Nigeria in the late sixties, there was a sudden shift from agriculture which was the backbone of Nigeria economy to crude oil production. The role of cocoa to most developing countries of the world cannot be doubted as cocoa is cultivated by more than fifty developing countries across Asia, Africa, and Latin America, all of which are found in the tropical or sub-tropical regions [7]. In Nigeria, Cocoa is cultivated in fourteen of the thirty-six states. The main regions in Nigeria in which cocoa is produced is found in the South West and South-East with an exception of Cross River. However, the highest cocoa producing states in these regions that account 80% of total production include Ekiti, Ogun, Ondo, Osun and Edo [4]. Cocoa is prominent in provision of raw materials, as well as source of income to governments of cocoa producing states [17]. Nigeria was placed at second position of world exporter of cocoa [1] decade ago. Recently, Nigeria is the fourth world cocoa exporter after Cote D'ivoire, Ghana and Indonesia in the share of 12% of total world production [10]. Regards local production, the South West is considered as the cocoa region of Nigeria based on contribution of 70% of

Nigeria's annual cocoa output. Cocoa farmers in the whole world survive on on cocoa for their livelihood, with an average of annual world ouput of three million tonnes [3].

Cocoa is recognized as one the main agricultural export in Nigeria though its production is small accounting for only 0.3% of the agricultural GDP [13]. The production of cocoa is not impressive in Nigeria which has manifested in decline and instability in its output owing to problem of poor management practices adopted by cocoa farmers. Cocoa has been identified as one crucial source of renewable energy that has a high potential for power generation and foreign exchange earnings. Increased demand for alternative use of cocoa beans as a renewable energy supply is germane to increased output and economic stability owing to the fact that an increasing use of the renewable resource has potential of positive impact on sustainable environment. Cocoa shell is useful in conversion to biofuel and chocolate waste products are also components of additional sources of fuel. In addition, cocoa pod husk is a renewable source of green energy as well as ingredients that contains bioactive components of pharmaceutical industries in the production of drugs. Crude oil is incomparable with cocoa as non-renewable and faces price instability in the world market, cocoa has a strong economic multiplier effect in job creation and employment generation for many stake-holders in cocoa value chains and thus provide a good linkage to the economy at large [9].

At the world production level, cocoa is largely produced by most developing countries across Asia, Africa, and Latin America, all of which are found in tropical or semi-tropical ecological zones [14]. The production data in the period 1980 and 2017 revealed that Nigeria is the World's fourth largest cocoa producer after Ivory Coast, Ghana, and Indonesia, producing an average of 296.72 thousand tonnes over the period which accounts for about 9 per cent of the World's average output over the same period. Cocoa production is crucial in its contribution to the economic growth of Nigeria, contributing an average of US$313.33 million to the annual Gross Domestic Product of Nigeria. Also, it added a mean annual growth rate of 2 per cent in its contribution to the economy in Nigeria between 1980 and 2017. In the consideration of foreign exchange earnings, it has been estimated that the value of the Nigerian exports of cocoa rose from 243.39 million dollars in 1980 to 598.19 million dollars in 2017 [16]. Therefore, an inference can be drawn that cocoa is a strategic agricultural export product with high value of investment and export potentials for income generation, foreign exchange revenue diversification from diverse manufactured and semi-manufactured products of the commodity that include finished products such as cocoa butter, cocoa cake, cocoa powder, chocolates and cosmetic products. Cocoa has an organized world market which makes it to stand out of all agricultural exports besides its crucial role as raw material for local industries. The countries of the world that import cocoa in large quantities include Great Britain, France, Uruguay, Germany and Holland [2].

The fact still remains that the sustainable growth and export potentials of cocoa are still underutilized nationally, income generation, industrial development, and generation of increased foreign exchange earnings. This is as a result of outcome of global restriction of Nigeria in the foreign trade due to low quality of cocoa beans and infrastructure deficit. Infrastructure deficit restrains processing capacity cocoa infant industries for increased value addition. Also, the infrastructure deficit in the country affects the efficiency in linkages of cocoa-based processing firms to the global markets which hinders the export competitiveness of cocoa-based products and other crucial agricultural products in Nigeria. [15]. Nigeria government in the recent time has made concerted efforts at improving export earnings through implementation of policies such as project made in Nigeria for export (MINE) which was targeted at unlocking the potential of special economic zones (SEZs) based on their comparative advantage. The policy aimed at increasing the manufacturing's share of GDP which remained at an average of 9 per cent over the period 2013 to 2017, wealth and income generation through an improvement in export earnings [18]. Other policies include overhauling and revitalization of Bank of Industry (BOI) for easy accessibility of loans to Medium and Small-Scale Enterprises (MSMEs) at single interest rate. Government actions also felt in roads links from rural areas to towns and cities by opening of new feeder roads and re-construction of old roads in order to ameliorate the transportation problem of agricultural products. Therefore, this study investigated the determinants of cocoa export earnings in Nigeria between the period of 1980 and 2019. The major objective of the study is to examine the determinants of cocoa export earnings in Nigeria between 1980 and 2019. Specifically, the objectives of the study are to: evaluate the trend in output and export supply of cocoa in Nigeria, examine the trend in cocoa export earnings in Nigeria and analyze the effect of significant factors on cocoa export earnings in Nigeria.

MATERIALS AND METHODS

Study area

The study area for this research is Nigeria. Nigeria is situated in the West African region and lies between latitudes 40^0N to 140^0N and longitudes 30^0E to 150^0E (National Bureau of Statistics, NBS, 2020) [11] It has a wide expanse of land of 923,768 sq.km. It shares boundary in the north by Niger Republic, in the west by Benin Republic and in the east by Cameroon Republic. The country's topography characterises by lowlands along the coast and in the lower Niger Valley to high plateaus in the north and mountainous along the eastern border. Much of the country is laced with productive rivers. Nigeria's ecology varies from tropical forest in the south to dry savanna in the far north, yielding a diverse mix of plant and animal life.

Data analysis

Data employed in the study were national annual aggregates obtained from secondary sources such as include publications of the Central Bank of Nigeria (CBN) [6], the National Bureau of Statistics (NBS) [11] and Food and Agriculture Organization (FAO) Statistics (FAOSTAT) [8]. Data were specifically collected on Nigerian cocoa production and export supply quantity, value of cocoa export quantity, producer prices of cocoa, gross domestic product (GDP), interest rates, inflation rates and exchange rate for the period under study (1980-2019). This study employed a number of analytical methods based on the objectives of the study. These include; means, standard deviation, coefficients of variation, percentages and average growth rate. These statistical tools (means, standard deviation, coefficients of variation, percentages and average growth rate) were used to describe trend in cocoa production, export supply and export earnings in Nigeria.

The Augmented Dickey-Fuller statistics was used to examine the stationarity of time series data. The Johansen's method was employed in verifying co- integration among the variables of the model. The error correction mechanism (ECM) was used to isolate the de1terminants of cocoa export earnings for the period covered by the study. The implicit model employed in this study is given as:

$$\Delta LnY_t = \alpha_1+\alpha_2\Delta lnY_{t-1}+ \alpha_3\Delta lnX_{2t-1}+ \alpha_4\Delta lnX_{3t-1} +\alpha_5\Delta lnX_{4t-1}+\alpha_6\Delta lnX_{5t-1}+\lambda_1 ECT_{t-1}+ u_{t1}\ldots\ldots(1)$$

where:

Y is the cocoa export earnings valued in thousand USD

X_1 is the cocoa export supply in metric tonnes

X_2 is the cocoa production quantity in metric tonnes

X_3 is the GDP valued in United States dollars

X_4 is the exchange rates was measured as amount of Naira exchanged for United States Dollar

X_5 is the interest rate in the economy measured in percentage

X_6 is the inflation rate in the economy measured in percentage

ECMt is the error correction factor.

Δ is the difference operator

$_{t-1}$ is the lagged values of variables

Ln is the logarithm operator

U_{ts} are stochastic random errors

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$ and λ_1 are parameters to be estimated.

RESULTS AND DISCUSSIONS

Trend in domestic cocoa production in Nigeria (tonnes)

Trend in cocoa production in Nigeria between 1980 and 2019 is presented in Table 1. The table shows an increasing, but fluctuating trend in average cocoa production across the sub-periods over the study period. It fluctuated from 175,080.00 tonnes in the 1980-1989 sub period to 348,531.10 in 2000-2019 sub-period, with the mean of 299,055.30 during the study period. Annual growth rate in the production of cocoa recorded a negative growth rate in 1990-1999 and 2010-2019 sub periods, but a positive growth rate1980-1989 and 2000-2009 sub periods respectively, with an average annual growth rate of 128.83% over the study period.

Table 1. Trend in Cocoa Production in Nigeria (1980-2019)

Sub-periods	Mean (tonnes)	Annual Growth rate (%)	Coefficients of variation
1980-1989	175,080	67.30	408.94
1990-1999	287,200	-7.79	556.88
2000-2009	385,410	185.24	7,817.41
2010-2019	348,531.1	-12.29	971.36
Total	299,055.30	123.83	28.69

Source: Computed from CBN, NBS and FAOSTAT, 2021 [6, 11, 8].

Trend in cocoa export supply (tonnes) in Nigeria (1980-2019)

The average cocoa export supply in Nigeria between 1980 -2019 is shown in Table 2. From the table, average export supply of cocoa fluctuated over the study period, decreasing and increasing alternately between the sub-periods, with an average of 47,462.43 tonnes during the study period. Similarly, annual growth of export supply of cocoa decrease and increase alternately over the study period, reaching its peak values (197.98%) in 2010-2019 sub -period.

The average annual growth rate of cocoa export supply stood at 56.75% between 1980 and 2019.

The coefficients of variation show high degree of instability varying from 152.36% in 2000-2018 sub-period to 611.67% in the 1990-1999 sub period, with an average of 211.54% between 1980 and 2019.

The coefficient of variations reflected a high degree of instability in cocoa production varying from 408.94% in the 1980 to 1989 sub-period to 971.36% in the 2010-2019 sub-period, with a mean of 28.69% over the study period.

Table 2. Trend in cocoa export supply in Nigeria (1980-2019) in tonnes

Sub-period	Mean (tonnes)	Annual Growth rate (%)	Coefficients of variation
1980-89	149,993.10	3.79	366.56
1990-99	147,323.40	32.76	`611.67
2000-09	208,695.80	77.69	429.13
2010-19	232,810.80	32.31	519.36
Total	330,102.20	197.98	152.36

Source: Computed from CBN, NBS and FAOSTAT, 2021 [6, 11, 8].

Trend in cocoa export earnings (000,000' US$) in Nigeria (1980-2019)

Table 3 presents the trend in cocoa export earnings between 1980 and 2019 in Nigeria.

Table 3. Trend in cocoa export earnings in Nigeria (1980-2019) in tonnes.

Sub-periods	Mean (000,000' US$)	Annual % Growth rate	Coefficients of variation
1980-1989	244,311	-45.10	395.69
1990-1999	173,361	117.40	333.45
2000-2009	353,175	185.24	271.96
2010-2019	552,735	8.68	660.73
Total	474,624	56.75	211.54

Source: Computed from CBN, NBS and FAOSTAT, 2021 [6, 11, 8].

The table reveals that cocoa export earning fluctuated over the study period; reaching its peak (US$552.735. million) in 2000-2019 sub-period and its lowest (US$173.361 million) in the 1990 to 1999 sub-period, averaging US$474.624 million between 1980 and 2019.

A negative annual growth rate (-45.10%) was recorded 1980 and 1989 sub-period, but it improved significantly between 1990 to 2009 period.

The average annual growth rate of cocoa export earnings stood at 56.75% between 1980 and 2019. High level of disequilibrium as reflected by coefficient of the variation which ranges from 271.96% in 2000-2009 sub-period to 660.73% in the 2010 to 2019 sub-period with an average of 211.54% for the entire period of 1980 - 2019

Unit root test

One of the major step to be taken in the analysis of a time series data set is to take a critical look at the behaviour of the data set over the period of the analysis. This is to affirm that the time series data set are either stationary or non-stationary over time. Time series is adequate for regression analysis using the ordinary least squares (OLS) if it is not unit root and thus stationary over time. However, if the series exhibit unit root that depicts non-stationary over time which makes the data set unsuitable for regression analysis by applying the ordinary least squares (OLS) method as this will end in spurious results that cannot be used for statistical inference and policies recommendation.

Unit root test for variables of the model for the study (original values)

The unit root test results for initial values of the variables of the model using the Augmented Dickey-Fuller (ADF) technique is presented in Table 4.

Table 4. Result of ADF Unit Root for Variables (Original values)

Variables	ADF value	Mackinnon critical values		
		1%	5%	10%
lnY	-3.02	-3.67	-2.97	-2.62
lnX_1	-1.61	-3.67	-2.97	-2.62
lnX_2	-2.30	-3.75	-3.00	-2.63
lnX_3	-2.11	-3.75	-3.00	-2.63
lnX_4	-3.13	-3.75	-3.00	-2.63
lnX_5	-3.47	-3.75	-3.00	-2.63
lnX_6	-2.30	-3.75	-3.00	-2.63

Source: Author Computation 2021.

The table reveals that the ADF statistics is less than critical values at 1%, 5% and 10% respectively, indicating that the variables of the model are not stationary in their original values, hence, the null hypothesis of presence of unit root in the variables of the model cannot be rejected under this condition.

These imply that the variables of the model cannot be used for regression analysis using their original values because the results will be spurious and unsuitable for statistical inference and policy recommendations.

Unit Root Test for Variables of the Study (First Difference)

The ADF unit root tests of the first difference of the variables of the model is presented in Table 5. From the table, the ADF statistics have values that are more than the critical values at 1%, 5% and 10% respectively. Therefore, the null hypothesis of presence of unit root in the variables of the model can be rejected, implying that the variables in their first difference form is suitable for regression analysis because the results of such analysis will be valid for statistical inference and policy formulation.

Table 5. Result of ADF Unit Root for Variables (First difference values)

Variables	ADF value	Mackinnon critical values		
		1%	5%	10%
$DlnY$	-7.88	-3.68	-2.97	-2.62
$dlnX_1$	-5.03	-3.68	-2.97	-2.62
$dlnX_2$	-4.45	-3.68	-2.97	-2.62
$dlnX_3$	-5.02	-3.68	-2.97	-2.62
$dlnX_4$	-6.10	-3.68	-2.97	-2.62
$dlnX_5$	-4.62	-3.68	-2.97	-2.62

Source: Author Computation 2021.

Lag length selection

Table 6 presents the lag selection-order criteria for the variables of the model.

The table reveals that based on LR, FPE, AIC, HQIC and SBIC criterion a lag order of 4 is recommended for co-integration and vector error correction regression analysis.

Co-integration test

Table 7 presents the results of Johansen co-integration analysis of the variables of the model. Results in the Table reveals that there is 1 co-integrating equation among the variables of the model, establishing a long run relationship among the variables of the model, affirming that the suitability of vector error correction (VECM) regression analysis for the model.

Table 6. Selection-order criteria for lag length of the variables

LAG	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-2,184.45				5.7e+45	125.226	125.537	
1	-2,014.9	339.11	49	0.000	6.2e+42	118.337	119.196	120.826
2	31,969.75	90.289	49	0.000	1.1e+43	118.557	120.168	123.223
3	-1,904.68	130.14	49	0.000	1.4e+43	117.639	120.001	124.482
4	-1,178.3	1452.8*	49	0.000	6.5e+27*	78.9312*	82.0452*	87.9522*

Source: Data Analysis, 2021.
Endogenous: Y, $\ln X_1$, $\ln X_2$, $\ln X_3$, $\ln X_4$, $\ln X_5$, $\ln X_6$
Exogenous: _cons

Table 7. Result of Johansen tests for co-integration

Max. rank	Parms	LL	Trace Eigen value	Critical statistic	Value
0	56	--2,152.661		132.5689	124.24
1	69	-2,130.8891	0.69175	89.0252*	94.15
2	80	-2,116.5041	0.54048	60.2552	68.52
3	89	-2,104.1511	0.48713	35.5493	47.21
4	96	-2,096.6297	0.33407	20.5065	29.68
5	101	-2,090.25	0.29167	7.7471	15.41
6	104	-2,086.9222	0.16463	1.0914	3.76
7	105	-2,086.3765	0.02907		

Source: Author Computation 2021.

Results of short run vector error correction model regression analysis

The results of short run Vector error correction model (VECM) regression analysis is presented in Table 8.

Results in the Table shows that the value of R^2 is 0.65 and is statistically significant at 5% level. This shows that the estimated model has a good fit. The error correction factor (-0.920) is negative and statistically significant at 10% level as expected. In the short run, the coefficient of cocoa output (X_2) is negative and statistically significant at 10% level, showing an inverse relationship between cocoa output and cocoa export earnings (Y).

Table 8. Short run vector error correlation model regression analysis results

Variables	Coefficients	St. error
Ce_1	-0.191	0.118
Cocoa export earnings (Y)	-0.067	0.230
Cocoa export supply (X_1)	-0.246	0.528
Cocoa production quantity (X_2)	-0.529	0.291
GDP valued in United State dollars (X_3)	-0.349	0.522
Exchange rate (X_4)	0.146	1,392.850
Interest rate (X_5)	0.565	4,423.033
Inflation rate (X_6)	-859.742	942.431
Constant	7,474.423	18,874.210
R^2	0.650	
Chi-square	42.171	
p-value	0.000*	
AIC	118.913	

Source: Author computation 2021.
* mean significant at 1% level; ** mean significant at 5% level; *** mean significant at 10% level

Results of long run vector error correction model regression analysis

Table 9. Long run vector error correction model regression analysis results

Variables	Coefficients	Standard error	z-value	p-value
Cocoa export (Y)	1	-	-	-
Cocoa export supply (X_1)	0.148	0.721	0.200	0.838
Cocoa production quantity (X_2)	2.977	0.519	5.73	0.000*
GDP valued in United State dollars(X_3)	1.136	0.192	5.93	0.000*
Exchange rate (X_4)	2,223.765	1,027.476	2.16	0.030**
Interest rate (X_5)	19,854.140	5,953.362	3.330	0.001*
Inflation rate (X_6)	1,214.928	1,732.173	0.700	-0.483
Constant	292,671.500			

Source: Author computation 2021.
* significant at 1% level; ** significant at 5% level; *** significant at 10% level

Table 9 presents the long run results of the VECM regression analysis. Results in the Table reveals that in the long run, agricultural land area (X_1), cocoa production (X_2) and inflation rate (X_5) negatively affect the export supply of cocoa, while exchange rate (X_3) positively affects export supply of cocoa in the study area.

CONCLUSIONS

The study analyzed the determinants of cocoa export earnings in Nigeria between the year 1980 and 2019. The study concludes that an annual growth rate in the production of cocoa recorded a negative growth rate in 1990-1999 and 2010-2019 sub periods, but a positive growth rate1980-1989 and 2000-2009 sub periods respectively. Also, annual growth of export supply of cocoa decrease and increase alternately over the study period, reaching its peak values (197.98%) in 2010-2019 subs - period. There is a high degree of instability in cocoa export earnings during the period of the study as reflected by the coefficient of the variation. Cocoa production (X_2), GDP (X_3) exchange rate (X_4) and interest rate (X_5) significantly influence cocoa export earnings in Nigeria over the study period. Based on the study findings, it is recommended that policy measures on domestic production and processing of cocoa into high quality cocoa beans that will command premium price in the international market should be taken. Also, there is need for provision of macro-economic friendly environment that will promote agricultural exports through effective and efficient monetary policies on macro-economic variables such as exchange rate and interest rate to improve earnings from agricultural exports.

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STUDY ON THE CURRENT STAGE OF DEVELOPMENT, PLANNING AND PROMOTION OF RURAL TOURISM AND AGRITOURISM IN THE ETHNOGRAPHIC AREA MARAMUREȘ

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Abstract

The paper presents general elements regarding rural tourism, agrotourism and the tourist potential of the rural area, the unique natural and anthropic tourist heritage of the Maramureș ethnographic area. The current stage of capitalizing the tourist potential is presented, by analyzing the main forms of rural tourism practiced in the area, by determining the indicators that characterize the number of rural tourist pensions, accommodation capacity and are proposed some strategies for tourism development and tourism promotion and advertising this area, at national and international level. In the first part, a realistic and pertinent analysis was made of the specific tourist potential of the Maramureș ethnographic area, through which it is clearly different from other ethnographic areas in our country and which capitalized at its true value can be a real magnet of attraction for domestic tourists, but especially for foreign ones. The second part highlighted the evolution and development of the number of pensions and accommodation capacity in this beautiful region, in the period 2016-2020, which was significantly affected especially by the pandemic situation in our country and other neighbouring countries and the European Union. Finally, based on the real situation of the development stage and use of the tourist potential in the studied ethnographic area, a series of new strategies for the development and promotion of the rural tourism and agrotourism activity were presented.

***Key words*:** *agritourism, management, rural tourism, tourist resources*

INTRODUCTION

As it is well known in time, the tourist activities carried out in the "green" rural area generate positive effects, but also undesirable effects, especially when the ecological loading capacity and the ecological peculiarities of the rural environment are not respected [13, 14]. Starting from this hypothesis, we considered that it is very good to carry out this study, to find out what is the current stage of development and arrangement of tourism in general and how it should evolve so that its uncontrolled development does not seriously and irremediably affect this fascinating and unique ethnographic area of Maramureș.

The advantages of practicing rural tourism and agrotourism are:

(a) Related to the tourist activity itself: Rest in the country is an increasingly attractive alternative for townspeople [2, 4]. In it, tourists are invited to participate in local traditional holidays, folk costume parades, craft fairs, visit of traditional houses, churches, monasteries and medieval castles, etc. [3, 6];

(b) Economically: Tourism in general stimulates the development of other branches of the national economy such as: industry, agriculture, construction, transport, trade [10, 16, 19, 31]. Agrotourism is a real chance for the local economy by developing traditional activities that have long been neglected, crafts, local artistic creations to satisfy tourists. As can be seen, agrotourism contributes to the capitalization of local tourist resources, raising the standard of living of the inhabitants, the socio-economic development of the rural locality and the community and the protection and conservation of the natural and built environment [8, 22, 29].

(c) Culturally, they are in close interaction, thus creating a series of social advantages, advantages that benefit both the agritourism entity and the environment of which it is part. This activates the socio-cultural, craft, folkloric traditions [9, 21, 27];

(d) At the political-demographic level, it helps to increase the phenomenon of stability, but also to restrict the process of emigration of the rural population, especially the young, preserves the existing socio-cultural models, popular traditions and local architecture. It contributes to the creation of a favorable external image of Romania on an international level, through the contact of foreign tourists with the ethnoculture and the natural and hospitable ambiance of the Romanian village [7, 17, 20].

The branded rural tourism product that has not been exploited at all until now in our country and especially in the studied area is the "tourist village". Tourist villages are those hearths of rural communities that by their specificity and particular note can be a rural tourism product, being prepared at the same time to satisfy a wide range of motivations of domestic and international tourism [1, 11, 22].

The application of the principle of specialization in the field of organization and functioning of the tourist village is necessary because each rural locality is an entity with its own particularities and specific activities, which only need to be identified and capitalized as efficiently as possible, from a tourist point of view [12, 18, 33]. In the studied area we meet: (a) Landscape and climatic villages such as Botiza, Breb, Vişeul de Sus and others; (b) Spa villages: Stoiceni, Ocna Șugatag, Coștiui, Borșa and others; (c) Pastoral tourist villages: Baia Sprie, Cavnic; (d) Sports tourist villages: Cavnic, Budești, Mara, Cosău, Mogoș; (e) Tourist villages of artistic and artisanal creation: Săcel, Sighet, Rogoz village, Șugatag village, Botiza, Margina, Cordun, Săpânța; (f) Ethnofolkloric tourist villages: Bogdan-Voda, Bârsana, Preluca Noua; (g) Villages with objectives of scientific interest, which have different types of nature reserves that, through their uniqueness and beauty, attract to visit many foreign tourists and natives: Slătioara, Glod, Chiuzbaia, etc; (h) Villages with historical, art and architectural monuments of exceptional value: Rozavlea, Budești, Săcele, Josani, Desești, Breb, Sârbi Village.

MATERIALS AND METHODS

In the first phase, the specific tourism potential of the Maramureș area was determined, very varied, diversified and concentrated, due to the existence of combined landforms throughout the territory, a favorable climate for tourism throughout most of the year, a rich faunal and floristic potential with unique species and ecosystems in Europe. The existence of some natural spa treatment factors, and of a cultural heritage - historical and architectural heritage of world reference, based on which the area can be included among the attractive tourist destinations in Romania and even in Europe [5, 32, 26].

Subsequently, the aim was to highlight this tourist potential by clearly highlighting the unparalleled natural and anthropic tourist heritage, with a special specificity of the Maramureș ethnographic area. The current stage of capitalizing the tourist potential was determined, by analyzing the main forms of rural tourism practiced in the area, by determining the indicators that characterize the number of rural tourist pensions, accommodation capacity, tourist circulation and proposed some strategies for tourism development and publicity of this area, at national and even international level [24, 28, 23].

Based on the documentation and studies carried out, it was found that the natural and anthropogenic potential are not sufficient in the development of a tourist area such as the Maramureș ethnographic area and that it must be supported by adequate management, economic power and a well-implemented strategy, in order to arrange and rearrange the existing tourist framework. Also, new projects must be started that will lead primarily to the preservation of the unique historical-cultural and craft heritage, to the obtaining of complementary incomes, but also to the raising of the standard of living, culture and civilization [24, 32, 23].

RESULTS AND DISCUSSIONS

Maramures is a geographical region, made up of the Maramures Depression in Romania and the eastern Transcarpathian region of Ukraine

(Rahău, Slatina, Teceu, Hust districts). With the administrative organization of Romania by regions (1947-1968), the name of Maramureș was extended in Romania to Chioar Country (Baia Mare), Lăpuș Country, Oaș Country and Sătmar Country. The historical capital Sighet (today Sighetu Marmației) has been replaced by the city of Baia Mare. Currently, the Romanian part of the Maramureș area is part of Maramureș County [15] (Figure 1).

Relief. Of the total area of the county, the mountainous area occupies 43%, with the Rodna Mountains and the Pietrosul Massif (2,303 m) - the highest in the Eastern Carpathians - and the volcanic area with the Gutâi and Țibleș Mountains (1,300-1,800 m); 30% of the surface is hills and plateaus and 27% are occupied by depressions, meadows and terraces. The forests represent one of the main riches of the county. The total area of the forest fund is 263,895 ha, of which 257,385 ha forest [24, 30, 32, 23].

Hydrography. The main watercourses are: Someș, Lăpuș, Iza, Vişeu, Vaser, Mara. Also, Maramureș County has in its natural heritage a series of: - glacial lakes: Iezerul Pietrosului, Tăurile Buhăescu, Izvorul Bistriței Aurii, Gropilor; - natural lakes: Vinderel, Măgura, Morărenilor; - lakes of dissolution and collapse of some mines with ancient salt mines, which are located at Ocna Șugatag and Coștiui. Lacul Alastru (Blue Lake), near the town of Baia Sprie, with a diameter of 60 - 70 m and a depth of more than 5 m [24, 32, 23, 26].

The climate of Maramureș is of temperate continental type, presenting differences of temperatures and precipitations between the high area of the mountains and the depression. Winters are cold and with abundant snow, Borșa resort being famous for winter sports [24, 32, 23, 26].

The administrative division of the county is as follows: 13 cities (of which 2 municipalities), 63 communes and 226 villages. The ethnographic area of Maramureș is one of the largest depressions in the Carpathian chain, covering an area of about 10,000 km². It is located in the northeastern part of the Carpathian Mountains and is divided into two areas by a mountainous branch in the upper basin of the river Tisa, called the Pop-Ivanu peak (Pop-Ivan Peak, 1,937 m): the southern part belongs to Romania, and the northern Ukraine (Figure 1) [15].

Fig. 1. Maramureș historical area
Source: processing according googles maps [15].

Anthropic agrotourism resources specific to the Maramureș ethnographic area

The Maramureș area is very easily identified by the Maramureș clothing art. All the pieces of the folk costume are the exclusive product of the home textile industry, having as a starting point the processing of yarns and finally the weaving of fabrics, in home micro-workshops, tailoring and embroidery. To all this are added the craftsmen specialized in making coats, sumanas, gubes, opanci and hats.

The main identifying elements of the folk costume were “zadiile”, the woollen fabric in the women's peasant folk costume. The port of Maramures stands out for its sober, restrained elegance, it is unitary and has “a completely original character, with specific elements that we do not find in other areas” [24, 32, 23, 26].

A real magnet for attracting tourists to the area are the Christmas Habits. On Christmas Eve, in the villages of Maramureș, the first to go to carolling are the children. He walked with the "Star" or the "Goat" whose game (killing, mourning, funeral, resurrection) was originally a serious ceremony. " Vicliemul " or "Irozii" is the tradition by which young people represent the birth of Jesus Christ at Christmas.

Also, an important role in attracting tourists in the ethnographic area of Maramureș is played by human activities with agrotourism function. Maramureș is a wood civilization, undoubtedly encouraged by the splendid wooden churches and the many buildings founded according to a secular architecture. The specific ceramics of the area are of different shapes and sizes, depending on their use. The vessels are colored in bright green, red, or blue, on a whitish background [24, 32, 23, 26].

A special place of unparalleled uniqueness and originality is the *Merry Cemetery from Săpânța*. The name of the cemetery comes from the multitude of multicolour crosses and from the satirical poems and epitaphs that are inscribed on the crosses. Legend has it that the cheerful attitude towards death is a habit of the Dacians who believed in eternal life and death for them was just the transition to another world.

The Maramureș Village Museum is a tourist attraction located in the town of Sighetu Marmației, Maramureș County, opened in 1981, which mainly groups a collection of houses specific to the Maramureș area. The museum comprises over 30 households, some fully furnished with original pieces. The preserved houses and households are grouped on the main subzones of the historical Maramureș [24, 32, 23, 26].

The monasteries are points of attraction for religious tourism such as: *Bârsana Monastery* located in the commune of the same name, built in the middle of the 16th century. *Săpânța-Peri Monastery* founded in 1391, by Dragoș Vodă's grandchildren, in which the headquarters of the Romanian Episcopate of Maramureș functioned for more than 300 years. With a maximum height of 78 m, the church of the Săpânța-Peri monastery is currently ranked 3rd among the places of worship in Romania.

The wooden church from Poienile Izei. The church was built of fir beams. The square altar is narrower than the rectangular plan of the main body of the church, as is typical of older churches. The building is one of eight churches included in the UNESCO International Heritage List. Gheorghe from Dragomirești painted the church in a post-Byzantine style in 1794. The paintings are very well preserved and include large scenes in simple frames [24, 32, 23, 26].

Botiza Monastery. A nunnery, the Botiza monastery (Balş Botiza hermitage) dedicated to the “Change in the Face” is a holy foundation in the commune of Botiza, which hosts an icon that works wonders. The construction of the monastery began in 1991, the works being coordinated by the craftsman from Botiza, Vasile Petrehuș, at the request of the faithful and the father. The monastery is built of solid fir wood, with a porch adorned with Maramures arches, sculpted in Maramures style.

Along with religious tourism, it is also possible to practice with great success the curative tourism or health care in the beautiful resorts such as: The spa resort of local interest Ocna Șugatag which is located in Maramureș County, 20 km from Sighetul Marmației, at 490 m altitude at the foot of the Țibleș-Gutâi mountains. Borșa spa and recreation resort located at the foot of the Rodna Mountains at 850 m altitude. The Borșa tourist complex located near the city benefits from a climate conducive to both the treatment and the practice of winter sports. The air is clean, free of allergens and strongly ozonated. There are also springs of bicarbonate, calcium, magnesium, ferruginous mineral waters used in the treatment of kidney and urinary tract diseases [24, 32, 23, 26].

Vaserului Valley - Mocănița from Vişeu de Sus. Often referred to as the "Vaserului Valley Railway", the Forest Railway in Viseu de Sus is located right in the north of Romania, on the border with Ukraine and represents a richness both technically and culturally and runs on a route of almost 60 kilometers, being known worldwide as the last true forest railway, which runs on steam [24, 32, 23, 26].

Analysis of the evolution of tourist reception structures in the period 2016-2020

Until December 31, 2020, Maramureș County had 38 rural localities in which only one touristic boarding house was identified in the commune of Vişeu de Jos and 156 agritouristic boarding houses in the 38 rural localities (Table 1).

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Figure 2 shows an increasing trend in the number of agritouristic boarding houses in Maramureș County in the period 2016-2020, from a number of 96 in 2016 to a number of 156 in 2020, growth is sustained even in 2020, despite the pandemic conditions. This is the result of the development of rural tourism in general, the preferences of potential tourists being oriented towards diverse, recreational activities, carried out in a less polluted space, also due to the fact that most were developed on existing housing of entrepreneurs.

Table 1. Tourist reception structures with accommodation functions by types and localities, from the Maramureș area, in the period 2016-2020

Tourist reception structures	**Localities**	**Years / number of pensions**					**Tourist reception structures**	**Localities**	**Years / number of pensions**				
		2016	2017	2018	2019	2020			2016	2017	2018	2019	2020
Touristic boarding houses	Dumbrăvița	1	1	-	-	-	Agritouristic boarding houses	Mireșu Mare	-	1	1	1	1
-	Ocna Șugatag	2	2	-	-	-	-	Moisei	7	9	10	10	15
-	Recea	1	1	-	-	-	-	Ocna Șugatag	13	26	20	21	24
-	Strâmtura	1	1	-	-	-	-	Oncești	2	3	4	4	7
-	Vișeu de Jos	2	2	1	1	1	-	Petrova	-	1	1	1	1
Total touristic boarding houses		**7**	**7**	**1**	**1**	**1**	-	Poienile Izei	10	10	9	10	10
Agritouristic boarding houses	Băiuț	1	1	1	1	1	-	Recea	1	1	3	3	3
-	Bârsana	7	7	5	5	6	-	Rona de Jos	-	1	1	-	1
-	Bogdan Vodă	1	1	1	1	1	-	Rona de Sus	1	1	1	1	1
-	Botiza	8	11	9	9	10	-	Ruscova	-	-	1	1	2
-	Budești	3	3	3	3	4	-	Săcălășeni	1	1	1	1	1
-	Călinești	-	1	2	2	2	-	Săcel	3	3	4	2	4
-	Cernești	-	-	1	-	-	-	Săpânța	3	4	4	4	6
-	Cicârlău	1	1	1	1	1	-	Sarasău	1	2	2	1	1
-	Coaș	-	-	1	-	-	-	Satulung	1	1	1	1	1
-	Colțău	4	5	5	5	5	-	Șieu	2	4	3	3	4
-	Copalnic-Mănăștur	1	1	1	1	3	-	Șisești	2	2	2	2	2
-	Desești	4	6	5	4	7	-	Strâmtura	2	2	3	3	3
-	Dumbrăvița	1	1	2	2	1	-	Suciu de Sus	1	1	1	1	1
-	Giulești	3	4	3	3	5	-	Vadu Izei	8	13	12	12	14
-	Groșii Țibleșului	-	-	-	-	1	-	Valea Chioarului	2	2	2	2	3
-	Ieud	1	1	1	1	3	-	Vișeu de Jos	1	1	2	2	1
Total agritouristic boarding houses									**96**	**132**	**129**	**124**	**156**

Source: processing according to the data of the National Institute of Statistics [25].

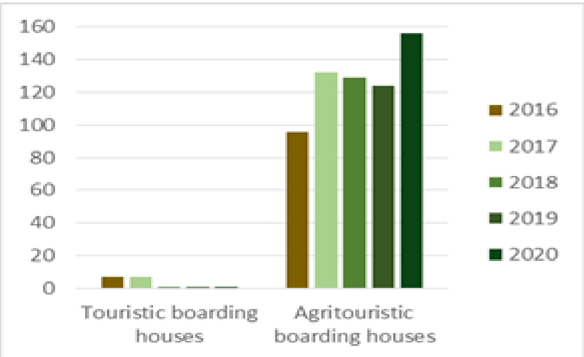

Fig. 2. The evolution of rural tourist boarding houses with accommodation functions in the Maramureș area, during 2016-2020
Source: processing according to the data of the National Institute of Statistics [25].

This development was made with very little investment, because the constructions existed, and in order to be made available to tourists, they were briefly arranged and built spaces for bathrooms and serving the hygienic meal, which meet the minimum classification criteria, at least 2 daisies.

The number of touristic boarding houses remains extremely small, from a number of 7 boarding houses in 2016 and 2017, to a single boarding house in 2018, 2019 and 2020. This was mainly due to the specific conditions existing in households in Maramureș, which could it easily provides tourists with a range of quality traditional products, with the help of which to attract and retain the tourist clientele.

Analysis of accommodation capacity in touristic and agritouristic boarding houses

The existing (installed) tourist accommodation capacity represents the number of tourist accommodation places registered in the last act of reception, homologation, classification of the tourist accommodation unit, excluding the extra beds that can be installed in case of need. The places related to the tourist reception structures with complementary tourist accommodation functions (cottages, campsites, etc.) to a basic tourist accommodation structure (hotel, motel, campsite, etc.) and the use of these places are included in the basic structure.

In the period 2016-2020, there was a continuous increase in the existing accommodation capacity as a result of the increase in the number of agritouristic boarding houses in the county. This is explained by the desire of the locals to start their own business in order to obtain additional income to the basic ones, due to the increase of the requirements for the practice of rural tourism (Table 2).

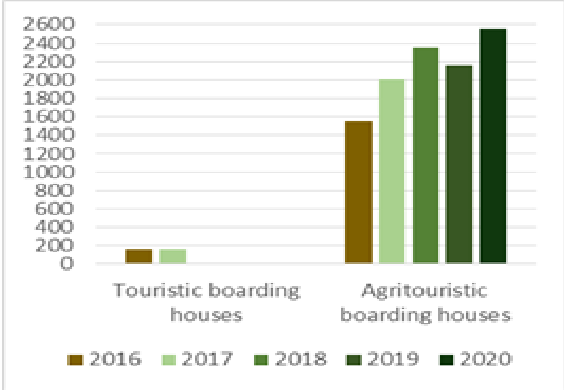

Fig. 3. Accommodation capacity in rural touristic boarding houses, in the Maramureș area, during 2016-2020
Source: processing according to the data of the National Institute of Statistics [25].

Table 2. Existing tourist accommodation capacity by types of reception structures and localities, from the Maramureș area, in the period 2016-2020

Type of tourist reception structures	Localities	Years / number of places					Type of tourist reception structures	Localities	Years / number of places				
		2016	2017	2018	2019	2020			2016	2017	2018	2019	2020
Touristic boarding houses	Dumbrăvița	16	16	-	-	-	Agritouristic boarding houses	Mireșu Mare	-	9	9	9	9
-	Ocna Șugatag	50	50	-	-	-	-	Moisei	117	164	186	186	214
-	Recea	43	43	-	-	-	-	Ocna Șugatag	231	371	391	405	446
-	Strâmtura	36	36	-	-	-	-	Oncești	48	53	85	85	117
-	Vișeu de Jos	20	20	7	7	7	-	Petrova	:	20	30	30	30
Total touristic boarding houses		***165***	***165***	***7***	***7***	***7***	-	Poienile Izei	10	109	104	99	114
Agritouristic boarding houses	Băiuț	14	14	14	14	14	-	Recea	21	21	74	74	73
-	Bârsana	138	140	115	115	139	-	Rona de Jos	-	8	8	-	8
-	Bogdan Vodă	19	19	19	19	19	-	Rona de Sus	36	36	36	36	36
-	Botiza	107	135	115	113	123	-	Ruscova	-	-	30	30	43
-	Budești	44	44	54	54	70	-	Săcălășeni	12	12	12	12	12
-	Călinești	-	16	32	32	50	-	Săcel	77	77	136	54	88
-	Cernești	-	-	14	-	-	-	Săpânța	34	45	51	51	66
-	Cicârlău	16	16	16	16	16	-	Sarasău	26	49	82	60	60
-	Coaș	-	-	63	-	-	-	Satulung	10	10	10	10	10
-	Colțău	64	75	75	75	75	-	Șieu	23	49	55	55	67
-	Copalnic-Mănăștur	11	11	11	11	37	-	Șisești	36	36	36	36	36
-	Desești	45	105	87	49	85	-	Strâmtura	26	26	62	62	62
-	Dumbrăvița	13	10	20	20	10	-	Suciu de Sus	14	16	16	16	14
-	Giulești	48	58	48	48	73	-	Vadu Izei	131	183	173	173	205
-	Groșii Țibleșului	-	-	-	-	16	-	Valea Chioarului	52	33	33	33	31
-	Ieud	19	27	27	27	47	-	Vișeu de Jos	14	14	27	27	13
Total agritouristic boarding houses									***1,555***	***2,006***	***2,351***	***2,151***	***2,556***

Source: processing according to the data of the National Institute of Statistics [25].

Figure 3 shows the evolution of the number of accommodation places in agrotouristic boarding houses in Maramureș County in the period 2016-2020, which shows that their number increased from 1,555 places in 2016 to 2,556 in 2020, an increase also being sustained in the year 2020, contrary to the restrictions imposed by the pandemic conditions existing at that time. From what was presented, it was found that the very high demand for recreational places in open spaces, during the pandemic period 2019-2020, led to an increase in the number of accommodation places, especially in agritouristic boarding houses, which have a growth rate of over 60%. The high demand during this period was also due to the restrictions imposed on the movement of tourists by neighboring countries and the European Union. Tourists preferred to spend their holidays in the country, where they did not need a green passport or a covid test, Maramureș area fully benefiting from these restrictive conditions. As can be seen from the presentation of the specific tourist potential, it has sufficient tourist and agrotourism resources to satisfy a wide range of requirements and needs of the tourist clientele in our country and beyond.

The number of accommodation places in the touristic boarding houses in Maramureș County in the period 2016-2020 is very small, from a number of 165 places in 2016 and 2017, it reached only 7 accommodation places, in the years 2018, 2019 and 2020, in Vişeu de Jos commune. This phenomenon was mainly due to the general trend in the studied area, of transforming rural touristic boarding houses into agritouristic boarding houses, as all households had certain traditional local natural products, which they could use and increase their added value by providing tourists (Table 2).

Figure 4 shows that the number of accommodation places, expressed in places-days for agritouristic boarding houses in Maramureș County in the period 2016-2020, had a period of growth from 2016 (563,140 places) to 2018 (734,497 places), and then in the last 2 years, 2018-2020, a decrease to 546,325 places in 2020. Although from the data presented above it was found that the number of accommodation places especially in agritouristic boarding houses has increased considerably, from Table 3 and Figure 4 it is found that the number of places expressed in days decreased in the first year of the pandemic to 688,325, and in the second year to 546,325, this was mainly due to the reduction of the number of accommodation places that could be made available to tourists, to 50% or up to only 30%, in situations where the evolution of the infection rate increased above certain percentages.

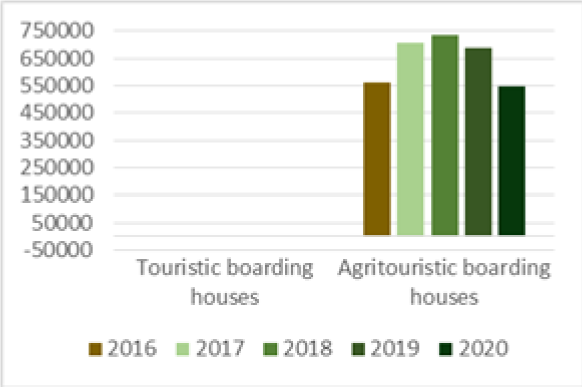

Fig. 4. Accommodation capacity in rural touristic boarding houses (places-days), in the Maramureș area, in the period 2016-2020; Source: processing according to the data of the National Institute of Statistics [25]

The number of accommodations expressed in places-days for rural touristic boarding houses in Maramureș County in the period 2016-2020 increased from 2,190 places in 2016, to a number of 3,650 in 2020. This increase is explained by the fact that these touristic boarding houses located in the environment rural areas could provide spaces for relaxation and leisure, in conditions of isolation and safety, in accordance with the requirements imposed by the restrictions during the difficult period of the pandemic (Table 3).

Tourism development proposals

The future of rural tourism in Maramureș is promising provided that there is a greater awareness of public authorities and the private sector, but especially of consumers, on the ability of rural tourism to contribute to the conservation of natural and cultural heritage in rural areas, and to improve living standards in this region of the country. A superior capitalization of the potential is held by the rural tourism with its forms, leisure tourism, ethnographic tourism (cultural-folkloric manifestations), cultural tourism, balneoclimateric tourism, ecological tourism, sports tourism (hunting schools), agrotourism (specialized farms).

Proposals for the development and diversification of the tourist offer

Analyzing the above and the current state of development of tourism in the region, we can say with conviction that it has not reached a maximum level of development, despite its rich and varied potential, and its development prospects are promising. A first step in

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supplementing the income is to diversify the tourist offer within the accommodation units and at the local, regional or interregional level, by giving up kitsch and promoting the traditional.

Table 3. The capacity of tourist accommodation in operation by types of tourist reception structures and localities (places-days), from the Maramureș area, during 2016-2020

Type of tourist reception structures	County	Localities	Years / number of places-days				
			2016	2017	2018	2019	2020
Touristic boarding houses	Maramureș	Vadu Izei	2,190	3,650	3,650	2,555	3,650
Agritouristic boarding houses	Maramureș	Băiuț	4,690	5,110	5,110	5,110	2,338
-	-	Bârsana	14,331	13,420	19,025	14,830	6,385
-	-	Bogdan Vodă	5,909	6,935	6,935	6,935	5,491
-	-	Botiza	38,955	43,370	38,282	38,650	29,250
-	-	Budești	16,088	16,060	17,590	19,834	18,670
-	-	Călinești	-	4,368	5,840	9,248	7,598
-	-	Cernești	-	5,110	4,256	-	-
-	-	Cicârlău	5,856	5,840	5,840	5,824	944
-	-	Coaș	13,482	22,995	15,309	-	-
-	-	Colțău	24,840	27,740	26,755	27,567	21,959
-	-	Copalnic-Mănăștur	4,015	4,495	4,015	4,004	4,089
-	-	Desești	14,982	35,559	30,167	18,601	23,777
-	-	Dumbrăvița	6,986	8,952	7,938	8,542	4,986
-	-	Giulești	11,027	8,522	11,210	12,394	8,306
-	-	Groșii Țibleșului	-	-	-	-	480
-	-	Ieud	5,610	8,407	9,855	9,855	14,881
-	-	Mireșu Mare	3,285	3,285	3,285	3,285	900
-	-	Moisei	34,294	45,139	44,809	44,736	32,517
-	-	Ocna Șugatag	97,003	133,389	132,132	132,846	100,091
-	-	Oncești	18,064	21,535	33,890	31,319	27,099
-	-	Petrova	1,220	8,344	10,950	10,950	8,220
-	-	Poienile Izei	35,045	34,868	35,669	35,472	41,682
-	-	Recea	23,305	22,295	26,400	25,126	15,195
-	-	Rona de Jos	-	3,650	3,650	3,650	5,475
-	-	Rona de Sus	12,084	13,140	13,140	13,140	10,404
-	-	Ruscova	-	-	10,588	10,950	9,463
-	-	Săcălășeni	4,392	4,380	4,380	4,368	3,468
-	-	Săcel	49,063	49,640	48,639	26,634	9,546
-	-	Săpânța	6,570	12,422	18,722	16,239	13,842
-	-	Sarasău	9,087	17,632	22,434	21,840	17,433
-	-	Satulung	3,660	3,102	920	2,140	1,590
-	-	Șieu	1,054	9,458	11,443	18,593	11,631
-	-	Șisești	12,680	12,900	13,140	13,140	10,404
-	-	Strâmtura	11,802	11,722	9,490	9,490	7,514
-	-	Suciu de Sus	3,430	5,110	5,110	5,110	3,850
-	-	Vadu Izei	48,905	58,266	59,694	57,658	55,013
-	-	Valea Chioarului	12,794	12,775	12,775	12,756	10,077
-	-	Vișeu de Jos	6,679	5,500	5,110	7,489	1,757
Total			***563,140***	***705,435***	***734,497***	***688,325***	***546,325***

Source: processing according to the data of the National Institute of Statistics [25].

The trade of handicrafts provides another framework for inter-relationship at the level of "countries". Through the exchanges made by the rural localities of the four Maramures countries, an inter-functional relationship is developed, conducive to the development of rural tourism and local communities. Creating a site for the promotion of traditional and artisanal products, with the possibility of purchase, would be another way to influence the growth of income in the region and to help motivate the perpetuation of crafts. The Internet can also be an opportunity for artisanal trade, thus becoming an e-commerce, as a new method of presenting and capitalizing on products [24, 32, 23, 26]. Diversifying the forms of tourism and creating thematic routes would mean important sources of income and especially to promote the region. Construction of new marked trails on the surrounding hills, and even mountains and maintenance of the old ones, arrangement of special places for picnics, where the fire is controlled, also construction of tourist cabins, with medium capacity, for the development of weekend tourism in the area of higher hills, there are only a few possibilities to increase tourist traffic and income.

Examples of thematic routes [24, 32, 23, 26].

1. The route of the wooden churches: Desești - Ieud - Bogdan Vodă - Bârsana - Giulești - Budești - Ferești - Vadu Izei - Rozavlea - Rogoz or on the route Sighetu Marmației - Vadu Izei - Ferești - Cornești - Călinești - Sârbi - Sat Șugatag Monastery.
2. The route of folk crafts (making dowry boxes, tools and household objects, carved and painted crosses, folk pottery, processing wool and animal skins, etc.): Desești - Plopiș - Băița de sub Codru - Săpânța - Vişeu de Jos - Șugatag Village - Botiza - Ferești - Călinești.
3. Tour of the spas: Ocna Șugatag - Băile Cărbunari - Băile Dănești - Băile Botiza - Băile Borșa.

Ways to develop and promote rural tourism in Maramureș County

As dominant intangible products, rural services are not easy to promote. Intangibility is at least difficult to describe in advertising, whether it is print, TV or radio. There is a need to develop a marketing program that widely promotes the entire sector, a cooperative marketing company, under the same umbrella, in which all operators will compete, with equal opportunities. All these elements of the promotional activity must be channelled to promotional events, fairs, exhibitions and conferences both nationally and internationally. The rural tourism product is supposed to be perceived especially by those with a certain degree of culture, the promotion in this case will be directed in attracting long and short-term tourists during treatment stays in rural areas, thematic or cultural circuits.

On the foreign market we have the categories of foreign tourists that are considered to be open to the promotion of rural tourism. A trip to Maramureș is a delight for the tourist eager to know the moral and spiritual values of the places, specific to the Romanian people but forgotten in other areas. Maramureș is par excellence the best-preserved source of ancestral traditions. It is the place were simplicity blends harmoniously with humanity, giving them that nobility full of grace [24, 32, 23, 26].

In the ethnographic and folkloric tourist villages in the Maramureș area (eg. Bogdan-Vodă) can be offered to tourists accommodation and dining services in authentic conditions (furniture, decor, bedding in popular style, traditional menus served in ceramic bowls, tablespoons wood, etc.). Permanent handicraft exhibitions (for sale) can be organized in these villages, and for tourists who do not stay in the locality, but only visit, one or more households can be arranged, with an open-air ethnographic museum.

The preservation and perpetuation of folklore and especially of ethnography (dress, work techniques, architecture, furniture and interior decoration, etc.) in their original traditional forms, is in decline, becoming increasingly isolated on the ethno-folk map of the country. The forms and content of urban life have penetrated and continue to penetrate impetuously and irreversibly into the rural environment as well.

Approaching the future of a rural locality from the tourist perspective and adapting them to this purpose, we consider that their ethnographic specificity can and must be preserved and perpetuated. Otherwise, the current interest of tourists for the Romanian village, for the rustic environment, in general, will gradually decrease. This desideratum must be pursued all the more, as many villagers from some localities in the area clearly show interest in maintaining their lifestyle, these localities having chances to become permanent tourist bases, of international popularity, particularly profitable [24, 32, 23, 26].

Agrotourism and rural tourism in addition to those presented above must also contribute to recreation, restoration and comfort, enriching knowledge and flourishing human personality. These activities cannot be carried out at a high level of quality without the pensions and agritourism farms having modern hygienic-sanitary facilities. For this, peasant households must be supported by a number of facilities.

In order for the support to be realized faster and directed towards the rural tourism activity, at the level of each county the territorial tourist centers must be built to deal with: attracting new members and creating in the area a current of specific marketing opinions; ensuring the inclusion in the national catalogue of all classified rural tourist structures, organizing with the support of the body of experts from the National Association and the relevant Ministry of Romania, professional training courses for the owners of rural tourist structures; providing technical assistance in the preparation of documentation for the classification and granting of non-reimbursable financial aid, participation in the activity of the technical commissions for the classification of tourist structures in the area.

CONCLUSIONS

Regarding the analysis of the main forms of rural tourism practiced in the ethnographic area Maramureș, we can conclude that the area is dominated by the number of agritouristic boarding houses, much higher than that of touristic boarding houses. This increase is due to the orientation of tourists' preferences towards such diverse, recreational activities, carried out in a picturesque space and as little as possible polluted. The increase in their number is also due to the fact that most of them have been developed on the already existing homes of entrepreneurs, with a minimum of investments for their transformation into tourist reception structures.

From the analysis of the indicators that characterize the dynamics of rural touristic boarding houses, the accommodation capacity, in the analyzed interval 2016 - 2020, increased in agritouristic boarding houses, but decreased considerably in touristic boarding houses, in 2020, the accommodation capacity expressed in places-days, decreasing below the last reference year analyzed, namely 2016.

Regarding the number of agritouristic boarding houses in Maramureș County, there was a tendency to increase them in the analyzed period, by approximately 62%, sustained growth even in 2020, despite the pandemic conditions, instead, the number of touristic boarding houses remained very small, limited to only one, in Vişeu de Jos.

During the same period, there was a continuous increase in accommodation capacity expressed in the number of places, existing in agritouristic boarding houses of about 64%. This is explained by the desire of the locals to start their own business, in order to obtain additional income to the basic ones and as a result of the increase of the preferences for the practice of rural tourism. The number of accommodation places expressed in places-days for touristic boarding houses in Maramureș in the period 2016-2020, increased by 66%, especially in the pandemic period 2019-2020, when they were used almost at full capacity.

Rural tourism must ensure the preservation of the countryside and in no way support its urbanization, it must reflect the rural and traditional note specific to Maramureș, both from an architectural and dimensional point of view. We must warn because improper and abusive practice can negatively influence the development of rural areas, loss of identity through industrialization, change of mentality, attitude towards architecture and folk dress, adoption of modern models in everyday life and activities.

The main measures that should be applied to carry out a tourism activity developed in the Maramureș area are: creation of programs and funds for co-financing regional development projects, correlation of national programs with those of local and regional interest, extension of communications in areas of tourist interest , efficient and modern transport, promoting the zonal tourist potential by participating in tourism fairs, by conducting advertising campaigns, preparing brochures with information about the tourist potential of the area and with suggestive images in this regard, media coverage of agritourism pensions and farms.

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STUDY ON THE INFLUENCE OF THE PANDEMIC ON THE INDICATORS CHARACTERIZING THE TRAFFIC AND QUALITY OF TOURIST SERVICES AT A BOARDING HOUSE IN DOLJ COUNTY

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Abstract

The paper presents a complex study on tourist traffic and the impact of the pandemic on the main indicators of quality of tourist services, at Simona boarding house - Dolj. The boarding house under study built its activity on a niche route, which caught on very well in the area, as it is primarily based on leisure activities and spending time outdoors, away from the noise and pollution of big cities. It is located in a more secluded area, at a greater distance from the main road, in an area with smooth hills and a special climate, which plays an important role in attracting tourists, a fact proven during the pandemic. In the first part of the paper, we focused on characterizing the area in terms of natural and anthropic tourism resources, after which an analysis was made of the main indicators that define the quality of services offered to tourists. Finally, based on the study and the results obtained, we concluded that Boarding house Simona - Dolj practices a modern management of the highest quality, as evidenced by the values of indicators that define the quality of tourism activities, which are at a higher level, high compared to similar ones at the national level, even in the severe and restrictive conditions of the pandemic period.

Key words*: *agritourism, boarding house, management, rural tourism, tourist resources

INTRODUCTION

The study was conducted at the boarding house "Simona" located in Perișor commune, Dolj county, in southwestern Romania, in the Oltenia Plain, a position that is more disadvantaged in terms of landforms with an interesting appearance to attract tourists [6]. The town is located 40 km from the city of Craiova - a city located in the center of the historic Oltenia region and 49 km from the town of Calafat. In terms of accessibility, the host commune for boarding house "Simona" is crossed by the national road DN56, which connects the city of Craiova and the bridge over the Danube from Calafat, being one of the most populated roads in the region, given that Calafat is a border town that connects Bulgaria to Vidin. Internationally, it is recognized as the European road E79 and is part of the road network that starts in Hungary, enters Romania and passes through the cities of Oradea, Deva, Petrosani, Targu Jiu, Craiova and Calafat, crosses Bulgaria and ends in Thessaloniki , Greece.

From the point of view of the relief, the locality is more vitreous compared to those located in the mountainous and submontane areas, in which the varied relief with sculptural forms and unique appearance can attract a larger number of tourists. Although the area is not attractive from this point of view, in the area and especially in the locality of Perișor, more and more rural tourist boarding house have started to appear and develop. This was primarily due to the successful example of Boarding house Cristian, which emerged as a pioneer in this area, but which has developed and evolved continuously [18]. With this example, several guesthouses have gradually emerged that are mainly focused on leisure and relaxation tourism and the promotion of traditional local gastronomic products, which are mainly addressed to the population of the city, who want to spend an unforgettable stay in the middle of the traditional atmosphere of the plain village, in the southern part of Oltenia.
The development of this activity was mainly due to the fact that the locals realized the many advantages that derive from practicing

an agrotourism and rural tourism activity as: the possibility of superior capitalization of local agricultural products, by direct sale or serving them to tourists at a price closer to their true value [3, 19], the possibility to obtain additional income from the tourism activity, in addition to the basic ones obtained from one's own household, the creation of new jobs and the acquisition of a new qualification in the field of tourism [14, 20], the conservation of the material and intangible heritage of the traditional Oltenian village [4, 8, 17], the enrichment of the level of culture and civilization of this rural area, through relationships with tourists from other parts of the country or abroad and others [1, 15], aspects reported by other researchers in the country and abroad [22, 24, 25].

Its location in a quiet area away from the main road, with a position on a higher area with geographical coordinates $44^{0}14'30''$ latitude and $23^{0}49'95''$ longitude [5], which offers a certain panorama over the area and locality. Through the services offered to tourists, this guesthouse began to be visited more and more by tourists and especially during the pandemic, when many residents of the city tried to take refuge in such a place, where they feel as safe as possible.

MATERIALS AND METHODS

First of all, we had to make a documentation on the main natural and anthropic tourist resources existing in the area, which are the main assets in attracting tourists, to Boarding house Simona, especially during the pandemic. The documentation was made by studying and analyzing the main bibliographic sources about the area, such as: monographs, studies on flora and fauna, study on village customs, traditions and rituals, relief maps, tourist and thematic, study on tangible and intangible heritage, etc. [2, 26, 32]. We also went to the boarding house to complete and verify all the data collected from the National Institute of Statistics (NIS), regarding the evolution of the main indicators that define the quality of the tourist services provided [16], which had to respect all the additional conditions imposed during the difficult period of the pandemic.

Based on data collected from the field and from the National Institute of Statistics (NIS), we performed an analysis and characterization of the evolution of quality indicators in 2017-2020, as well as a diagnosis regarding the impact of quality of agrotourism activities on traffic of the boarding house and customer loyalty, which as it turns out were the basic elements in the proper functioning of the activity of the boarding house, even during the pandemic. At the same time, we analyzed the tourist offer of the boarding house, comparing it with a similar one from the locality, but classified at a higher number of daisies and we determined based on the data the use index and the occupancy rate of the boarding house, in the studied period 2017-2020 [11].

RESULTS AND DISCUSSIONS

Study on natural tourist resources

According to the studied literature, the commune of Perișor was founded in 1864, and its name comes from a pair plantation on the old hearth of the village. The first documentary attestation of the locality dates from 1570 in the charter of Alexandru Voievod [12, 13].

The **relief** of the area is generally a more monotonous plain, without shapes with a special appearance that would be a strong element in attracting tourists [29]. The town is located in a hilly area, between smooth hills. The relief of the region includes the Danube meadow area, the plain and the hill area. The altitude increases from 30 to 350 m above sea level, from south to north of the area, and according to the main agent that generated the landforms on most of its territory falls perfectly in the category of the Danube area [13].

The **climate** of the studied region and of Perișor locality belongs to the temperate climatic zone, with Mediterranean influences due to the south-western position. The position and the depressional character of the land it occupies, determine, on the whole, a warmer climate than in the central and northern part of the country, with an annual average of 10-11.5^{0}C and lower precipitations, with an average between 525-650 mm annual [12].

Vegetation. Most of the south of Oltenia is covered by rich fields, the vegetation being specific to the forest-steppe and steppe area, with extensive deciduous forests, especially oak, poplar and acacia. Strong and aggressive intervention on the natural environment has led to the large-scale replacement of natural vegetation as a result of deforestation, crops and uncontrolled urbanization. The vegetation includes a wide range of grassy and tree species, depending on the variety of soil and climate. In the northern part of the area, with higher hilly lands, there are forests of *Quercus cerris* and *Quercus frainetto, Quercus petraea*. Along with these, there are other deciduous species that appear in the lower hills and even in the plains, such as: linden, elm, ash, hornbeam. There are also oak species in association with hazelnut, rosehip, sea buckthorn, etc. [28].

The **fauna** has been severely impoverished in the last two centuries due to human intervention, which has led to the transformation of the forest area into an anthropogenic steppe. Large mammals live in the area of deciduous forests and undergrowth, such as deer, wild boar, rabbit, fox, etc. Among the birds, the small, singing ones are specific: the nightingale, the cuckoo, the blackbird, the turtle, the tit, the goldfinch, which are also common in the streams near the waters. In the plain, rodents (field mice, gray rats, woodpeckers) and small predators (ferret, weasel) are present, and among larger mammals, the fox and the rabbit. Among the most common birds are: quail, partridge, woodpecker, starling, and porpoise and swallow often nest in the muddy or sandy banks of the relief steps. In the ponds found in the area there are fish species such as redfish, catfish, perch, zander. The terrestrial and aquatic fauna has undergone changes caused by abusive hunting and fishing, many of the species that populate the territory surviving in small numbers or disappearing altogether [12, 30].

Hydrographic network and water mirrors. From the network of running waters that drain the territory, the Danube, the main collector, and the Jiu River, the hydrographic axis with north-south orientation, stand out first of all. The hydrographic network is completed by the tributaries of these two major arteries. At the edge of Perișor commune there is the accumulation lake into which the Perișor brook flows, located in the Desnățuiului Plain. It is populated with fish, but is not sufficiently exploited for tourism or sports purposes. Also, the Jivan brook crosses the plains of Perișor commune. Among the most important lakes and ponds in the area we mention Bistreț Lake, Fântâna Banului, Maglavit, Golenți and Ciuperceni [12,13].

From the point of view of natural resources, the absence of natural landscapes and anthropic transformations determine a reduced tourist potential, but which is compensated by natural reserves and natural monuments, such as: Ciurumela Forest from Poiana Mare; Bucovăț fossil point; The ornithological reservation from Ciupercenii Noi (south of Calafat) is the only place that has not remained untouched; The wild peony reservation from Plenița - unique in Romania; Nicolae Romanescu Park in Craiova - Made according to the plans of the French architect E. Redont between 1900 and 1903 [18, 27].

Study on anthropic tourist resources

Museums, monuments, sites and architectural ensembles.

The Perișor locality has housed the “Heroes” Monument since 1927, built in honor of the martyred heroes who fought in the First World War. There are also two Neolithic archeological sites. At the level of Perișor locality there is a museum in which objects related to the aviation pioneer Henri Coandă are exhibited, emphasizing the holidays spent with grandparents, in Perișor commune, Dolj county. The "Henri Coandă" Museum operates in the old town hall building where there are two rooms dedicated to the memory of the great scientist. In another room, the museum presents various ethnographic cultural assets. In front of the museum was placed a bronze bust of the great scientist Henri Coandă and an IAR-93 plane, one of the first Romanian aircraft to which he contributed. The museum can be visited on request [27, 30].

Monasteries, cathedrals and churches. Within the locality there are three churches, namely: in Perișor commune 2 churches, and in Mărăcine village, located 5 km from Perișor commune, a church. The churches in Perișor are declared historical monuments [31]. They were built in 1700 ("Saint Nicholas" Church), respectively in 1500 ("Saint Nicholas" Church in the village of Mărăcine, Perișor commune) [27].

Cultural facilities. In the commune of Perișor there is a cultural home established in 1972, which is in a state of degradation and is to be rehabilitated by the local administration. At the same time, within the new construction of Perișor City Hall there is a library with over 15,000 copies and the second library which is located within the General School "Henri Coandă" - Perișor [13].

Ethnographic and folkloric values. Within the commune there is a folk ensemble called "Peony" which constantly participates in various competitions and shows. Next to the town hall there is an open-air stage where cultural events are organized at which the ensemble performs artistic demonstrations. Perișor commune day has become a tradition for the commune's citizens. It was celebrated before the pandemic, every year in October, after the fruits were harvested. Citizens could also enjoy two more folk festivals that coincide with the Christian holidays, namely the feast of Saints "Constantine and Helen", in which the villagers gathered at "fairs". The second feast is represented by the "hora" performed on the second day of Easter, when the villagers shared food, to commemorate those who passed away [7, 12, 13].

Tourist services offered by Boarding house Simona

In addition to accommodation in rooms with three daisies, guests receive a complimentary breakfast. It is made from traditional food produced and prepared by the hosts themselves or from local producers, adapted to the season. For example, in the hot season, breakfast can contain fruits (apples, pears, plums, melons, strawberries, cherries), vegetables (tomatoes, cucumbers, radishes, etc.) and dairy products (cheese, milk, yogurt, cheese). In the cold season, customers can enjoy pork dishes (haggis, bucket meat, sausages), pickles or preserves (stew, zacusca, jam, compote) made by the host. Boarding house "Simona" has its own kitchen, well equipped that tourists can use to prepare food for other meals [7].

Recreational services. According to travel agencies for online bookings and other travel products, boarding house "Simona" offers the following activities: for nature lovers - cycling (there are bicycles for all ages on site), hiking (on the meadows near the boarding house admiring the accumulation lake from Perișor or Perișorului Forest) or fishing on the nearby lake. For the more adventurous, at the location I find two ATVs (for any season) and a snowmobile (for the winter period), these activities being for a fee [21].

Moreover, at the location there is a multifunctional court for sports activities (football, table/field tennis) and a place for children, and from 2020 the guests of the boarding house, but not only, can enjoy the sun, at the swimming pool in the courtyard of the boarding house. There are two swimming pools, one for adults and one for children. Around the pool, many sun loungers are waiting for their guests, and soft drinks are put up for sale on the pool terrace [7].

Study of statistical indicators that define the quality of rural tourism activity in Boarding house Simona

a. Accommodation capacity

The boarding house has an accommodation capacity of 10 places, respectively 4 rooms, with equipment corresponding to the comfort category, for which it received the classification of 3 daisies [9].

Table 1. Number of tourists arriving, 2017-2020

Year	Number of tourists arriving
2017	275
2018	237
2019	270
2020	135

Source: processing according to data collected from the field and from NIS [23].

b)The number of tourists arriving at the boarding house

In the period 2017-2020, according to table 1, it was relatively constant until 2019 inclusive, being over 237 tourists. In 2020, it decreased a lot, by almost 50%, reaching only 135 tourists, due to the large restrictions imposed in the pandemic.

c) Overnight stays

The number of overnight stays at the boarding house during 2017 - 2020, according to table 2, was relatively increasing, except for the year 2020, as follows: 2017 - 373 overnight stays, 2018 - 398 overnight stays, 2019 - 468 overnight stays, respectively 2020 - 269 overnight stays, due to the same phenomenon that also led to a drastic decrease in the number of tourists arriving at the boarding house.

Table 2. The number of overnight stays in the period 2017-2020

Year	Number of
2017	373
2018	398
2019	468
2020	269

Source: processing according to data collected from the field and from NIS [23].

d)Tourism demand indicators

Tourist demand for rural tourist boarding houses in the locality in the period 2017 - 2020, according to Table 3: Tourist boarding house 1: - 4 daisies (in this case represented by Boarding house "Cristian").

Table 3. Tourist demand for rural tourist boarding houses in the locality during 2017-2020

Specification	No. tourists arriving at boarding houses			
	2017	2018	2019	2020
Tourist boarding house **1** - 4 daisies	328	298	229	95
Tourist boarding house **2** - 3 daisies	275	237	270	135

Source: processing according to data collected from the field and from NIS [23].

The number of tourists arriving at the boarding house was in 2017 - 328 tourists, 2018 - 298 tourists, 2019 - 229 tourists, 2020 only 95 tourists.

Boarding house 2: - 3 daisies (represented by Boarding house "Simona"): the number of tourists arriving at the boarding house was in 2017 - 275 tourists, 2018 - 237 tourists, 2019 - 270 tourists, 2020 - 135 tourists.

It can be stated that, although the Boarding house “Simona” is qualified with 3 daisies, it did not register significant differences of clients compared to the competing boarding house. It can be noted that in 2020, although the specific conditions imposed by the pandemic at national and even international level were unfavorable, the boarding house in question had a higher number of customers compared to 4 daisies, due to the pool put into operation during the season of that year and other related activities, outdoor leisure [7, 18].

e) Average number of tourists

The average number of tourists arriving per day at the boarding house 2017 - 2020, according to table 4, on average the number of tourists arriving at the boarding house, compared to the days was relatively constant, being generally over 0.65 tourists/day, except 2020 where there was a sudden decrease, to only 0.37 tourists/day, due to the reduction of the number of tourists admitted to the boarding house, according to the covid infection rate of over 10%, registered in Dolj County during that period.

Table 4. Average number of tourists arriving per day in the period 2017-2020

Year	Average number of tourists arriving per day
2017	0.75
2018	0.65
2019	0.74
2020	0.37

Source: processing according to data collected from the field and from NIS [23].

f) Number of days - tourists

The number of days tourists staying in the boarding house during 2017-2020, according to Table 5, fluctuated from year to year, as follows: in 2017 there were 102,575 tourists, in 2018 there were 94,326 tourists, in 2019 there were 126,360 tourists, and in 2020 36,315 tourists. This indicator correlated very well with the number of tourists arriving and overnight stays, which varied depending on the specific conditions encountered in the boarding house in that year [10].

Table 5. Number of tourist days accommodated during 2017-2020

Year	Number of tourists	Overnights	Total number of tourist
2017	275	373	102,575
2018	237	398	94,326
2019	270	468	126,360
2020	135	269	36,315

Source: processing according to data collected from the field and from NIS [23].

g) Average length of stay

The average length of stay at the boarding house during 2017-2020, according to Table 6, increased from year to year, the longest average length of stay, being recorded in 2020, as follows: in 2017 it was – 1.36 days/stay, in 2018 - 1.68 days/stay, in 2019 - 1.73 days/stay, in 2020 - 1.99 days/stay. This increase of almost 30%, compared to 2017, was mainly due to the desire to escape the people from the city, in nature, in the conditions of beauty and purity of the rustic environment in the village of Perișor, after more than a year of isolation conditions, imposed by the pandemic.

Table 6. Average length of stay during 2017-2020

Year	Number of tourists	Overnights	Average length of stay
2017	275	373	1.36
2018	237	398	1.68
2019	270	468	1.73
2020	135	269	1.99

Source: processing according to data collected from the field and from NIS [23].

f) Accommodation capacity in operation

As can be seen from Table 7, the accommodation capacity in operation (places-days) of Simona boarding house during 2017-2020, is influenced by the number of operating days of the boarding house, as follows: 2017 - 256 days/year, 2018 - 245 days/year, 2019 - 270 days/year, 2020 - 200 days/year. It should be noted that, in general, the guesthouse cannot operate all year round because maintenance activities must be carried out on the accommodation and serving meals. Moreover, in 2020, special attention was paid to the sanitation of the boarding house, which led to the unavailability of operation for several days. Thus, in the year: 2017 - the accommodation capacity was 2,560 tourists, compared to the number of operating days, in 2018 - the accommodation capacity was 2,450 tourists, compared to the number of operating days, in 2019 - was 2,700 tourists, compared to the number of operating days, and in 2020 - the accommodation capacity was only 2,000 tourists compared to the number of operating days.

Table 7. Accommodation capacity in operation (places-days) during 2017-2020

Year	Number of operating days	Accommodation capacity in operation
2017	256	2,560
2018	245	2,450
2019	270	2,700
2020	200	2,000

Source: processing according to data collected from the field and from NIS [23].

g)The maximum theoretical offer at the boarding home is 365 units-days, for each year, but as can be seen in Table 7, its actual offer varied according to the number of operating days, which was 256, in 2017, it increased to 270, in 2019, after which in the peak year of the pandemic, it decreased to only 200 days.

h)The characterization of the efficiency of using the technical-material accommodation base was performed according to the following indicators [16. 9]: Usage index agritourist boarding house % (I_u) and Degree of occupancy agritourist boarding house % (Do).

Figure 1 shows that the utilization index (Iu) of the accommodation capacity in operation, of the boarding house in the period 2017-2020, is 40.1% in 2017, 38.50% in 2018, 46.8% in 2019 and 18.2% in 2020. The index was relatively constant, keeping a percentage between 38% - 47%, in the period 2017 - 2019, but in 2020 there was a sharp decrease, thus reaching only 18.2%. Also, from the same figure it is observed that the occupancy rate of the accommodation unit Go (%) in the period 2017-2020, is 34.5% in 2017, 44.7% in 2018, 58.6% in 2019 and 26.3 % in 2020. It increased steadily during the period under study, the highest percentage being achieved

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in 2019 - 58.6%, but in 2020 there was a sharp decrease, so the occupancy rate reaching only 26.3 %, a phenomenon due mainly to the severe conditions of the pandemic, when strict rules were imposed on the occupancy rate of the boarding house, depending on the evolution of the COVID infection rate, at national and local level.

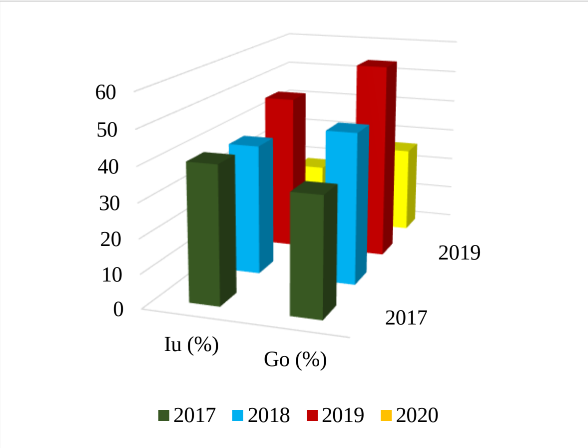

Fig. 1. Evolution of the utilization index (Iu) and the degree of occupation (Go) of Simona boarding house, 2017-2020
Source: processing according to data collected from the field and from NIS [23].

In conclusion, the "Simona" boarding house, located in Perișor commune, Dolj county, enjoyed a harmonious and ascending path in terms of the main quality indices that characterize the tourist services offered. The number of tourists has increased from year to year, with the improvement of the interior and exterior of the boarding house and the services offered, but also with the development of the commune. The boarding house awaits tourists with home-made dishes with natural products from their own production or from other local farmers. The hosts are at the disposal of the tourists to offer information about the attractions in the surroundings, but also with relaxing outdoor experiences and to tell some stories about the history and evolution of the town and the historical province of Oltenia.

CONCLUSIONS

The analysis showed that rural tourism in the area is not developed according to the demand of the domestic and international tourism market, the existing tourist infrastructure does not fully meet the requirements of tourists in terms of quantity and quality of accommodation and recreation places, facing currently with technical, financial and educational difficulties. At county and Perișor commune level, the aim is especially the large-scale development of tourist activities aimed at protecting and conserving the natural environment and built as: agrotourism, rural tourism and ecotourism, which make full use of Natura 2000 sites, as a sustainable opportunity for development and evolution, for humans and nature. The tourist potential of the area adjacent to Perișor commune is mainly focused on the Danube River where representative for tourism is: water mirror for cruises, boat trips or sports competitions, sport fishing area, beach areas, forest fund adjacent to the river, for rest - recreation or sport hunting.
Rural tourism and agrotourism in the area are two areas that can be developed by arranging leisure centers, rest centers, hunting camps, children's camps, hotels, guesthouses. The absence of natural landscapes and anthropic transformations have led to a low tourist potential which is offset by meadow landscapes adjacent to the Danube, with forest patches, sand dunes, water holes that attract sport fishermen, existing wineries and vineyards but especially the uniqueness and beauty of the traditional folk costumes. From the point of view of the existing anthropic resources in the area, they can be easily completed with the existing tourist attractions, first of all in the city of Craiova, Calafat and Băilești. Here, tourists can make day trips with the transport provided by the host, because the distances are short, and the experience of a day for culturalization spent in these cities can have a value of significant spiritual enrichment and be unforgettable, due to the tourist anthropic objectives with heritage value that can be visited.
Regarding the main quality indicators analyzed at Simona boarding house, it can be seen that it has a modern and very good quality management, quickly adapted to the specific, heavy conditions of the pandemic, which have been a touchstone for many

structures in the area and even from the country. As can be seen from this analysis in the run-up to the pandemic, the signs that characterize the quality of tourism in the boarding house have increased progressively, year by year, due to quality and efficient management, except for 2020, when due to restrictive conditions regarding the safety of tourist traffic depending on the infection rate, they decreased significantly, correlating with the level of restrictions imposed in this area and county and with the additional safety, hygiene and cleanliness measures imposed in such conditions.

The good quality of the tourist services offered at this boarding house is very clear from the index of use and the level of occupancy, which as can be seen from the data presented were above the national average, which was about 35%, and at hotel of about 40%, at the level of agrotourism boarding houses, of only 17%. At Simona boarding house, the occupancy rate reached a maximum level of 58.6%, in 2019, after a constant increase due to the quality tourist services offered and the diversification of the range of leisure and free time activities. Occupancy decreased significantly in the year of the 2020 pandemic, by about 50%, but it remained above the national average occupancy of all tourist reception facilities, which fell by 11%, in 2020, standing at about 22%. In 2020, as shown in Figure 1, it was lower, only 26.3%, but above the national average and well above the average of the agritourism boarding houses, at national level, which shows that the hosts of boarding houses are handled very well all the visitors who crossed their threshold, respecting all the additional norms of quality and hygiene, imposed in the pandemic conditions.

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MODELING PROFITABILITY IN RICE FARMING UNDER PHILIPPINE RICE TARIFFICATION LAW: AN ECONOMETRIC APPROACH

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Abstract

This research study aimed to elucidate the significant predictors of profitability in rice farming under the implementation of the Rice Tariffication Law (RTL) in the Philippines. Data from 177 rice farmers in Hilongos, Leyte, Philippines were analyzed using descriptive analysis and econometric modeling. Results showed that the profitability of rice farmers is decreasing since the implementation of RTL in the country. This happens because of a large supply of rice (imported) in the country which resulted in a decrease in farmers' produce rice marketability price. Meanwhile, the agricultural inputs during RTL are also high. The econometric model has revealed that there are only a few significant predictors of profitability in rice farming during the implementation of RTL such as leisure time (p-value=0.076), perception of government (Scale of 1 to 10; p-value<0.001), and farm assets (p-value<0.001). Conclusively, farmers must reduce their allotted time for unnecessary leisure activities and engage more in productive farming activities to increase economic profit amid the promulgated RTL. The results suggested that government support and development program is needed for the poor farmers' sustainability especially in rural areas to continue during the implementation of RTL. The local government must take an initiative to form farmers' associations and cooperatives to provide for farmers' needs and can access credit for farm inputs. Furthermore, the government must provide training and seminars for farmers concerning RTL to become aware and knowledgeable about the pros and cons of the policy.

Key words**:** *Rice Tariffication Law, economic profit, econometric modeling, rural areas in the Philippines*

INTRODUCTION

Economic profitability is the main target of a farmer. According to Brožová [8], profit will vary depending on the costs and revenues which are considered as main economic constituents. In the Philippines, rice production is one of the main sources of income (profit) for Filipino people in rural areas. Rice is known as "Palay" in the country and it is considered a staple food for millions of Filipinos [27]. In fact, Casinillo [12] stated that rice farming is one of the issues in the agricultural sector that is a focal point of the Philippine government to progress. Hence, the government has implemented different agricultural programs that might improve the production of rice as well as the well-being of rice farmers.

Recently, one of the government programs that intrigues a lot of agricultural economists is the Rice Tariffication1 Law (RTL). RTL is also known as landmark policy reform or Republic Act (RA) 11203 [7]. The law was signed by the Philippine president "Rodrigo R. Duterte" last February 14, 2019, that modifies the Act of 1996 which is Agricultural Tariffication [26], and was promulgated in March 2019 [4]. The purpose of this law is to liberalize the import-export and trading of rice from different countries, particularly, by lifting restrictions for imported rice to increase the supply in the Philippines [26], [18]. In other words, the main target of RTL is to increase the purchasing power of rice consumers in the country. However, the implementation of the law has become a controversial issue on how it would change the poverty and food security in the Philippines. RTL has drastically changed the landscape of the rice sector in the country and generates debates between economists and policy makers [4]. Several studies have shown that RTL decreases the rice prices for both producers and consumers which affects the production and consumption of every household in the country [4], [20], [23]. Hence, some groups of people with a high-profile object to the implementation of RTL because of the negative impact on rice producers. In particular, some rice farmers in rural areas are adversely impacted by the Law considering that they are net sellers [12]. In that case, the negative impact of tariffication policy for rice revolves around the well-being of farmers through prices.

Accordingly, because of the low prices of domestic rice, results in low satisfaction in farming due to reduced economic profit [12], [10]. Additionally, prices of agricultural inputs are dramatically increasing and farmers are clamant for government support to sustain their rice production every cropping season [12], [20], [26]. Although the Law has mandated a fund for annual rice production as support or assistance to rice farmers, there are rural areas in the country that are not benefited from the said funding [6], [10]. On the face of it, farmers in rural areas are not satisfied with the impact of RTL on their rice production as their source of income. Hence, it is necessary to investigate some factors that might influence rice farmers' economic profit and this study is realized.

Elucidating the predictors of economic profit in rice farming under the implementation of RTL is scarce in the literature. In general, this study constructed an econometric model that predicts the significant causal factors of profit in rice production. To be specific, the study answers the following goals: (1) to summarize the socioeconomic profile of farmers; (2) to document causal factors that significantly influence the rice farmers' economic profit in one cropping season under Philippines RTL. The purpose of this study is to provide new information or policy that will improve the current law and progress the economic behavior in the country. The results of this study may also supply some suggestions that might improve the economic profit of farmers as well as well-being in farming to achieve sustainable rice production. Furthermore, the findings of this study might help as a basis for other researchers in agriculture and contribute new knowledge to rice production literature.

MATERIALS AND METHODS

Research Location

The site of this study is the rice farm land of Barangay Tabunok (Bato-Tabunok Barangay Road) Hilongos, Leyte, Philippines. In fact, Barangay Tabunok has a wide farm area for rice production and most of the residents are dependent on rice farming as a source of main income [12]. The study only considers farmers with at most 2 hectares of land area intended for rice farming alone. This is to investigate the effect of RTL on small-scale rice farmers in rural areas in Leyte, Philippines. Map 1 shows the location site where the research study is conducted.

Map 1. Location of Barangay Tabunok (Bato-Tabunok Barangay Road) Hilongos, Leyte, Philippines
Source: [16].

Sampling procedure

As for the sample size, a probabilistic sample procedure was employed. In that case, the sample size was approximated with the aid of a 95% confidence interval, where the Z computed value is equivalent to 1.96. In this study, there is a piece of limited information about the farmers, thus, we used *a* p=0.5 proportion as assumed. Hence, the sample size formula is given by the equation 1:

$$n_0 = \frac{Z^2_{\alpha/2}(p)(1-p)}{e^2} \quad (1)$$

where e refers to the margin of error and it is set by the researcher as 5%. Since the population of rice farmers is known to be finite in the study site, the computed sample size was adjusted with the aid of the equation 2:

$$n = \frac{n_0}{1+\frac{n_0}{N}} \qquad (2)$$

where N is the population number of farmers. So, the number of participants for this study was 175 rice farmers. After that, simple random sampling was employed.

Research instrument and data gathering

A developed structured questionnaire was used to gather relevant data needed for this study utilizing a face-to-face interview.

The questionnaire consists of socio-demographic profile (first part) of rice farmers such as age (in years), sex (0-female, 1-male), role in the family (0-nonhead of the family, 1-head of the family), household size, years in education, civil status (0-unmarried, 1-married), leisure time (scale of 1 to 10), social relationship (scale of 1 to 10), health status (scale of 1 to 10) and perception to government (scale of 1 to 10).

The second part of the questionnaire is economic variables such as household assets (₱), monthly household expenses (₱), and farm assets (₱).

For the third part, farmers were asked how much is there total expense or cost (₱) and total revenue (₱) for one cropping season under the implementation of RTL.

And economic profit was calculated as total revenue (₱) less total expense or cost (₱).

Prior to the conduct of the survey, the approval of the Barangay captain was asked and respondents were informed that the participation is voluntary.

Data analysis and empirical model

This study considered a complex correlational design to investigate the relationships between dependent variables and several independent variables using regression modeling [19]. Descriptive statistics such as minimum value (min), maximum value (max), mean (M) and standard deviation (SD) were used to summarize the data.

Multiple linear regression (econometric modeling) was employed to capture the significant predictors of profitability in farming under the implementation of RTL using the ordinary least square (OLS) model. Hence, the econometric model takes the form:

$$\mathrm{P_i} = \beta_0 + \beta_1\mathrm{age_i} + \beta_2\mathrm{male_i} + \beta_3\mathrm{h\_head_i}$$
$$+\beta_4\mathrm{hhsize_i} + \beta_5\mathrm{y\_educ_i} + \beta_6\mathrm{married_i}$$
$$+\beta_7\log(\mathrm{hhassets}+1)_\mathrm{i} +$$
$$+\beta_8\log(\mathrm{hhexpense}+1)_\mathrm{i}$$
$$+\beta_9\mathrm{leisure_i} + \beta_{10}\mathrm{socialrltn_i}$$
$$+\beta_{11}\mathrm{health_i} + \beta_{12}\mathrm{government_i}$$
$$+\beta_{13}\log(\mathrm{farmasset}+1)_\mathrm{i} + \mathrm{e_i} \qquad (3)$$

where: $\mathrm{P_i}$ refers to the profit in one cropping season under RTL, $\mathrm{age_i}$ refers to the age of farmers in years, $\mathrm{male_i}$ is a dummy variable that represents male farmer, $\mathrm{h\_head_i}$ is a dummy variable that captures a farmer that is head of their family, $\mathrm{hhsize_i}$ refers to the number of family members, $\mathrm{y\_educ_i}$ refers to the farmers' number of years in education, $\mathrm{married_i}$ is a dummy variable that captures married farmer, $\log(\mathrm{hhassets}+1)_\mathrm{i}$ refers to the logarithm of household assets (₱) plus 1, $\log(\mathrm{hhexpense}+1)_\mathrm{i}$ refers to the logarithm of household expense per month (₱) plus 1, $\mathrm{leisure_i}$ refers to the farmers perception on their leisure time (scale of 1 to 10), $\mathrm{socialrltn_i}$ refers to the farmers perception on their social relationships (scale of 1 to 10), $\mathrm{health_i}$ refers to the farmers perception on their health aspect (scale of 1 to 10), $\mathrm{government_i}$ refers to the farmers perception on their health aspect (scale of 1 to 10), $\log(\mathrm{farmasset}+1)_\mathrm{i}$ refers to the logarithm of farm assets (₱) plus 1, and $\mathrm{e_i}$ represents as random error in equation 3.

RESULTS AND DISCUSSIONS

Socioeconomic profile of rice farmers

This section depicts and summarizes the different socioeconomic profiles of rice farmers in a particular cropping season under the implementation of RTL. Table 1 shows that the age of farmers is approximately 54 ($\pm$12.79) years old. According to Casinillo [12], farmers are relatively old since the younger generation is sent to school to obtain decent work. Most (80%) of the farmers are male and only 20% of them are female. Dominant of these farmers are head of their families (82%) that carries responsibility for needs. The average number of family members of farmers is close to 4 ($\pm$1.56). On average, these farmers are elementary graduates (7.58 ($\pm$3.07) years in education) and 79% are in married life. Approximately, farmers' household assets are close to ₱45,006.47 (±₱91,370.21) and their monthly household expense is about ₱4,940.33 (±₱2,943.36).

On a scale of 1 to 10, farmers' leisure time is just about 3.91 (±1.88) which is considered relatively low. This is because of the adverse effect of RTL, farmers need to do hard work on their rice farm to maintain its productivity which needs to reduce their usual leisure activities. Moreover, the Philippine government is rated low (3.46±1.92) on a scale of 1 to 10 by farmers due to the effect of RTL on rice prices. Farmers' social relationships and health were rated 5.69 (±2.22) and 5.92 (±2.68), respectively, which can be interpreted as moderate. Farmers' farm assets are more or less ₱10,246.69 (±₱23,579.87). Furthermore, in one cropping season under the implementation of RTL in the Philippines, the farmers’ profit is approximately ₱4,804.09 (±₱3,712.52). All respondents (farmers) of this study said that the profit is decreased as opposed to the previous cropping season (before the implementation of RTL). The impact of RTL in the country has lowered the rice output prices of farmers which occur simultaneously as the farm inputs are increasing. Hence, the economic profit of farmers especially in rural areas is negatively affected by RTL [10].

Table 1. Socioeconomic profile (n=175).

Variables	M±SD	min	max
Age (in years)	53.99±12.79	22	89
Male[a]	0.79±0.41	0	1
Head of the family[a]	0.82±0.38	0	1
Household size	3.89±1.56	1	9
Years in Education	7.58±3.07	1	16
Married[a]	0.79±0.41	0	1
Household assets[b]	45,006.47±91,370.21	500	1,126,510
Household expense[b]	4,940.33±2,943.36	1,100	22,433
Leisure[c]	3.91±1.88	1	9
Social relationship[c]	5.69±2.22	1	10
Health[c]	5.92±2.68	1	10
Government[c]	3.46±1.91	1	9
Farm assets[b]	10,246.69±23,579.87	0	2,090,000
Profit[b,d]	4,804.09±3,712.52	129	21,250

Note: a-dummy variable; b-in Philippine Peso (₱); c-Scale of 1 to 10; d-one cropping season under RTL.
Source: Own calculation and analysis based on data gathered (2022).

An econometric model for profitability

Table 2 presents the four diagnostic tests for the econometric model to ensure the validity of the results. The model was tested for heterogeneity of the variance of all observations in the data set with the aid of the Breusch-Pagan test and found that it is heterogeneous at a 1% level of significance. In that case, the model was corrected using a robust standard error in the model [13]. Using the Ramsey RESET test, it is found that there is no omitted variable bias exists (*p*-value=0.142) in the constructed linear regression model as shown in Table 2.

The variance inflation factor is equal to 1.56, which implies that the constructed model is safe from multicollinearity problems, that is, no correlation exists between pairwise independent variables [2]. Moreover, with the aid of the Shapiro-Wilk test, it is depicted that the residuals of the model are not normal at a 1% level (Table 2). However, it is shown in Fig. 1 that the Kernel density estimate graph of residuals is almost normal relative to the normal density graph. Hence, the model is considered valid for the interpretation of results.

Table 2. Diagnostic test for the regression model.

Assumptions	Test Statistic		*p*-value
Homoscedasticity	Breusch-Pagan	χ^2=6.45	0.011
Omitted variables bias	Ramsey RESET	F=1.84	0.142
Multicollinearity	Variance inflation factor (VIF)	VIF=1.56	-
Normality of Residuals	Shapiro-Wilk test	Z=2.58	0.005

Source: Own calculation and analysis based on data gathered (2022).

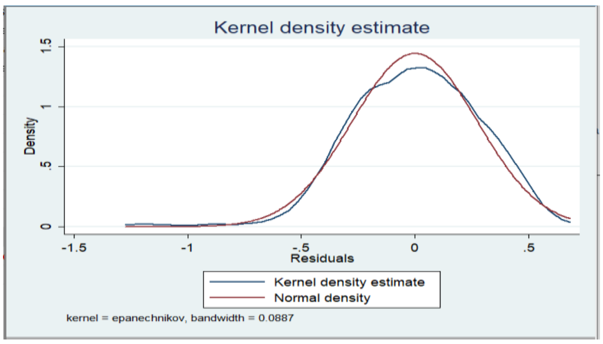

Fig. 1. Kernel density estimate graphs for residuals.
Source: Own calculation and analysis based on data gathered (2022).

Table 3 shows that the constructed model is significant (F_c=9.65, p-value<0.01) at a 1%

level of significance. This implies that several significant predictors influence the profitability of rice farming. Notice that several of the variables in the regression model are not significant, in fact, the goodness of fit (R^2) is only 0.35. It is worth noting that farmers are in a culture shock or upset mood due to the impact of RTL on rice prices. In that case, some socioeconomic profile of farmers does not correlate with their economic profit due to the unproductive or unsatisfied behavior in farming. Table 3 depicts that the following socioeconomic variables are not significant factors in the profitability in rice farming under RTL: (1) age of farmers (*p*-value=0.795); sex (*p*-value=0.604); being a head of the family (*p*-value=0.408); household size (*p*-value=0.963); years in education (*p*-value=0.502); civil status (*p*-value=0.416); household assets (*p*-value=0.617); monthly household expense (*p*-value=0.618); social relationship (*p*-value=0.356); and health (*p*-value=0.996).

Table 3. Linear regression model for profitability in rice farming and its determinants.

Predictors	OLS Model		
	Coefficient	*Std. Error*	*p-value*
Constant	2.6487**	0.549	<0.001
Age (in years)	-0.0005^{ns}	0.002	0.795
Male^a	0.0349	0.067	0.604
Head of the family^a	-0.0589^{ns}	0.071	0.408
Household size	0.0006^{ns}	0.013	0.963
Years in Education	0.0062^{ns}	0.009	0.502
Married^a	0.0663^{ns}	0.081	0.416
log (Household assets^b+1)	0.0289^{ns}	0.058	0.617
log (Household expense^b+1)	0.0743^{ns}	0.148	0.618
Leisure^c	-0.0244*	0.013	0.076
Social relationship^c	0.0160^{ns}	0.017	0.356
Health^c	0.0001^{ns}	0.011	0.996
Government^c	0.0833**	0.017	<0.001
log (Farm assets^b+1)	0.0590**	0.016	<0.001
Participants	175		
F-computed	9.65		
p-value	<0.001		
Goodness-of-fit (R^2)	0.349		

Note: a-dummy variable; b-in Philippine Peso (₱); c-Scale of 1 to 10; d-one cropping season under RTL; ns- not significant; * - significant at 10% α level; ** - highly significant at 1% α level.
Source: Own calculation and analysis based on data gathered (2022).

This finding is not parallel to the existing studies in the literature which stated that farm business profitability is associated with a socioeconomic profile and farmers' attitudes [11], [17], [21], [22].

Table 3 reveals that for every 1 unit increase in the perception of leisure time (scale of 1 to 10), there is a decrease of ₱0.0244 in farmers' profit while other variables were held constant. This result is significant at the 10% level which indicates that if a farmer spends time on leisure activities, then their productivity is slightly decreasing. In other words, the result goes to infer that if a farmer works harder in rice farming, they tend to reduce their leisure time. In fact, allocating more time to leisure will increase the well-being of farmers because they can spend more time with their families and friends. However, the work engagement in rice farming will reduce, where in fact, it needs more focus due to the effect of RTL. Hence, farmers need to sacrifice leisure time over work engagement to maintain productivity in farming [3], [15]. Additionally, findings suggest that farmers need to adopt a sustainable activity such as reducing costs that increases labor savings and avoiding unsuitable expensive practices [14]. The model depicted that the farmers' perception of government support is a significant predictor (*p*-value<0.001) of profitability in rice production (Table 3). For every 1 unit increase in farmers' perception of government, there is ₱0.0833 corresponding increase in economic profit while holding other predictor variables constant. In that case, farmers need help for their rice production activity by the government to maintain farmers' sustainability under the implementation of RTL. Government sustainability programs [24] and agricultural inputs support [1] are a great help to rice farmers in rural areas to continue despite the low rice price brought by RTL. Moreover, the result suggests that the government must modify the policies in RTL and invest in farm inputs that favor the local rice farmers' well-being to continue the rice production in the rural areas of the country [25]. Plus, the aid of government concerted investment and rural development projects as well as training can help rice farmers produce a higher sustainable agricultural experience that strengthens the livelihoods of local farmers in the country [14].

Furthermore, the regression model shows that farmers' farm asset is significant as a predictor of farmers' economic profit. Farm assets refer to the agricultural tools and equipment needed in rice farming. On average, for every 1% increase in farm assets value (₱), there is an increase of ₱0.00059 in farmers' economic profit, ceteris paribus. In fact, if a farmer owns agricultural tools, then it is an advantage since they will not spend any more on borrowing in every cropping season. Additionally, if a farmer owns agricultural equipment (e.g. tractor), they will no anymore hire a labor force for hauling agricultural inputs and other machinery. In that case, farmers can minimize the cost needed for the cropping process and even in harvesting. Findings suggested that the agricultural sector in the country must support and help the poor farmers' needs in farming to progress as independent business farmers in the remote areas of the country [9]. This support will lower the input costs involve in rice production and positively impact their profitability despite the RTL's effect. Furthermore, supporting the rice farmers in relation to the water irrigation program will enhance the productivity of rice yields as well as its economic profit [5].

CONCLUSIONS

The study revealed a low economic profit in rice farming during the implementation of RTL and farmers utterly said that their income has decreased as opposed to the previous cropping seasons (before the implementation of RTL). Although the law targeted a high supply of rice in the country as the main staple food and a low price of rice to consumers, rice farmers were affected by low rice output prices while agricultural input prices are simultaneously increasing. The econometric model has shown that the significant determinants of profitability in rice farming include a low perception score of leisure time, a high perception score of government support, and farm assets. This implies that farmers need to increase their work engagement in rice farming to positively influence their profitability during the implementation of RTL while decreasing their involvement in leisure activities. Farmers are necessary to spend their time on essential activities on the farm rather than spending it on unsuitable and useless human action. Additionally, poor farmers especially in rural areas in the country are in need of government support to sustain and continue to grow rice amid the negative effect of RTL. In that case, the government must find ways to mitigate the adverse impact of the law on poor and non-competitive rice farmers. The government must propose a budget to support poor farmers concerning agricultural inputs because it has a significant role to help farmers to gain more profit and it has a positive effect on rice production. Moreover, the government must provide machinery and equipment for farming to increase the productivity and efficiency of rice production in remote areas in the country. Results recommended that the local government unit must conduct training and seminars that will enhance the farmers' knowledge, attitude, and practices to progress their production despite the promulgated RTL. On the farmers' side, they should plant other crops aside from rice to increase their economic profit. It is also recommended that a related study must be realized in other remote (rural) areas in the country to gather more sufficient data that will elucidate the well-being of rice farmers under the implementation of RTL. Furthermore, for future study and empirical analysis, one may consider other economic variables like savings and access to credit to strengthen the current results of this study.

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DEVELOPMENT OF ORGANIC FARMING IN MOLDOVA: TENDENCIES AND CHALLENGES

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Abstract

The pedoclimatic conditions of Moldova are favorable for the development of ecological agriculture and trading organic agri-food production is a real chance to gain new distribution markets. As the demand for organic agricultural products is increasing, it can be considered a new opportunity for the agri-food export development. The aim of this paper is to analyze the current situation in the development of ecological agriculture in Moldova and its prospects for future growth. The research is based on data provided by Ministry of Agriculture and Food Industry (MAFI), Agency of Interventions and Payments in Agriculture (AIPA). The paper includes an analysis regarding the dynamics of areas cultivated under organic farming in Moldova, number of ecological farmers, their territorial distribution, and state subsidies allocated for development of ecological farming. Farmers education and training have an important role in promoting organic agriculture and ecologic practices in farming. The most challenging problem in organic farming is preventing and controlling diseases and pests. Thus, scientific research plays a specific role in promoting ecological agriculture, and it has a responsibility to focus on giving technical-practical solutions that are simple to implement for all technological components.

Key words**:** *ecological agriculture, organic farming, subsidies*

INTRODUCTION

Organic farming has a large contribution to environmental protection, maintaining the natural balance and obtaining valuable agricultural products without a negative effect on population health. In recent decades organic farming is developing rapidly worldwide.

Practicing ecological agriculture is governed by many requirements and principles, which start from the quality of the land to the actual production of the final product. The role of this system of agriculture is to produce much cleaner food, more suitable for the metabolism of the human body, but in full correlation with the conservation and development of the environment. Genetically modified organisms and their derivatives are prohibited in organic farming [3, 11, 13].

Organic farming is a modern global trend and is increasingly widespread around the world. According to FAO data, in the last 16 years, its area has increased by 4 times, and more than 2 million organic producers have been certified, of which more than three quarters are in developing countries. Currently, organic production includes 1% of the world's agricultural area. Trends in the development of organic production are current in more than 170 countries of the world, and this figure increases annually because organic products are becoming increasingly in demand for various objective reasons by different segments of the population. The development of organic farming is an opportunity to diversity the exported agri-food products on global agri-food market [10].

In recent decades, organic farming has developed rapidly in the Member States of the European Union (E.U.). The area of agricultural land under organic farming had expanded with over 45 percent in 2020 comparing to 2012 in European Union countries. According to Eurostat data, ecologic agriculture in E.U. was practiced on 14.7 million hectares of agricultural land in 2020. The largest share between member states belongs to France, Spain, Italy and Germany. This was due to the negative reaction to the consequences of intensive traditional agriculture to some components of the environment and the quality of agri-food products. Another reason was the adoption of normative acts and materials within the E.U. countries regulating the production, processing, and labelling of organic products, as well as the information support provided to the population and the markets of organic products.

In Moldova the development and practice of ecological agriculture started in the late 90s. However, earlier research addressing sustainable agriculture was promoted, within three research institutes regarding: soil conservation research - 1949, biological methods of plant protection from 1968 and the design of alignment strips to protect agricultural fields since 1965.

The pedoclimatic conditions of Moldova are favorable for the development of ecological agriculture and trading organic agri-food production is a real chance to gain new distribution markets. As the demand for organic agricultural products is increasing, it can be considered a new opportunity to boost agricultural exports on new markets [12].

The aim of this paper is to analyze the current situation in the development of ecological agriculture in Moldova and its prospects for future growth.

MATERIALS AND METHODS

The research is based on the analysis of data regarding the dynamics of areas cultivated under organic farming in Moldova, number of ecological farmers and their territorial distribution. To assess the state support for ecological agriculture, the number of beneficiaries for subsidizing the development of ecological agriculture was examined. The data provided by Ministry of Agriculture and Food Industry (MAFI), Agency of Interventions and Payments in Agriculture (AIPA) was used.

RESULTS AND DISCUSSIONS

Organic farming offers many more advantages both to agricultural producers, consumers of products and to the environment. Thus, more and more agricultural producers are shifting from conventional to organic farming.

In Moldova, the development of ecologic agriculture is supported by the adoption of the Law no.115/2005 on organic agri-food production [8], the Government Decision no.1078/2008 on the approval of the Technical Regulation "Organic agri-food production and labelling of organic agri-food products" [5] and the Government Decision no.884/2014 for the approval of the Regulation on the use of the national trademark "Organic Agriculture – Republic of Moldova"[6].

According to the Law nr. 115/2005, regarding the ecologic agri-food production, all organic production is certified complying with European requirements. The certification and inspection of organic agricultural production is done by an authorized institution of the Ministry of Agriculture and Food Industry. It reflects the rules regarding the production, methods and principles of ecologic agri-food products, labelling, inspection and certification mechanism, imports, exports, and financial incentives for ecologic agri-food producers [8, 12].

Traditionally, agricultural sector was supported by government through different policies and strategies, particularly focusing on farmers income support to ensure agricultural supply with high quality products. Nevertheless, supporting the promotion and development of organic farming is a fundamentally new element of rural development policy, designed to encourage different rural initiatives, helping farmers to restructure their farms, to diversify the range of products, and to access traditional and new markets [11].

Due to its contribution to GDP, significant percentage of overall exports (over half), and substantial labor force employment, the agricultural sector has always been important to Moldova's economic development. Nevertheless, organic farming is a new approach in the development and revival of the agricultural sector.

Analyzing the dynamics of organic farming development in Moldova, a slight increase of

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the areas under ecological agriculture with large fluctuations is observed (Table 1).

Table 1. Dynamics in ecological farming development

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Area, ha	80	169	250	715	7,346	11,766	16,585	19,740	22,102	61,644	45,326	29,798	25,500	30,001	75,686	20,584	28,548	29,352
Number of producers	11	17	23	31	64	155	185	160	172	77	64	58	40	103	136	125	152	144

Source: based on data from the Ministry of Agriculture and Food Industry [9].

From the data regarding the area registered in the organic agriculture, experienced large fluctuations. The largest area under ecologic agriculture was cultivate din 2017, with 75,686 hectares, experiencing a large reduction in 2020. One of the reasons for this decline, was
caused by the costs of ecological inputs that are imported by agricultural producers.
Between 2007 and 2011, there was a rise in the number of agricultural organic producers, from 64 to 185, as well as the area used for ecological agriculture, from 7,346 ha to 61,644 ha. One of the main reasons regarding the increase in the dynamics registered from 2003 to 2011 were the favorable policies supported by the Government, being granted subsidies from 2007 to reimburse the expenses in the conversion period Starting with 2012, the subsidies were granted only at the establishment of the multiannual plantations, which may have had a negative impact on the sector.
In the following period 2012-2016 a decline is observed followed by an immediate growth in 2017 is noticed, due to improvement in governmental policies that allow favorable conditions for development.
In 2020, 144 organic operators were registered in the Republic of Moldova (mostly agricultural producers specialized in different crops, beekeepers and eco certified processors). The total area of ecologic certified land or the land is the conversion period was 29 352.1 hectares, being recognized as ecologic crops – 87 eco varieties and as ecologic products – 65 varieties.
In 2020, we had 144 organic farmers registered (Table 1). Among them, the largest share belongs to farms that have 78 percent certified organic land. In the context of the development of organic products markets and consumer interest, as well as the chance for rural community development, the value chain of organic agriculture is a promising one.

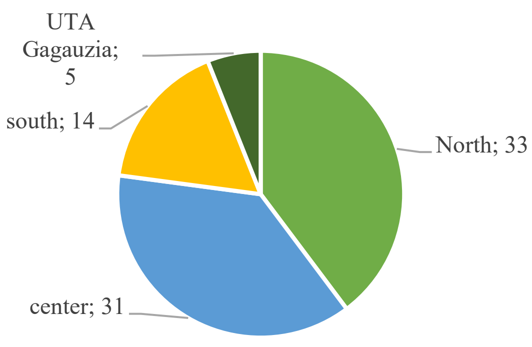

Fig 1. Distribution of ecological farmers by geographical zones (%)
Source: based on data from „Ecological agriculture atlas" [2].

Regarding the geographical distribution of ecological producers, most are in the north (33%), followed by center and south region (with 31 and 14%) (Figure 1).
In Moldova the principles of sale of organic agri-food products are poorly developed.

Analyzing the trade chain, we notice the use of several terms such as "bio", "eco" or "organic" that orient consumers to organic products. Organic products are represented by products obtained and labelled in such a way as to inform the buyer that this product, or the ingredients in the product, have been produced according to organic production methods. The economic operator, following the receipt of the organic product certificate from the inspection and control body, acquires the right to label its products with the indication organic (eco), biological (bio) or organic. Their main role is to support the buyer, who is thus able to more easily identify the products that have been grown/processed in compliance with the principles applicable in organic farming [8].

According to Law 115 from 2005 about ecologic production, certification and inspection of production is compulsory to apply the national organic agriculture logo "Organic Agriculture – Republic of Moldova". Inspection and certification organizations granted 144 operators accreditation in 2020.

For an area of 7,312.16 hectares, two authorities certified more than half of the organic operators (57%). The use of the trademark is over-regulated, and only few farmers can comply with the authorization requirements. Currently, only four domestic producers use the national logo for ecological agriculture. Moreover, the authorization is issued by the Ministry of Agriculture and Food Industry (MAFI) for only one year.

Table 2. Area under ecologic agriculture, by products

Type of product	Area, ha	
	2019	2020
sunflower	6,571.29	6,315.12
wheat	5,537.58	4,363.91
corn	4,557.87	5,560.44
walnut	4,605.45	2,587.16
pea	1,193.6	1,371.66
soya	1,078.91	1,444.93
rape	1,033.29	766.73
apple tree	473	462.01
plum tree	370	277.97
lavender	265.4	267.07

Source: based on data from Ecovisio atlas [2].

Among main cultivated crops under ecologic agriculture a largest area is registered by sunflower, wheat, corn, walnut, pea, soya (Table 2).

In 2020, over 75% is maintained by annual cereal crops (22,242 ha) in the total area of organic land.

According to MAFI data, a decrease in the export of organic products from 55.4 thousand tons in 2018 to 5.9 thousand tons by the 2020, was experienced (Figure 2). This sharp decrease is due to unfavorable climate conditions and the effects of a severe drought that affected dramatically the harvest.

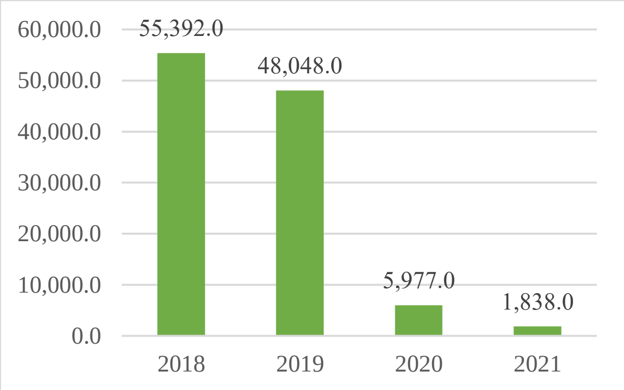

Fig. 2. Evolution of certified ecological products exports, tons.
Source: based on data from the Ministry of Agriculture and Food Industry [9].

Among main exported crops is sunflower, corn, peas, soya etc.

To support ecologic agriculture and organic food production in Moldova, the Government through different organizations is involved. These include the Investment Agency, the Agency for Interventions and Payments in Agriculture (ODIMM), as well as the Organization for the Development of the Small and Medium Enterprises Sector (ODIMM) (AIPA).

The Government Decision No. 592/2019 [7], which approved the Small and Medium Sized Enterprises (SMEs) greening program, [7] which responds to the national priorities on the greening of enterprises, as indicated in the following governmental acts: the approval of the Eco SMEs Program demonstrates the Republic of Moldova's dedication to accelerating the process of reducing the link between economic growth and environmental degradation, as stated in "The Vineyard We Want," the Final Declaration of the United Nations Conference on Sustainable Development (and the provisions of the National Development Strategy "Moldova 2020". Depending on the scale (in accordance with the set grid), different amounts of money are provided to implement greening actions: up to 200 thousand lei for small scales and 500 thousand lei for large scales.

An equally important role in supporting and developing organic agriculture and organic food production is played by the Agency for Intervention and Payments in Agriculture (AIPA). AIPA is an administrative authority responsible for the correct and transparent implementation of the sources of the National Fund for the Development of Agriculture and Rural Environment, as well as the resources of the development partners. Thus, according to Government Decision no. 455/2017 [4], to support the promotion and development of organic agriculture, financial support is provided under Sub-measure 2.5 to all producers who are registered in the organic farming system as a compensatory payment for income foregone and additional costs incurred by beneficiaries who enter voluntary commitments and undertake to remain in this agriculture system. for a duration of 5 years. The financial support shall be granted in the current subsidy year for conversion to organic farming and for the maintenance of organic farming in the field of crop production and organic beekeeping.

Table 3. State subsidies allocated for the development of ecological agriculture

Years	Applications for subsidies	Granted applications	Amount applies, thousands MDL	Amount granted, thousands MDL
2016	14	12	641.8	596.02
2017	31	30	1,880.1	1,590.2
2018	72	69	7,740.9	7,251.5
2019	76	67	8,603.7	7,845.1
2020	65	63	6,901.0	6,220.3
2021	59	53	7,482.2	6,808.8

Source: based on data from Agency of Interventions and Payments in Agriculture [1].

In 2018 there is a significant boost in the number of subsidies applications received by The Agency of Interventions and Payments in Agriculture. From 72 applications worth 7,740.9 million lei were submitted, of which 69 were accepted and 94% of the requested amount was paid to agricultural producers.

Since 2019 subsidies application from producers that are registered in organic farming is constantly increasing. In 2019, 76 files with the value of MDL 8,603.7 thousand were submitted and 67 files – MDL 7,845.1 thousand were approved. From 2020 there is a decrease of the agricultural producers who apply to obtain subsidies that led to the operation of the changes to the Government Decision no. 455/2017 to increase the amount of subsidy for agricultural land in conversion.

CONCLUSIONS

In Moldova, the development of organic farming is a new tendency, slowly growing in recent years. With a share of 1.14 percent in total agricultural area and 144 operators registered in organic farming it is an opportunity for the development of agricultural sector. Recently, an increase by twice in the number of applications to support organic farming is observed, which indicates an interest from farmers in conversion of agricultural land to ecologic agriculture. Another reason for the further development of ecological agriculture in Moldova is the dramatic increase in inputs prices used in traditional agriculture which stimulates farmers to orient towards organic production. Among main cultivated crops under ecologic agriculture a largest area is registered by sunflower, wheat, corn, walnut, pea, soya.

Farmers education and training have an important role in promoting organic agriculture and ecologic practices in farming.

The most challenging problem in organic farming is preventing and controlling diseases and pests. Thus, scientific research plays a specific role in promoting ecological agriculture, and it has a responsibility to focus on giving technical-practical solutions that are simple to implement for all technological components.

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ZOOSYST – COMPUTER SYSTEM DESTINATED FOR THE ANALYSIS OF THE PRODUCTION POTENTIAL OF RUMINANT SPECIES

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Abstract

In order to carry out an efficient and competitive activity, livestock holdings must follow both the technical efficiency, respectively the physical result per unit of the source's effect, as well as the economic efficiency of the activity and join the trends regarding the promotion of qualitative factors, among which they are part the application of modern technologies and computerization. The IT product ZooSyst is a web application intended for the analysis of economic efficiency for sheep, goats, bulls, and buffalo species, through which farmer users will have the possibility to calculate the economic efficiency for the specific activity and to choose the optimal option in the specific branch of activity, ensuring a more judicious matching of objectives with resources. This IT product made available to farmers raising sheep, goats, taurine, and buffalo species offers the possibility of calculating the technological estimate, the income, and expenditure budget, and economic efficiency indicators, for the milk or meat production activity. The online monitoring of agricultural expenses and income is of great interest due to the integration of information and communication technology with agricultural sciences, being based on specific concepts: client/server architecture, integrated platform software, decision support, remote relational communication with bases of web-distributed data, object-oriented programming, econometrical modeling, interactivity, etc. The ZooSyst computer system was designed and realized by the ADER 24.1.2 Project - "Research on the economic efficiency of raising sheep, goats, dairy cows, cattle and buffaloes".

Key words**:** *ZooSyst, web, budget, indicators, technological estimate*

INTRODUCTION

The information society has become an undeniable reality of our days. Many economic activities are transforming to cope with the changes generated by the increasing role of information in traditional activities, such as agriculture [3]. The introduction of information technologies is often presented as one of the ways to transform agriculture into an economically efficient activity [2]. Information technologies can benefit farms, directly or indirectly, when used for precision agriculture, resource management, product marketing, financial management, or in agricultural higher education [6]. An analysis of the level of computerization in Romanian agriculture leads to the conclusion that a small number of farms use computer technologies to access, process, and use the information necessary for the decision-making process, whether it is the production activity or the economic-financial management of the activities carried out [8]. To increase labour productivity, it is needed to assure a modern technical endowment, the knowledge transfer to farmers, the increase of their training level and managerial skills, the intensification of the extension system services, the stimulation of young farmers and women to develop business in agriculture and traditional activities and services, the assurance of funding for investments and modernization, the creation of jobs and new income sources for the agricultural employees and rural population [11].

The purpose of this paper is, in general, the promotion of information technology, in various forms, in the production and management process of agricultural activities, and in particular of the IT product ZooSyst [12]. ZooSyst is a web application developed and produced for technical and economic analysis of the performances of animal farms and the efficiency of using the production factors in classic operating conditions.

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The main structural elements [1], [5] of the informatics system are:
-technical basis or hardware system, which consists of all technical means for collecting, transmitting, storing, and processing data;
-software system, which includes all work modules built for the web operation of the product, according to the functions and objectives that have been preset;
-scientific and methodological basis,
which consists of econometrical models of economics, respectively methodologies, methods, and techniques for achieving information systems;
-information base, which includes data undergoing processing, information flows, systems and nomenclatures.

MATERIALS AND METHODS

From a technical standpoint, ZooSyst is an application built on a Server Side Scripting platform because it allows the creation of complex Web applications (Fig. 1) by processing data on the server and generating pages dynamically, ensuring increased speed and security.

Fig. 1. ZooSyst - main window.
Source: Own contribution.

In this way, Web applications can interface with database servers, having the possibility to access data read in HTML forms and to implement libraries to access external resources. As technologies for the development of the ZOOSYST product, we used the following languages/frameworks:
1. **PHP** – The programming language;
2. **CakePHP** – The back-end framework;
3. **HTML 5** and **CSS 3** – Front-end languages, **Bootstrap** – CSS framework;
4. **MySQL** – Database management system.
PHP ("**Hypertext Preprocessor**") is one of the most widely used server-side programming languages a general-purpose scripting language, especially suitable for developing Web applications, which can be integrated into HTML The popularity of this programming language is due to the following features [10]:
-*Familiarity:* the syntax of the language is very easy;
-*Simplicity:* the syntax of the language is quite free, without including libraries or compilation directives;
-*Efficiency:* PHP uses resource allocation mechanisms, very necessary in a multi-user environment such as the web;
-*Securit*y: PHP provides a flexible and effective set of security measures;
-*Flexibility:* PHP is modularized to keep pace with the development of different technologies and is integrated into many existing web servers;

-*Gratuity*: PHP is developed under the open source license, an aspect that determined its adaptation to the needs of the web, and the efficiency and security of the code.
PHP code consists of instructions - commands given to the interpreter, following which the desired tasks are performed. In creating the ZooSyst system, I used PHP mainly to generate HTML code, which contains instructions for displaying, connecting to databases, reading/writing/manipulating files, warning, sending messages, and others (Fig. 2).
PHP allows describing control structures, procedures, and user functions, being focused on the component interface of the program and providing the ability to create the source code for Windows-standard interfaces, such as windows, buttons, lists, etc.

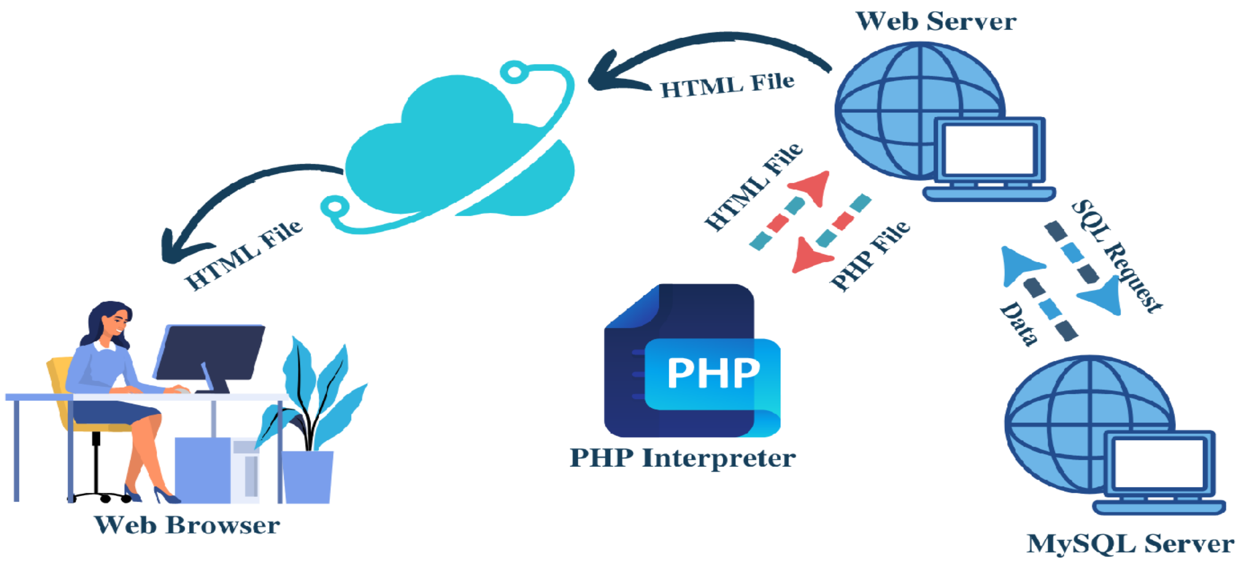

Fig. 2. Functional diagram of the PHP-HTML-MySQL web application suite
Source: Own contribution.

The databases were created and managed in MySQL (MyStructured Query Language), which is an open-source relational database management system. MySQL is an interactive system whose purpose is to act as a database manager, using the SQL language to manage data (specifically, entering, accessing, and processing it). The main qualities of MySQL [9] are that:
-it is distributed free of charge via the Internet;
-it is open source, meaning any programmer can modify its code;
-it allows the creation of any type of application;
-it has elevated security privileges;
-it is capable of handling large volumes of data;
-it has a large technical support capacity;
-it does not require many resources for operation, which induces low costs;
-its structure involves layers and modules, which gives it high stability;
-the data import and export process is simple.
The main database of the ZooSyst web application is the fodder database, containing a total number of 375 variants, sorted alphabetically, which resulted from the combination of two tables: the fodder table (160 variants) and the concentrating table (215 variants). This database relates to the database that contains the species/categories of ruminants (small - for meat/milk, respectively large - for meat/milk) and to the database that contains the expenditure categories.
CakePHP is an open-source framework for PHP, which facilitates the use of databases with active registration, respectively the use of the Model View Controllers architecture - that is powerful, easy to grasp, and guarantees a strict, but natural separation of business logic from data and presentation layers.

CakePHP is intended to make developing, deploying, and maintaining applications much easier. Other features are [10]:
-CRUD integration for simplified use of SQL databases;
-that it uses active records and Data mapper design patterns; it is fast and flexible, with a templating engine that uses PHP syntax and provides utility ("helper") classes that make formatting easier;
-that it works in any subdirectory as long as it is accessible via an HTTP server;
-its security components, rights management, and session management;
-the flexibility to hide views and actions;
-command-line scripts that allow automatic code generation from the physical data model.

HTML (HyperText Markup Language) is a mark-up language used to create web pages that can be displayed in a browser. The purpose of HTML is rather to present information – paragraphs, fonts, tables, etc. – than to describe the semantics of the document. In front-end web development, HTML is used in conjunction with CSS.

CSS (**Cascading Style Sheets**) is a language for styling HTML elements, practically in modern Web Design being used for styling web pages, from the color of the letters and the background up to the positioning of the elements on the web page. The introduction of CSS was necessary to separate the content of HTML pages from formatting or layout, and to allow for clearer and more user-friendly programming, both for the authors of the pages themselves and users while ensuring code reusability and ease of use maintenance.

Bootstrap is the most popular CSS framework used in developing responsive and mobile websites, for front-end components of websites and web applications.

RESULTS AND DISCUSSIONS

Presentation of the results of the ZOOSYST web application

ZOOSYST offers the possibility to calculate the technological estimate, the income and expenditure budget, and the economic efficiency indicators, for the milk or meat production activity.

→ ***The technological estimate*** constitutes the basic document for the elaboration of the annual production plan, the income and expenses budget, as well as for the preparation of operative plans. It is a technical-economic document that is drawn up for each category/species of animals, practically an instrument that highlights the technology of raising animals, the productions obtained, and the expenses determined by them. The main elements found in the technological estimate are [4]: the level of the average production and, respectively, the average daily gain, in the herds intended for fattening;
-duration of growth and exploitation, depending on the species and product;
-the initial and, respectively, the final weight of animals subjected to fattening;
-quantitative and qualitative structure of daily feed rations, corresponding to each species, age category, destination, and production level;
-the necessary medicines and sanitary-veterinary material related to the practiced technology;
-consumption of fuels, fuels, electricity;
-the constructive types of shelters in which the activity is carried out.

→ ***The income and expenditure budget*** represents the final document, which expresses the efficiency of the general activity of the farm, by accumulating income, expenses, and production results. The budget is designed in the form of a balance sheet, containing the expenditure part and the income part, also including the recorded financial results - respectively the profit and its distribution method.

Within expenses [4] two important groups are distinguished: variable expenses and fixed expenses:
-*The main variable expenses* are: expenses with feed, expenses with biological material, expenses with electricity and fuel, expenses with medicines and sanitary-veterinary materials, other material expenses, supply quota, and insurances.
-*The main fixed expenses* are: labor expenses, general expenses, interest expenses on loans, and depreciation expenses for buildings and utilities.

→ ***The technical-economic indicators*** are tools for monitoring, evaluation, forecasting, and decision-making support for the farmer, which quantify both the efforts made to obtain the respective production and the effects resulting from these efforts. Practically, to determine the efficiency of animal production, indicators are used that reflect the influence of different factors on the production process. The profitability of an economic unit is expressed through a system of indicators because no indicator or economic category can perfectly, complexly, and completely reflect reality, phenomena, or economic processes. The system of profitability indicators is characterized by a higher degree of synthesis, and reflection of the economic and financial results. They must be correlated with the other indicators of economic efficiency - from the various subsystems - which constitute factors that determine the amount of profit and the level of the rate of return.

From a constructive point of view, the IT system is made up of three categories of elements:

(1)*Input data = information entered by the system user*

(2)*System constants* = nomenclatures, internal tables, and tables of links to the program:

-the table with categories of animals (classified into small ruminants and large ruminants),

-the feed table (which contains the fodder and concentrate categories),

-the table with the calculated values of the Standard Output coefficients (Table 1).

Table 1. Standard-Output coefficients

	Name of species/category of animals	**SO coefficients (Euro/head)**
1	Dairy cows	1,200.46
2	Cattle for meat	344.4
3	Female buffaloes for milk	1,200.46
4	Dairy sheep	54.91
5	Sheep for meat	26.72
6	Dairy goats	112.98

*Note: SO = coefficient value*number of heads/series
Source: own contribution.

(3)*Output data* = reports generated after loading input data and constants, previously defined, based on calculation algorithms specific to each design module:

-technological quote/category of an animal;

-income and expenditure budget/ animal category;

-technical-economic indicators.

I. Description of the informational flow of the ZOOSYST web application

Step 1. User authentication

- username and password are entered, which are received by the previous request to the administrator of the ZOOSYST site.

Step 2. Completion of elements for a technological estimate

- choose the **Categoria de animale (**Category of animals**)** from the list (they are 6 categories: dairy cows, cattle for meat, female buffaloes for milk, dairy sheep, sheep for meat, and dairy goats);

- enter the value for the **Numar de capete** (Number of heads);

- enter the value for **Productia medie** (Average production);

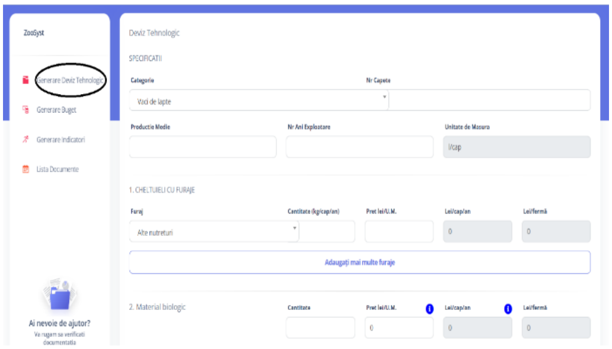

Fig. 3. Production features window.
Source: ZOOSYST.

- the input categories (Figs. 3 and 4) are completed with values: **Furaje** (Fodder)**, Material biologic** (Biological material)**, Energie si combustibil** (Energy and fuel)**, Medicamente si material sanitar** (Medicines and sanitary material)**, Alte cheltuieli material** (Other material expenses)**, Asigurari** (Insurances)**, Cheltuieli cu forta de munca** (Labor costs)**, Cheltuieli generale** General expenses)**, Dobanzi la credite** (Loan charges), **Amortisment** (Depreciation).

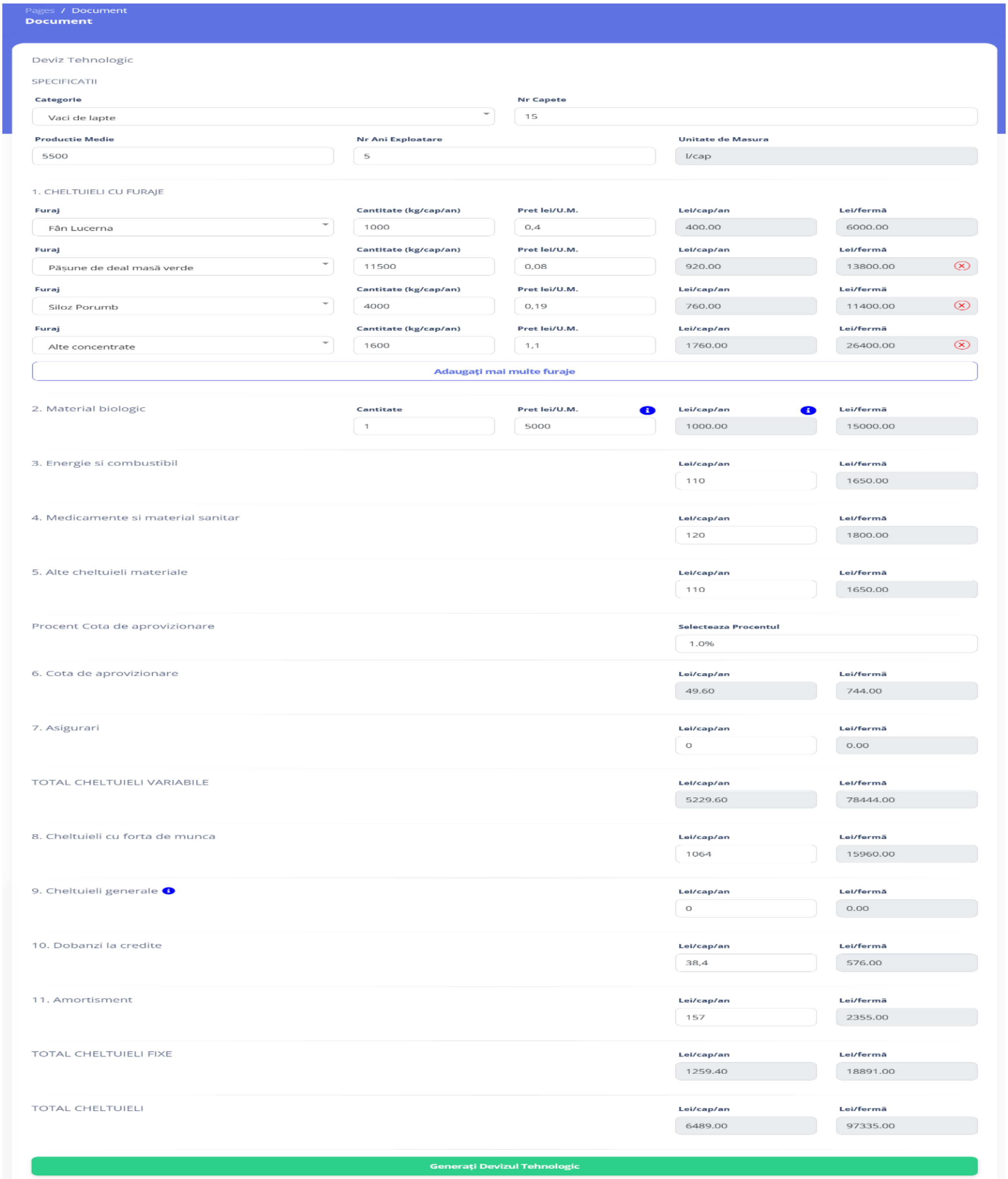

Fig. 4. Data editing window for the technological sheet estimate.
Source: ZOOSYST.

- after all the categories of expenses incurred in the production process for the respective species/category have been completed, the technological estimate (Table 2) can be generated, which will appear in an Excel spreadsheet format.

Remarks:

✓ The value for the **Producția medie** (yield) is calculated according to inputs: **Sporul mediu zilnic** (Average daily gain), **Greutate la intrare** (Input weight), and **Valoare coeficient SO** (Value of the SO coefficient)

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✓ **Cheltuielile cu furaje** (Feed expenses) made up of the total expenses corresponding to each feed category, selected according to the feed ration used in the farm. The values in the columns **Cantitate** (Quantity) and **Pret lei/U.M** (Price RON/ U.M.) are going to be entered by the user, while the values in the columns **Lei/cap/an** (RON/head/year) and **Lei/ferma** (RON/farm) are going to be calculated using **Numar capete/serie** (No. heads/series) in according to the following formulas:

Table 2. The technological sheet estimate

1	DEVIZ TEHNOLOGIC VACI DE LAPTE					
2			Total Capete	Productia medie		Ani Exploatare
3			15	5500	l/cap	5
4			ANUL			2022
5			U.M/cap			
6	SPECIFICARE	U.M.	Cantitate	Pret lei/U.M	Lei/cap/an	Lei/fermă
7	1. Cheltuieli cu furaje	kg			3840	57600
8	Fân Lucerna	kg	1000	0,4	400	6000
9	Pășune de deal masă verde	kg	11500	0,08	920	13800
10	Siloz Porumb	kg	4000	0,19	760	11400
11	Alte concentrate	kg	1600	1,1	1760	26400
12	2. Material biologic	lei	1	5000	1000	15000
13	3. Energie si combustibil	lei			110	1650
14	4. Medicamente si material sanitar	lei			120	1800
15	5. Alte cheltuieli materiale	lei			110	1650
16	6. Cota de aprovizionare	lei			49,6	744
17	7. Asigurari	lei			0	0
18	TOTAL CHELTUIELI VARIABILE	lei	0	0	5229,6	78444
19	8. Cheltuieli cu forta de munca	lei			1064	15960
20	9. Cheltuieli generate	lei			0	0
21	10. Dobanzi la credite	lei			38,4	576
22	11. Amortisment	lei			157	2355
23	TOTAL CHELTUIELI FIXE	lei	0	0	1259,4	18891
24	TOTAL CHELTUIELI	lei	0	0	6489	97335

Source: ZOOSYST.

Lei/cap/an = Cantitate * Pret lei/U.M
Lei/ferma = Lei/cap/an * Numar capete/serie

✓ The value from the category **Material biologic** (Biological material) is entered according to the production category: meat or milk, as follows:

- for meat species, in the **Cantitate** (quantity) column has to be entered the value from the **Greutate la intrare** (Input weight).

- for dairy species, the user will input the production animal value on the column **Pret lei/U.M**. (price/measure unit), and the value in the column **Lei/cap/an** (price/head/year) is calculated according to the formula **Pret lei /U.M./nr. ani de exploatare a animalului** (Price RON/U.M./no. years of exploitation of the animal).

✓ The values for **Energie și combustibil, Medicamente și material sanitar, Alte cheltuieli materiale, Asigurari** (Energy and fuel, Medicines and sanitary material, Other material expenses, Insurance) are entered accordingly in the column **Lei/cap/an** (lei/head/year), and the value from the column **Lei/ferma** (Lei/farm) is calculated according to the formula above.

✓ For the **Cota de aprovizionare** (Supply Quota) choose the corresponding percentage from the list, after which the program will calculate the value **Lei/cap/an** (Lei/head/year), and the value in the column **Lei/ferma** (lei/farm) is calculated according to the formula from point 1. All the expenses specified above form the category of variable expenses, so the values for the columns **Lei/cap/an** (Lei/head/year), and **Lei/ferma** (lei/farm) from **TOTAL CHELTUIELI VARIABILE** (Total variable expenses) is calculated as the sum of the corresponding values.

✓ **Cheltuieli cu forta de munca** (Labor expenditures) will be calculated and updated for each year of production, based on changes that may occur in input values: **Numar muncitori/ferma** (Number of workers/farm), **Salariul brut/luna** (Gross salary/month), **Numar luni** (Number of months) and **Numar capete/serie** (Heads/series).

✓ For the **Cheltuieli cu forta de munca** (Labor expenditures), **Cheltuieli generale** (General expenditures)**, Dobanzi la credite** (Loan interest) **and Amortisment** (Depreciation), the user will enter the value from the column **Lei/cap/an** (lei/head/year), and the value in the column **Lei/ferma** (Lei/farm) is calculated automatically. All expenses from this point form the category of fixed expenses and the values for the columns **Lei/cap/an** (lei/head/year) and **Lei/ferma** (Lei/farm) from **TOTAL CHELTUIELI FIXE (**Total fixed expenses) are calculated as the sum of the corresponding values.

TOTAL CHELTUIELI = TOTAL CHELTUIELI VARIABILE + TOTAL CHELTUIELI FIXE

TOTAL EXPENDITURES = TOTAL VARIABLE EXPENDITURES + TOTAL FIXED EXPENDITURES

Step 3. Completion of elements for the income and expenditure budget

- in the window by Fig. 5 complete the inputs: N**r. vitei valorificati/ferma (No. calves recovered/farm), Pret în viu/cap** (Price/Live animal)**, Pret/cap reforma**

(Price/culled head), **Cantitate gunoi grajd valorificat/ferma** (Amount of manure recovered/farm), **Pret gunoi/tona** (Manure price/ton).

The data editing window for the secondary production is presented in Fig.5.

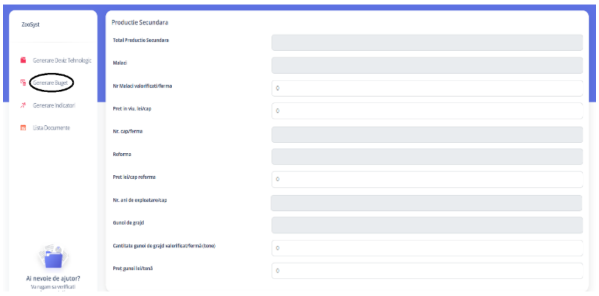

Fig. 5. Secondary production window.
Source: ZOOSYST

The data editing window for income and expenditure budget are shown in Fig. 6.

The values are taken and used in the calculation of the elements of the budget, as follows:

- enter the value for the **Subventii (**Subsidy) and **Pret piata** (The market price), respectively the value of the percentage related to the tax rate is chosen from the list.

to calculate the value of **Impozite si taxe (**Taxes and fees).

- all expenditure categories have been calculated or taken over automatically from the technological estimate and the budget can be generated (Table 3).

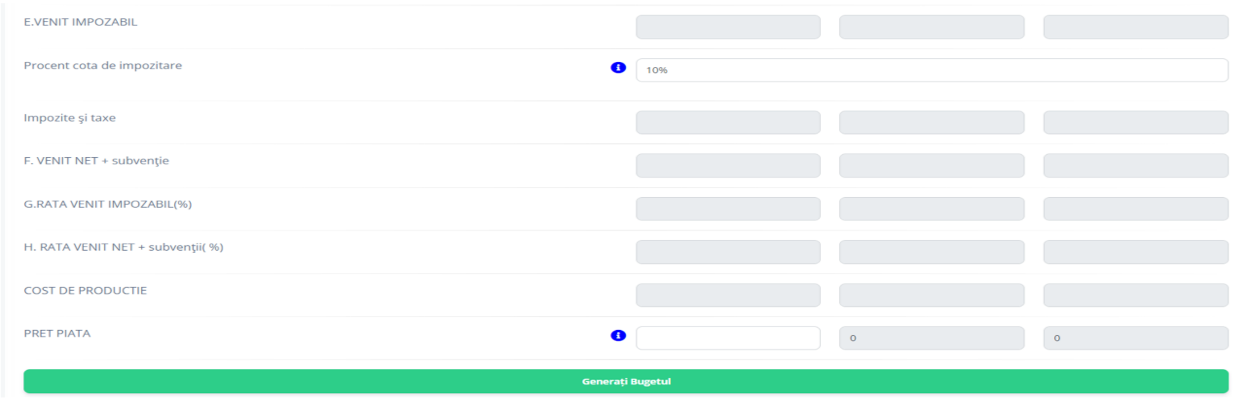

Fig. 6. Data editing window for the income and expenditure budget.
Source: ZOOSYST.

Table 3. The income and expenditure budget

1	DEVIZ TEHNOLOGIC VACI DE LAPTE					
2			Total Capete	Productia medie		Ani Exploatare
3			15	5500	l/cap	5
4			ANUL			2022
5			U.M/cap			
6	SPECIFICARE	U.M.	Cantitate	ret lei/U.M	Lei/cap/an	Lei/fermă
7	1. Cheltuieli cu furaje	kg			3840	57600
8	Fân Lucerna	kg	1000	0,4	400	6000
9	Păşune de deal masă verde	kg	11500	0,08	920	13800
10	Siloz Porumb	kg	4000	0,19	760	11400
11	Alte concentrate	kg	1600	1,1	1760	26400
12	2. Material biologic	lei	1	5000	1000	15000
13	3. Energie si combustibil	lei			110	1650
14	4. Medicamente si material sanitar	lei			120	1800
15	5. Alte cheltuieli materiale	lei			110	1650
16	6. Cota de aprovizionare	lei			49,6	744
17	7. Asigurari	lei			0	0
18	TOTAL CHELTUIELI VARIABILE	lei	0	0	5229,6	78444
19	8. Cheltuieli cu forta de munca	lei			1064	15960
20	9. Cheltuieli generate	lei			0	0
21	10. Dobanzi la credite	lei			38,4	576
22	11. Amortisment	lei			157	2355
23	TOTAL CHELTUIELI FIXE	lei	0	0	1259,4	18891
24	TOTAL CHELTUIELI	lei	0	0	6489	97335

Source: ZOOSYST.

Step 4. Completion of elements for the technical-economic indicators

- in the Work Productivity window (Fig. 7), fill in the inputs: **Nr. muncitori/ferma** (No. workers/ farm), **Nr. zile lucrate/om/an** (No. days worked/ man/ year) and **Nr. ore/zi/om** (No. hours/ day/ man).

Table 4. Technical-economic indicators

1	INDICATORI VACI DE LAPTE			
2	Nr. crt.	INDICATORI	UM	Valori
3	0	1	2	3
4	1	Producţia medie	l/cap	5500,00
5	2	Valoarea producţiei	lei/l	1,21
6	3	Valoarea producţiei principale	lei/l	1,10
7	4	Cheltuieli totale	lei/l	1,18
8	5	Cheltuieli pentru producţia principală	lei/l	1,07
9	6	Cheltuieli variabile	lei/l	0,95
10	7	Cheltuieli materiale	lei/l	0,92
11	8	Cheltuieli fixe	lei/l	0,23
12	9	Cheltuieli cu forţa de muncă	lei/l	0,19
13	10	Costul unitar	lei/l	1,07
14	11	Preţul de valorificare	lei/l	1,10
15	12	Productivitatea muncii în expresie fizică	Ore-om/l	0,06
16	13	Productivitatea muncii în expresie valorică	Lei/ora-om	17,19
17	14	Cheltuieli cu forţa de muncă la 1000 lei producţie totală	lei	159,84
18	15	Cheltuieli materiale la 1000 de lei producţie totală	lei	761,64
19	16	Cheltuieli la 1000 de lei producţie principală	lei	972,29
20	17	Profit sau pierdere pe unitatea de produs	lei	0,03
21	18	Rata rentabilităţii	%	2,85
22	19	Marja asupra cheltuielilor variabile (MCV)	lei	0,26
23	20	Marja asupra cheltuielilor variabile %	%	21,44
24	21	Pragul de rentabilitate în unităţi valorice PR	lei	5874,55
25	22	Pragul de rentabilitate în unităţi fizice PR	l	5340,50
26	23	Rata riscului de exploatare	%	97,10
27	24	Indicele de securitate (Is)		0,03
28	25	Poziţia absolută faţă de PR	lei	175,45
29	26	Poziţia relativă faţă de PR		0,03

Source: ZOOSYST.

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Fig. 7. Work productivity window.
Source: ZOOSYST.

- the computer system takes the values of the indicators obtained in the previous screen and then calculates the financial indicators, specific to the profitability analysis, which it displays in spreadsheet format (Table 4).

The window for generating technical-economic indicators is presented in Fig. 8.

Step 5. Document list view

After going through the steps described above, the program allows you to choose ***Lista documente*** (The list of documents) option, basically, a set that contains the technological estimate, the income and expenditure budget, respectively the technical-economic indicators, and which can be generated for each species/category among those analyzed within ZOOSYST.

The list of documents is presented in Figure 9.

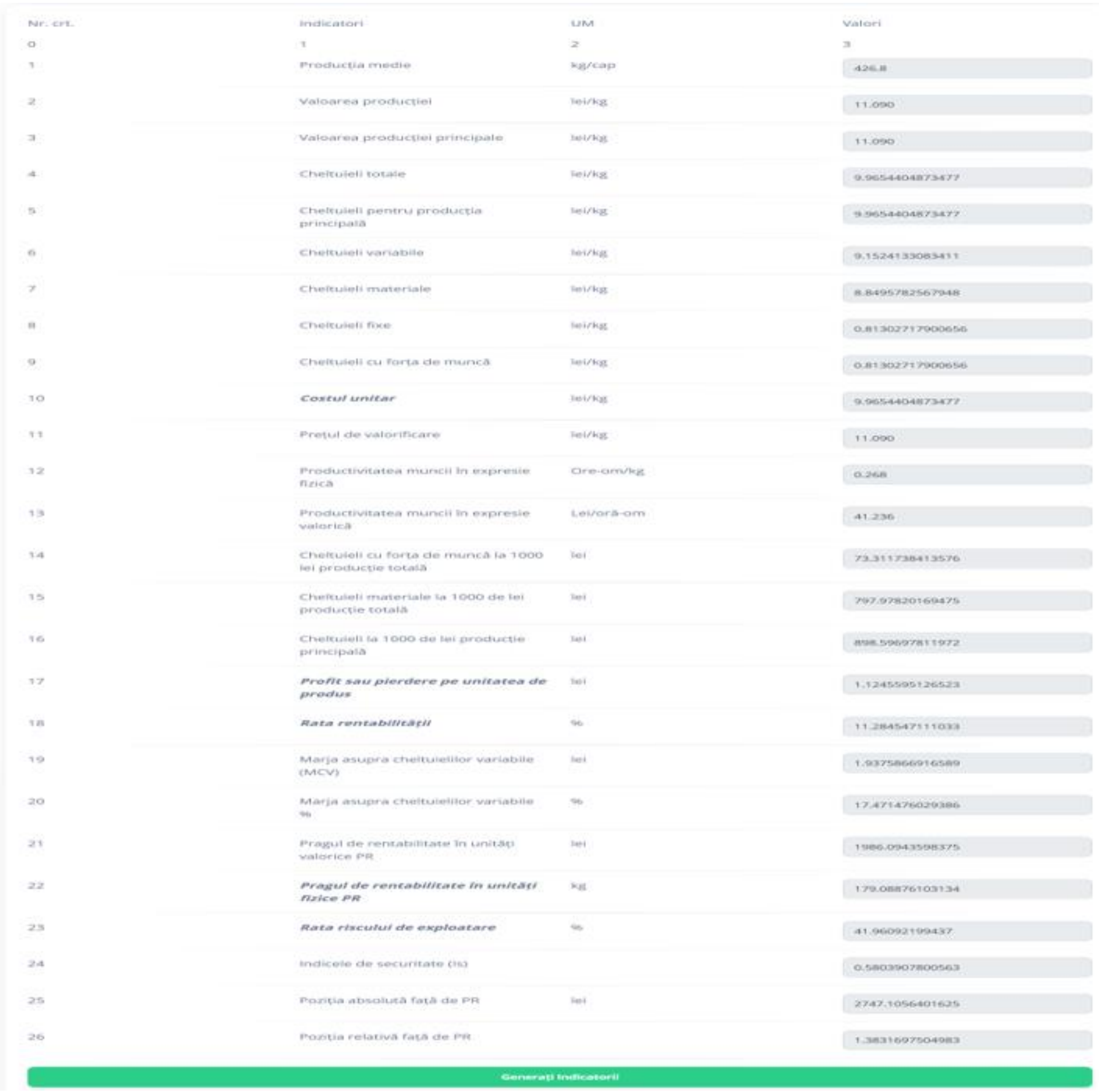

Fig.8. The window for generating technical-economic indicators.
Source: ZOOSYST.

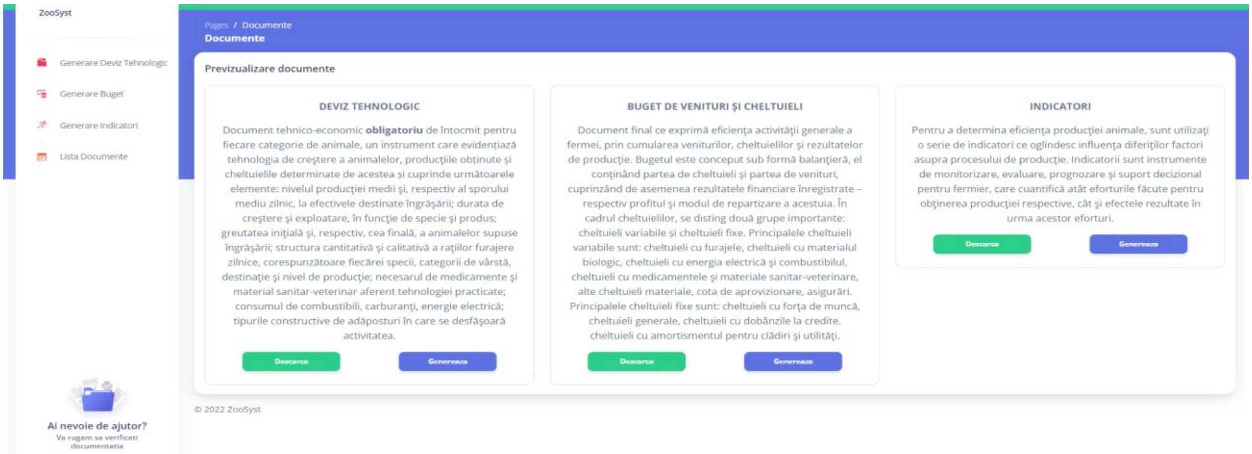

Fig. 9. Document list generation window.
Source: ZOOSYST.

CONCLUSIONS

The use of high-performance computer systems, adapted to the informational needs of farmers, can lead to the improvement of farm management and can contribute to the gradual transformation of agriculture from subsistence agriculture into a high-performance economic activity [7]. For this purpose, this paper proposes the development of computer systems accessible to small and medium-sized farms, which, at the same time, meet their special informational needs.

The ZOOSYST web application allows the analysis of production activity based on specific economic and technical indicators and provides management information necessary to plan the best allocation of resources. From an economic-financial point of view, this analysis can highlight correlations between revenues and expenses from the development production (grouped into variable costs and fixed costs) and allows the development of different hypotheses and simulations on the farm's profits. From the point of view of management, the analysis allows optimal sizing decisions on the production capacity and attracts investments for the development and modernization of the farm.

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WEB PLATFORM FOR THE PRESENTATION OF ACADEMIC FIELD TRIPS AND TRAINEESHIPS IN HIGHER EDUCATION - AGROTOURISM AND PUBLIC FOOD SPECIALIZATION

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Abstract

The participation of university students in workplace learning programs, which aims to develop their socio-professional skills, is a fundamental activity for their proper insertion into the labor field, after their graduation. A practical approach to all the theoretical knowledge accumulated over the years of study will contribute significantly to the sedimentation, respectively to the acquisition of pragmatic skills, anchored in reality, and frequently requested by every nowadays employer. Traineeships aim to facilitate a context for the application of theoretical knowledge in a professional setting, giving each student the experience of work, responsibility, accountability, and the satisfaction to be able to perform certain tasks by themselves. Carried out to complement the study program, they represent a real springboard for the student in finding a job in a highly challenging economic environment. The traineeship can be carried out in many industries and services, being a mandatory activity, included in the curricula of the bachelor's and master's programs. This paper aims to present a webpage-type application which was created to present and promote the traineeship opportunities within the specialization Engineering and Management in Public Food and Agritourism of the Faculty of Management and Rural Development, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania (UASVM). All the information and pictures presented on the web page are related to a full license cycle of 4 years, which took place before the 2019 Covid pandemic.

Key words: *student, traineeship, agritourism, public food*

INTRODUCTION

Lifelong learning is a continuous process of flexible learning opportunities, by correlating studying and the skills acquired in formal institutions with the development of skills in non-formal and informal contexts, especially in the workplace [3].
A traineeship represents the activity that the students carry out according to the curriculum and whose purpose is to check the applicability of the theoretical knowledge that the students have acquired during the faculty’s classes and to familiarize the students with the practices from the real economic and social environment [24, 26].
The specialized practice in the Faculty of Management Economic Engineering in Agriculture and Rural Development is organized accordingly to the actual legal provisions [15] and is provided in the university curriculum as a mandatory discipline, of 3 - 4 weeks, which culminates with a project/practice report.
According to the “Regulation on the organization and conduct of specialized internships within the IMAPA license program [22]”, specialized traineeships are carried out at organizations in the field of production and services, commercial companies active in the agricultural sector or related fields, at farms or agritourism establishments, public food establishments, boarding houses, at specialized research institutes, at central or local public administration institutions or in other organizations with legal personality in the country or abroad [12, 17], which can ensure the internship in correlation with the requirements of the license program. Before the start of the traineeship, an agreement regarding its implementation will be concluded between the internship organizer, the internship partner, and the trainee.

The educational objectives that have to be achieved, the skills obtained through the internship, as well as the methods of conducting the internship are described in the document attached to the convention regarding the implementation of the internship, called the traineeship portfolio.

The internship organizer (as the university) appoints a coordinating teacher, responsible for planning, organizing, and supervising the implementation of the internship. The supervising teaching staff, alongside the tutor appointed by the practice partner, establishes the practice theme and the professional skills that are the object of the internship. At the end of the programme, the tutor prepares a report, based on the evaluation of the level of competence acquired by the intern [18]. The result of this evaluation will form the basis of the grading of the trainee by the teaching staff responsible for conducting the internship. Following the completion of the internship, the internship organizer will grant the trainee the number of transferable credits specified in the traineeship agreement [11].

The main purpose of the professional practice represents the sedimentation of the knowledge accumulated during the years of study, by correlating them with case studies and real tasks, which require adaptation and use of theoretical notions in a practical manner [15]. This activity brings the student closer to the field of work, presenting the requirements imposed by various fields of activity to which he/she can go after graduation.

The fulfillment of the specific objectives, aimed at successfully solving all the tasks received during the internship, will lead to [20]:

-Alignment of theoretically acquired knowledge with the requirements of practical activity;

-Optimizing the relationship between the academic and the economic environment, aiming to adapt the curriculum to the market requirements, the easier transition between the academic environment and the active life, respectively the easier insertion into the labor market;

-The receptiveness of the economic environment to the importance and benefits of internships;

-Opening students' attitudes regarding the advantages of professional practice programs, emphasizing the development they bring to their practical skills.

The purpose of this article is to present and promote the internships, respectively the documentation and practice trips in which one of the authors participated, in the period 2016-2020, during the four years of being a student majoring in Engineering and Management in Public Food and Agrotourism - Faculty of Management and Rural Development, UASVM Bucharest. All images from trips and internships are from the author's archive.

MATERIALS AND METHODS

In order to put into practice the objectives that were the basis of the article, it was chosen a modern method of a multimedia presentation throughout a web page.

From a constructive point of view, a WIX website builder platform (Fig. 1) was used to create the website, which is user-friendly, free, modern, and rich in functions.

The method of creating web pages in WIX is mainly based on the drag-and-drop function, a standard practice for the platforms in its category. According to the authors of the platform, its purpose is to offer the possibility of creating a website without the need to know how to code in HTML, CSS, or JS.

The WIX platform [mmm] contains a large number of editing options for content elements, the list of elements accessible in the WIX site builder is composed of [30]:

-Texts (regular, headings, paragraphs)

-Images (both files and images from Facebook or Instagram accounts)

-Galleries (regular, 3D, sliders)

-Buttons (several dozens of ready-made button projects)

-Fields (Regular, patterned fields or containers mentioned above)

-Stripes (classic, parallax + some additional types)

-Shapes (lines, arrows, icons, banners, decorative shapes)

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-Video files (from Youtube or Vimeo)
-Music files (WIX offers a wide range of audio players for audio files + integrations with external systems: SoundCloud, Spotify, iTunes, Apple Music)
-Social media plugins (Facebook, Instagram, Twitter, Pinterest, Youtube, VK).
-Contact modules (forms, Skype, subscription fields, Google maps).
-Site menu (with motifs, vertical, horizontal, and a menu for anchors)
-Lists (messages, events, references for products and services, staff)
-Blog
-Online shop for HTML code (HTML, CSS, JS, Flash)
-Fields for login (for simple users and administrators)
-PayPal payment options
-Anchors (elements that will always be displayed on top)

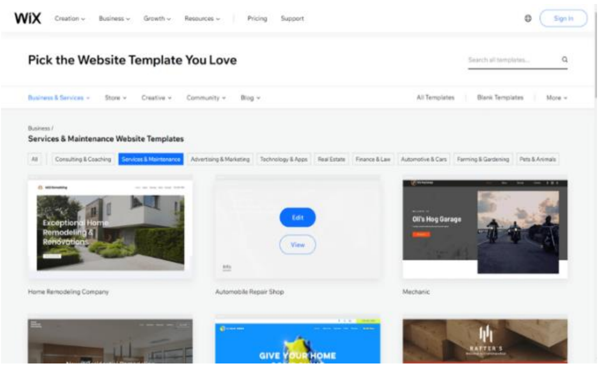

Fig. 1. WIX platform main menu
Source: [30].

Adding different elements to the content of a site is easy and intuitive, using the drag-and-drop method. The WIX program is definitely one of the best options on the market, successfully combining high functionality and multiple, modern options with good optimization, ease of use, and ergonomics. A huge advantage of the WIX site maker is its stability and the fact that you can transfer an idea online without having to work on the site's code. In addition, already during the editing of the site, a clear picture of how the future site will look is provided, being a very useful tool.
At the same time, a disadvantage of the WIX platform could be the lack of support in the Romanian language, as the tutorial base and app's functions are in English.
As seen in Fig. 2, all the elements of the site are arranged centrally, at the top is the header - which displays the university's logo - and below there is the content, on a white background chosen for legibility and visibility.
The navigation bar comprises five buttons/menus – Acasă, Anul I, Anul II, Anul III, Anul IV – each of which is created with a link property to a page whose content is displayed according to the title. Both the Acasă button and the top image of the university's coat of arms lead to the main page, with all these content elements embedded in the page with links to the main page.

Fig. 2. Navigation bar with menus
Source: own contribution.

All site's pages contain the navigation bar and the logo, arranged throughout it on a white background.
The texts and images displayed on the website pages are framed on a white, green, and yellow background to create a visually pleasing color scheme, and the color of the text alternates between green, white, and black.
Images are not displayed at their maximum potential resolution in a manner for the site to be viewable on any type of device (some devices do not support high resolution, and under these conditions, the site will not be able to be displayed on it).
The pictures are not arranged in the same way in any of the menus because we did not want to create a routine, they alternate between right and left alignment or center alignment.

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RESULTS AND DISCUSSIONS

The structure of the site was designed as follows:

→ The **Acasă** button (Fig. 3) – represents the main page of the site, which contains a brief description of the site's content and integrates a satellite map indicating the location of the University of Agronomic Sciences and Veterinary Medicine in Bucharest and, implicitly, of the Faculty of Management and Rural Development.

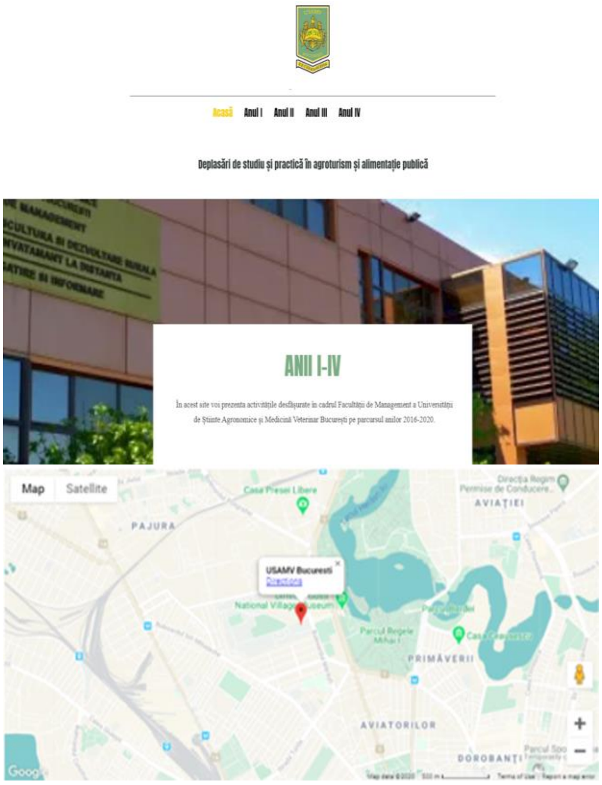

Fig. 3. "Acasa" Page
Source: Own contribution.

→ The following buttons: ***Anul I, Anul II, Anul III, Anul IV*** – lead the user to different pages where the trips are reported in chronological order, as we are going to present them in the following paragraphs.

By pressing the **Anul I** button, the website will open the page with the presentation of the trips and the traineeship from the first year of the faculty (Fig. 4).

The first trip was to Ploiesti, as documentation and practical research visit (Fig. 5).

Fig. 4. "Anul I" Page
Source: personal archive.

During this trip, it was visited the Clock Museum "Nicolae Simache" [4], which has a collection of almost 1,000 pieces, among them: a sundial, a clock set in motion by a waterfall, the first pocket watch ("the egg de Nürnberg"), tower clocks, pieces made by London craftsmen, French, Austrian or Swiss clockmakers, clocks with musical mechanisms, clocks that belonged to personalities, fun clocks (of the miller, blacksmith, barber, etc.), clocks with various indications outside the hours, as well as other items related to the theme.

Fig. 5. "Anul I" Page – visit to Ploiesti
Source: personal archive.

The County's Museum of Natural Sciences [23] was established in 1956 and since then has been in a continuous process of expansion and modernization. It is nationally recognized as one of the most prestigious centers of this profile in Romania.

The **Anul II** button allows the display of study and practice trips made in the second year, in the order specified below.

Fig. 6. "Anul II" Page
Source: personal archive.

Thus, in the second year, the specialized practice was carried out in the field of public catering and agritourism in the balneo-climatic resort of Balvanyos (Fig. 7), at the agritourism guesthouse whose owner is Mr. Attila Daraguș, professor of Culinary Techniques at the Faculty of Management and Development Rural.

Fig. 7. Traineeship at Balvanyos
Source: personal archive.

"Sfânta Ana" Lake is the only crater lake in Romania located in the volcanic crater of the volcano named Ciomatu Mare of the Eastern Carpathians, near Tușnad in the Natural Reserve of Mohoș, Harghita County (Fig. 8).

Fig. 8. "Anul II" Page – visit to "Sf. Ana" Lake
Source: personal archive

Fig. 9. "Anul II" Page – Travel to Buzau
Source: personal archive.

Another study trip was to Buzău and was centered on visiting two wineries, one of them belonging to the material base of USAMV Bucharest. The Licorna Winehouse winery [16] was opened in 2013, but its history starts 100 years ago, the red wine being its specialty. The varieties planted on the 30 hectares of the Licorna winery are Sauvignon blanc, Fetească albă, Chardonnay, Romanian Tâmiaosă, Fetească neagra, Merlot, and Cabernet Sauvignon.

The trip continued with a study visit to the Research - Development Station for Viticulture and Winemaking Pietroasa [21] - an area steeped in history, famous for its viticulture treasury and its unique wines. Pietroasa is the place where history meets the voice, harmony, and charm of wine. Considered the "cathedral of viticulture", Pietroasa represents values such as tradition, continuity, and performance (Fig. 9).

The last trip was to Giurgiu County, to the Comana Natural Park [6] – a protected area with an area of approximately 25,000 ha. The purpose of this park is to protect the floristic and faunal diversities within its premises.

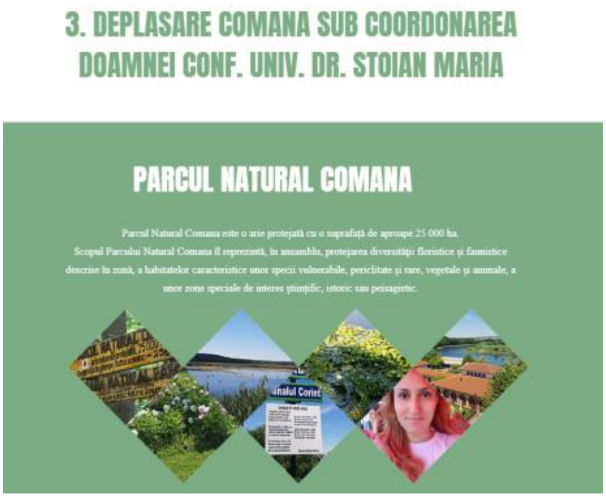

Fig. 10. "Anul II" Page – visit to "Comana" Natural Park. Source: personal archive.

The Adventure Park is like a magical outdoor land, where every sporting activity leads the visitors to push their limits and helps them to build their self-confidence. The fresh air and surprising trails offer guests a pleasant and recreational way to spend their free time with family or friends (Fig. 10).

By choosing the **Anul III** button the site will display a list of the trips made that certain year (Fig. 11). On this page, compared to the other ones, I inserted a list-type object because in, the third year, there were the most trips, and it will facilitate the access to the specific information.

Fig. 11. "Anul III" Page
Source: own contribution.

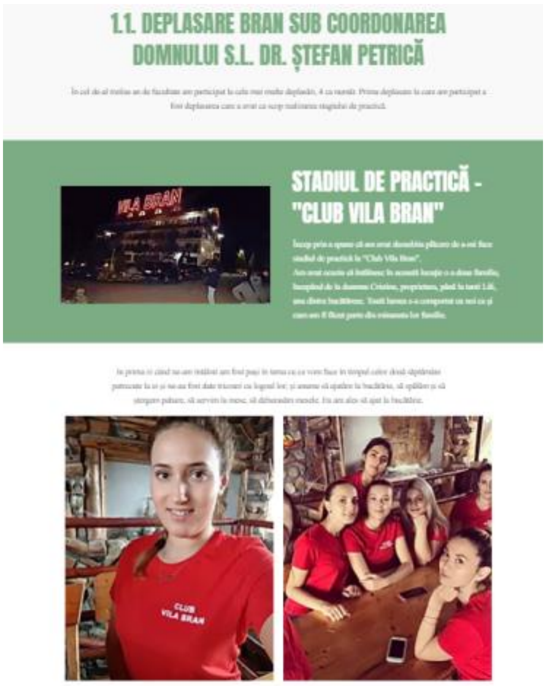

Fig. 12. "Anul III" Page – traineeship at "Club Vila Bran".
Source: personal archive.

In the third year, the first internship took place at Club Vila Bran [5] - a mountain complex located 1 km from the center of Bran and 4 km from the Zănoaga ski center, with terraces with a panoramic view of the Bran Castle and the Bucegi Mountains. The traditional Romanian restaurant at Vila Bran offers a campfire with folk music and mulled red wine

(Fig. 12). In addition, the guests are entertained by traditional Romanian and Greek dances, and international music recitals. Among the activities offered, as part of the complex's entertainment program, there are horse and pony riding, archery, and water gymnastics. At the same time, it is important to mention that, the complex can organize a variety of team-building actions and trainings for companies.

The second specialized internship of the third year took place at the Practice Center in Public Food and Agrotourism in Bran - a complex consisting of 2 guesthouses - owned by the Faculty of Management and Rural Development (Fig. 13).

The students were assigned to groups of 20 trainees, the duration of the internship being 2 weeks, during the entire study year.

Fig. 13. “Anul III” Page – traineeship at Faculty’s Practice Center in Bran
Source: personal archive.

In the Bran area, the practice partners with whom legal practice agreements were concluded were:

- Vila Bran 4 students/year of study,
- Hanul Bran 4 students/year of study,
- Complex Wolf 2 students/year of study,
- Casa Bran 2 students/year of study,
- Popasul Reginei 4 students/year of study,
- Vraja Munților 2 students/year of study,
- Pensiunea Carpatia 2 students/year of study,
- ANTREC Bran 1 student/year of study.

In that year, a 3-day trip was carried out, which included documentary visits to the Cozia Monastery (Fig. 14) and the Astra Museum (Fig. 15), respectively to several objectives in Sibiu - the Christmas Market, the city’s zoo garden (Fig. 16).

Fig.14. “Anul III” Page - study visit at “Cozia” Monastery.
Source: personal archive.

The “Astra” Museum is the most important ethno-museum institution in Romania. Conceived under the auspices of the Transylvanian Association for Romanian Literature and the Culture of the Romanian People, the ASTRA Museum (then the Museum of the Association) hold its first exhibition on August 19, 1905. The museum was born from the desire of the Transylvanian Romanians to define their own ethnocultural identity, in the ethnic conglomerate of The Austro-Hungarian Empire and against the backdrop of the cultural emancipation of all the peoples of central and South Eastern Europe [2].

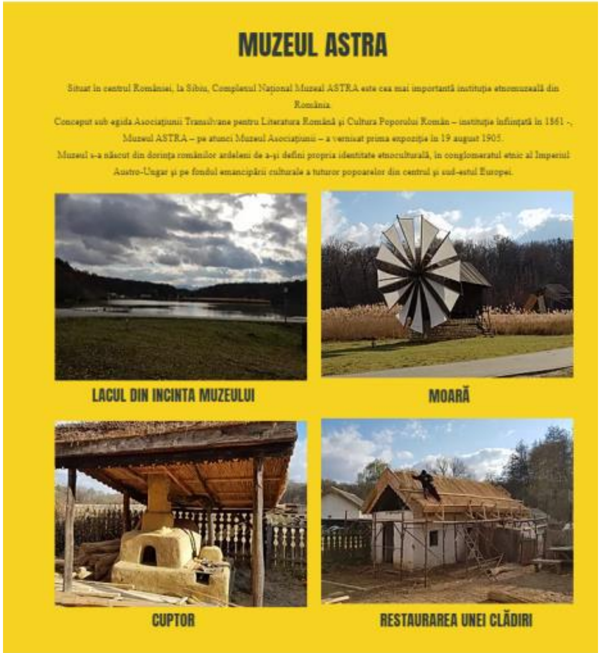

Fig.15. “Anul III” Page - study visit at “Astra” Museum. Source: personal archive.

The Zoo in Sibiu began its activity in 1929, on an area of over 15 hectares. It is worth mentioning that the oak tree at the entrance is over 600 years old.

Fig.16. “Anul III” Page – visit to the Zoo of Sibiu
Source: personal archive.

Opened for the first time in 2007 - the year in which Sibiu held the title of the European Capital of Culture - the Christmas Fair became known throughout the country for its scale and tradition, and from then it has become a local custom of Sibiu. The event is organized by the Events for Tourism Association and co-financed by the Sibiu City Council through the Sibiu City Hall.

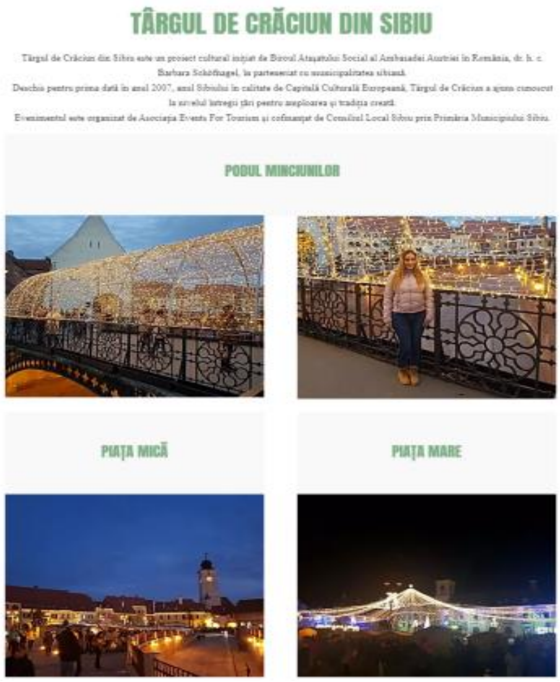

Fig.17. “Anul III” Page – the Christmas Market, Sibiu Monastery.
Source: personal archive.

Another three-day trip took place in Iasi County. The "Lungu" farm or "Lungu" Domains [18], established in 2001 and with an area of 2,000 ha (Fig. 18) was the first spot visited by the group of students. The farm's main fields of activity are viticulture, agriculture, animal husbandry, horticulture, and tourism.

Fig.18. “Anul III” Page – study visit at “Lungu” farm
Source: personal archive.

The trip continued with a visit to the "Panifcom" cattle farm (Fig. 19), which is one of the best-performing farms in Romania. The farm has 4,000 ha cultivated and a number of approximately 1,700 heads of cattle.

Fig.19. "Anul III" Page – study visit at "Panifcom" farm.
Source: personal archive.

In Fig. 20 are presented images from the last visit within this trip, which took place at the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine - an institution specialized in higher agronomic and veterinary medical education, with national and European prestige. Its fundamental mission represents the training of engineers specialized in agronomy, horticulture, agricultural biotechnologies, engineering and management in agriculture and rural development, food product engineering, environmental engineering, animal husbandry, biology graduates, and veterinary doctors.

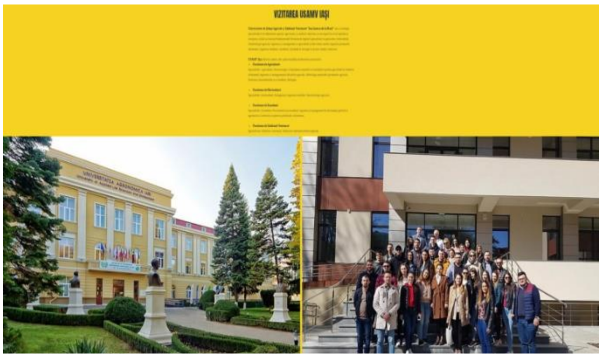

Fig. 20. "Anul III" Page – visit at USAMV Iasi
Source: personal archive.

The last study trip from the third year targeted the following tourist attractions in Arges County [25]: the Golești Museum (Fig. 21), the Golești Museum (Fig. 22), and the Curtea de Argeș Monastery (Fig. 23). The Golești Museum was established in 1939 by King Carol II and has developed over the years with new basic exhibitions that reflect both the family history and the history of Argeș traditional culture and civilization.

Fig.21. "Anul III" Page – visit at "Golesti" Museum
Source: personal archive.

The Royal Church is the only church that has on one of the walls a unique painting in the world, which represents the pregnant Mother of God. The over 300 scenes of the original painting from the 14th century represent, according to the opinion of specialists, one of the most valuable examples of Byzantine art in South-Eastern Europe, without being able to be integrated into a particular school and movement.

Fig.22. "Anul III" Page – visit at "Golesti" Museum
Source: personal archive.

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Curtea de Argeş Monastery represents a sanctuary of Romanian monasticism due to the desire of the Royal Family of Romania to be buried here.

Fig. 23. “Anul III” Page – visit at “Curtea de Arges” Monastery.
Source: personal archive.

Fig. 24 shows a screenshot of the menu related to the **Anul IV** page, where the user can find a list of the study trips that were carried out, but we have to mention that - due to the spread of the SARS-CoV-2 at the beginning of 2020 – three of the already planned trips were canceled (an agritourism fair in Italy and two visits to agritourism objectives in the Counties of Harghita and Iași).

Fig. 24. “Anul IV” Page
Source: own contribution.

However, in the first semester of that academic year, students had the chance to participate in "Agritechnica" - the most important fair of agricultural technologies, which is considered the showcase of the world agricultural engineering industry and a forum for the future of plant production (Fig. 25). The visit was part of a circuit that included Germany, the Czech Republic, and Hungary. In addition to the academic goal, the students had the chance to visit the tourist attractions in the cities where they stayed.

Fig. 25. “Anul IV” Page – visit to “Agritechnica”
Source: personal archive.

The story of the magnificent “Marienburg” Castle [19] (Fig. 26) is a tale of true love. Located between Hanover and Hildesheim, at 135 meters above sea level, it is a tranquil, untouched monument to a great romance. Every detail in this superb, authentically preserved summer residence speaks of a tale of two hearts, the true story of the love between Queen Mary and King George V, the last King of Hanover.

Fig. 26. “Anul IV” Page – visit at “Marienburg” Castle
Source: personal archive.

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Hanover [19], the capital of Lower Saxony, is Germany's greenest city, a pleasant and modern city that has adopted elements from all corners of the world, being a mix of people and architecture. In a country full of cities that became more touristic, Hanover has entered the niche of the big technology fairs, whether they are industrial or IT-focused. It is said that the exact time in IT is given in Hanover, and the CeBIT fair is the largest IT fair, where firsts and even revolutions in the field of information and communication technology are announced.

Fig.27. “Anul IV” Page – visit to Hanovra, Germany
Source: personal archive.

The Astronomical Clock in Prague [28] (Fig. 28) is an important tourist attraction, due to its special manner of announcing the exact hour. Every time the hours are announced, there is a real animated show that attracts like a magnet all the tourists in the vicinity.

“St. Vitus” Cathedral (Fig. 28) is an excellent example of Gothic architecture and is the largest and most important church in the Czech Republic. In addition to religious ceremonies, the coronation ceremonies of kings and queens were also held here. The cathedral represents a huge tourist attraction, both through the original and through the classic of its architectural elements. “Charles” Bridge (Fig. 28) is the most famous of these and marks the main road between two important tourist spots of the capital: Prague Castle and the Old Town. Its architecture is based on the Gothic style and numerous statues in the Baroque style, plus three towers that make it up [28].

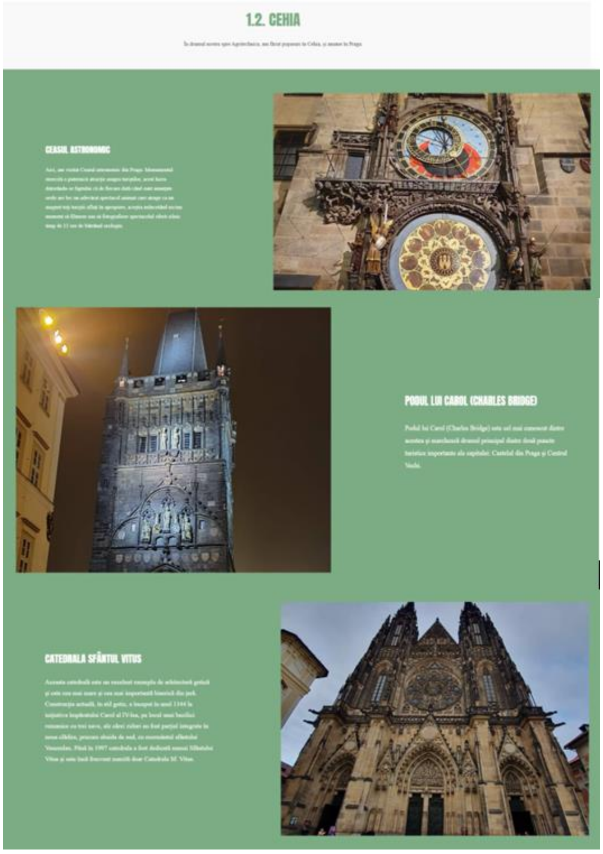

Fig. 28. “Anul IV” Page – visit to Prague, the Czech Republic
Source: personal archive.

The Hungarian Parliament (Fig. 29) is one of the most majestic political institution buildings in the world. The phenomenal view it offers is due both to its location (right on the banks of the Danube) and to the graceful yet severe style it exemplifies, a style known to those versed in the field as Gothic Revival or Neo-Gothic [14].

Fig.29. “Anul IV” Page – visit to Budapest, Hungary
Source: personal archive.

The second study trip from year IV was an internal one (Fig. 30), destined for the Apuseni area, and was carried out together with students from years II and III from the IMPA specialization. On the route, the Cozia Monastery (Fig. 31) was visited again, which has been guarding the Olt Valley for over six centuries and delightfully surprises its tourists on every occasion.

Fig. 30. “Anul IV” Page – visit to “Golesti” Museum
Source: personal archive.

The “Cozia” Monastery was built between the years 1387-1391 by ruler Mircea cel Bătrân, at the behest of St. “Pious Nicodim” from Tismana, who was "Mircea's advisor in divine matters". The monastery complex from Cozia has located 3 km from the balneo-climate resort Calimanesti-Caciulata, on the right bank of the Olt, and approx. 20 km north of Ramnicu Valcea [9].

Fig. 31. “Anul IV” Page – visit at “Cozia” Monastery
Source: personal archive.

The journey continued with the visit to the “Alba Carolina” Fortress (Fig. 32), a strong fortification, which was built as a complex system of defense against the Turks and a way to consolidate the control over the conquered territories – practically, the Citadel's role was military, given by the bastion system, the type of artillery pieces it was equipped with, as well as the size of the troops inside it.

The “Alba Carolina” Citadel has experienced spectacular transformations in recent years, which make it increasingly visible on the tourist "cake" of Europe. In parallel with the restoration works, co-financed from European funds, the valorization of its exceptional cultural heritage was also considered. The fortification is the place where cultural festivals take place, famous orchestras are heard, and where top Romanian and foreign artists perform [1].

Fig. 32. “Anul IV” Page – visit to “Alba Carolina” Fortress
Source: personal archive.

Among the objectives visited was the “Urşilor” Cave [29] (Fig. 33) from Chişcău, Bihor County, respectively the Turda salt mine [27] (Fig. 34), Cluj County.

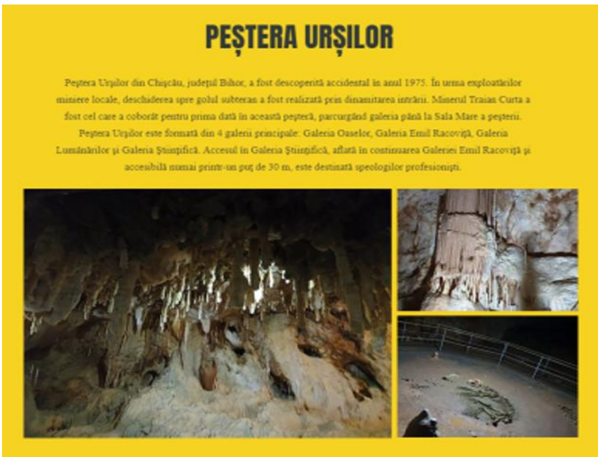

Fig. 33. “Anul IV” Page – visit at “Ursilor” Cave
Source: personal archive.

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The "Urşilor" Cave was accidentally discovered in 1975 and is structured on 3 visitable galleries and a "Scientific Reserve". The three galleries: Gallery of Bones, Gallery Emil Racovita, and Gallery of Candles can be visited in an organized way with a guide. This impressive cave is one of the most visited tourist attractions in the Apuseni Mountains, which is 1.5 kilometers long and at an altitude of 482 meters [29].

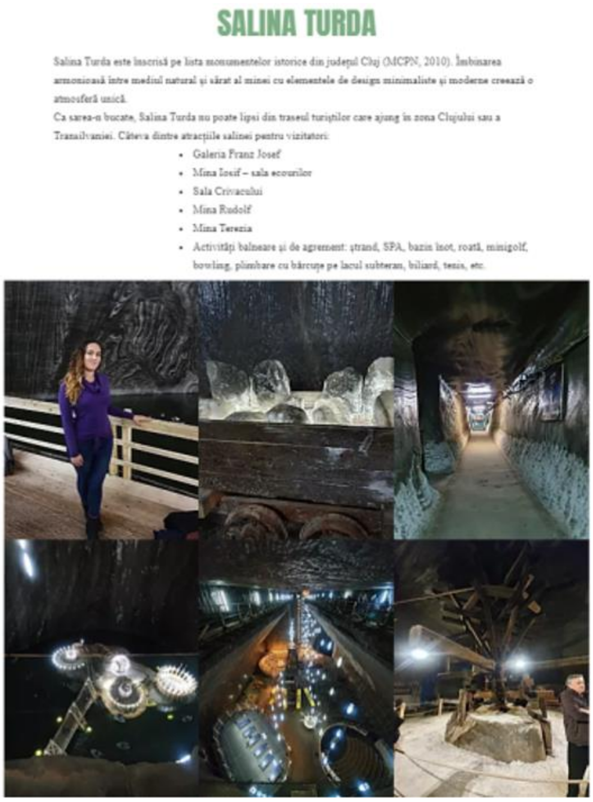

Fig. 34. "Anul IV" Page – visit to "Turda" Salt mine
Source: personal archive.

Salt mine "Turda" has been registered since 2010 on the list of historical monuments in Cluj County. The harmonious combination of the mine's natural and salty environment with minimalistic and modern design elements creates a unique atmosphere.

"Turda" Salt mine cannot be missing from the route of tourists who arrive in the area of Cluj or Transylvania. Some of the salt mine's attractions for visitors: "Franz Josef" Gallery, "Iosif" Mina (hall of echoes), "Crivac" Hall, "Rudolph" Mine, "Terezia" Mine, Spa, and leisure activities: beach, SPA, swimming pool, wheel, minigolf, bowling, boating on the underground lake, billiards, tennis, etc. [27].

The second internal trip - actually, the last one from the fourth year - was carried out in Hunedoara County [13] (Fig. 35), on which occasion many tourist attractions were visited.

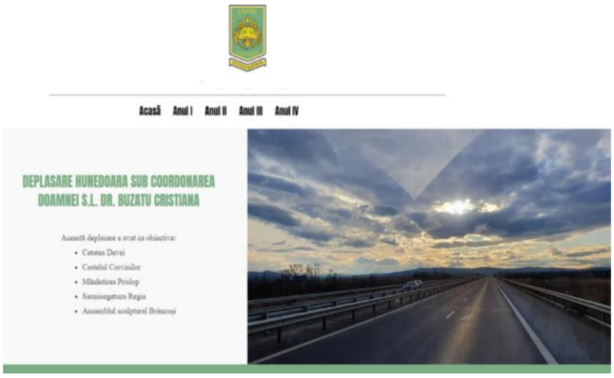

Fig. 35. "Anul IV" Page – visit to Hunedoara County
Source: personal archive.

In Fig. 36 is presented Deva's Fortress of Deva, documented in 1269, and a historical monument that has become the symbol of Deva. It was built in the middle of the 13th century on Dealul Cetății, on the site of an oppidum-type Dacian settlement, and is mentioned in the document under the name "Castrum Deva". Deva's Fortress is one of the most important fortifications in the middle ages and one of the best touristic objectives in Hunedoara county. Due to the hill on which it is built, which now carries its name (the Fortress' Hill), it was a strategic point of defense on Mureșului Valley which is situated between Transylvania and Banat [13].

Fig. 36. "Anul IV" Page – visit to the Deva's Fortress
Source: personal archive.

"Corvinilor" Castle (Fig. 37) represents the medieval fortress of Hunedoara and was built

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on an old Roman fort. The first owner of this Gothic architectural monument was Prince Voicu, father of Iancu de Hunedoara, who received the castle as a gift from King Sigismund I of Luxembourg. Access to the castle is via a wooden bridge, supported by four massive stone pillars, placed in the bed of the Zlaşti stream [8].

Fig. 37. “Anul IV” Page – visit at “Corvinilor” Castle
Source: personal archive.

“Prislop” Monastery (Fig. 38) represents an important Orthodox religious settlement in Transylvania. The old church from the 16th century is declared a historical monument. An annual, intense pilgrimage takes place at the Prislop Monastery, especially at the grave of Father Arsenie Boca.

Fig. 38. “Anul IV” Page – visit at “Prislop” Monastery
Source: personal archive.

The capital of the Dacian state, „Sarmizegetusa Regia” Citadel (Fig. 39) was built at an altitude of 1,200 m, in the Orăştiei Mountains, at Grădiştea de Munte, and represents the largest settlement discovered so far in the entire Dacian space. Strategically hidden in the heart of the forests, this extensive fortified settlement was a residence of the Dacian kings and reached the peak of its development during the time of Decebalus.

Fig. 39. “Anul IV” Page – visit at the Dacian Fortress of “Sarmizegetusa Regia”
Source: personal archive.

Some of the evidence of the high degree of development of the Dacian civilization in terms of military, spiritual and craft arts can still be observed throughout the site [10].

Fig. 40. “Anul IV” Page – visit at “Constantin Brancusi” Sculptural Ensemble, Târgu Jiu
Source: personal archive.

The “Constantin Brâncuși” sculptural ensemble from Târgu Jiu [7], also known as the "Calea Eroilor" monumental ensemble from Târgu Jiu, was conceived, designed, and built by Constantin Brâncuși, as a tribute to the fallen heroes who fought in the First World War. The four sculptural components are arranged on the same axis, oriented from west to east, with a length of 1,275 m, starting with — The Table of Silence, The Alley of the Chairs, The Gate of the Kiss, and The Endless Column.

Here the journey ends with what represented the practical part (with documentation and study trips, visits, and traineeships) developed during the 4 years of the Bachelor's degree in Engineering and Management in Public Food and Agritourism Specialization of the Faculty of Management and Rural Development, USAMV Bucharest.

CONCLUSIONS

In order to achieve the previously established objectives of the professional practice, in optimal conditions, it is required that all the involved parties in this activity show professionalism and contribute to the consolidation of the professional relationship between student - tutor – coordinator teacher of the traineeship programme. This relationship must be based on honesty and professional respect, so as to deliver the necessary context for the good preparation of the student, by offering him a wide range of availability for dialogue.

For the students who do the internship in tourist guesthouses, it is mandatory to understand the importance of the development of agritourism in rural areas. The rural towns where agritourism will be practiced are going to become places where all the elements of sustainable development will be brought together [12]. There can also be found a desire to improve the infrastructure with the aim of establishing a spiritual life in the rural locality, thus, creating improvements in the support of public services. In this way, it will be noticed that agritourism influences the external environment (economic, social, cultural, and environmental), leaving its mark on the economic development of the respective locality.

Agritourism, an unique architecture in the current world, traditional hospitality, as well as tourism, in general, need promotion campaigns that show everybody the diversity of the tourist offer and leisure possibilities. Tourists must make a first impression about the destination as a summary of several criteria: local tradition, natural setting, quality accommodation services, leisure opportunities, and, last but not least, gastronomy.

The Faculty of Management and Rural Development, through the study program Engineering and Management in Public Alimentation and Agritourism, includes in the field of tourism well-trained specialists to administer, manage and improve this sector. Thanks to the traineeships during the bachelor’s or master’s programmes, students develop professional skills, such as teamwork, responsibility, communication, time management, etc.

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FUNCTIONING OF LOCAL ACTION GROUPS – FINANCIAL ANALYSIS AND SIMPLIFICATION PROPOSALS

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Abstract

Rural Local Action Groups are funded under LEADER through the Rural Development Programmes of the Member States over the last 30 years in order to cover two categories of needs: mainly, for financially supporting the best projects in their own territories that meet local needs, and secondly for ensuring their own running and animation costs. In the literature there are numerous papers dealing with the main allocation of funding, analysed at European, national or regional level, but very few articles that analyse the second component of financing. The paper presents an analysis of the situation of running and animation expenses carried out by the Romanian LAGs during the period 2017 - 2021 and, in the context of the elaboration of new programmatic documents for the next financing period, proposes variants of simplification and reorganization of budget chapters, that leads not only to administrative burden reduction, but also to a better local strategy implementation.

Key words: *LEADER, running and animation costs, simplification, standard costs, Local Action Group*

INTRODUCTION

In Romania, the LEADER concept was first introduced during the EU programming period 2007 – 2013, i.e. 20 years behind countries such as Ireland, Italy or France.

The term "LEADER" originally came from the French acronym for "Liaison Entre Actions de Développement de l'Économie Rurale", meaning "Links between the rural economy and development actions".

However, in the 10 years of operation it has had a real impact in the rural area, both through the financing of various projects that meet the needs of the territory, but also through the creation for the first time in Romania of functional public-private partnerships.

The Local Action Groups (LAGs) are financed through the National Rural Development Programme; during the programming period of 2014 – 2020, including the transition period of 2021 – 2022, for the implementation of Local Development Strategies (LDS) and for ensuring the running costs for LAGs, there were allocated over 765 million euros, representing 6,03% of the public amount of the Programme (MADR, 2022a) [14]. There is also an increase in the allocation for the LEADER program for the period 2023-2027, given that the 500 million euros allocated under the National Strategic Plan submitted by Romania to the European Commission represents over 8,5% of the total envelope (MADR, 2022b) [15].

There are numerous materials in the literature on LEADER evaluation, which can be classified into two main categories (Metta, 2016) [11]: the literature on the evaluation of the LEADER program and the literature on the evaluation methodology of Local Development Strategies.

LEADER evaluation materials refer to legislative documents (European Commission – DG AGRI, 2014; 2015 [4, 5]; European Parliament, 2013 [8]); evaluation and self-assessment guides elaborated by governmental authorities (European Commission, 2017) [6], and, finally, a long collection of studies and academic research that:

- Analyses the empirical application of different LEADER evaluation approaches (LAGs self-assessment - Birolo, 2013[2]; quantitative impact evaluation - Pisani & Franceschetti, 2011[17]; Rusu (2021) [19]; Staic et al. (2022) [20]; evaluation of the social impact of LEADER - Permingeat, Vanneste, 2019 [16] etc).

- Analyses the application of evaluation methods and LEADER indicators (Data Envelopment Analysis for measuring the LAGs performance from the point of view of their efficiency -Lopolito A., Giannoccaro, &Prosperi, 2011[10]);
- Proposes a critical analysis of the LEADER evaluation system, e.g., the existing tensions between the LAG management and the administrative bureaucracy of LEADER and the use of participative forms of evaluation (Ray, 2000) [18].

Although there is an extensive literature about LEADER evaluation, there is no research on running and animation costs, both in terms of the size and in terms of a budgetary structure to ensure the efficient conduct of specific operations, according to LEADER principles.

Starting from a European Court of Accounts statement, according to which „*despite public-private partnerships (PPPs) have the potential to achieve faster policy implementation and ensure good maintenance standards, the audited projects were not always effectively managed and did not provide adequate value for money. Potential benefits of PPPs were often not achieved, as they suffered delays, cost increases and were under-used*" (ECA, 2018) [3], we formulate the following hypothesis:

- The degree of contracting and absorption of LAGs in Romania depends on how the funding allocated for running and animation is spent;
- The performance of LAGs in Romania is influenced by their size in terms of the rural population they address.

MATERIALS AND METHODS

For the purpose of this study, both quantitative and qualitative approaches were used. In the quantitative approach, all payment requests for operating and entertainment expenses submitted by LAGs to the paying agency from the beginning of their operation were centralized, dividing the amounts authorized according to the budget chapter. Included in the analysis were all payment claims submitted between 26.01.2017 - 31.07.2021, i.e. from the date of submission of the first payment claim for reimbursement of expenses related to the operation of the LAG until the reference date on which the Managing Authority decided to evaluate the performance of the LAG (MADR, 2021a) [12].

The analysis focused on: (1) the structure of the LAG budget; (2) the degree of spending of funds allocated for the for running of the LAG and for animating the territory in correlation with the degree of contracting of funds allocated to the implementation of the Local Development Strategy; (3) as well as the correlation between the LAGs performance and the rural population covered.

The centralisation of the payment claims by LAG was then corroborated with the situation regarding the surface, population, and the degree of contracting and payment of all authorised LAGs (MADR, 2021b) [13]. We have calculated Pearson correlation coefficients for all the data series mentioned above.

A qualitative approach was used to gain a deeper understanding of the importance of the main issues encountered in the operation of LAGs, to create a simpler framework for reimbursement of expenditure of running and animation costs in the next programming period. The study was conducted from March to June 2022 and information was collected from all functioning LAGs using questionnaires.

RESULTS AND DISCUSSIONS

The LEADER approach has been implemented in all EU member states as well as in many non-EU countries to support development processes in rural areas focusing on the local community, and "*to help the rural actors to realize the potential of their region on a long-term basis*". (WINNET, 2020) [21].

The European policy shift from the top – down approach to endogenous programmes has shown that initiatives such as LEADER bring a greater development to local communities. According to a recent study published by the European Commission, "*LEADER effectively developed solutions to address economic and social development challenges and opportunities at local level. The study suggests that LEADER's strongest areas are job creation and maintenance, local added value of products and enterprise modernisation. Enhancing local governance capacities and knowledge within LEADER operations was also identified as a benefit.*" (European Commission, 2022) [7].

The LEADER approach is based on the following seven specific features shown in Figure 1.

Fig. 1. The seven principles of LEADER
Source: WINNET, 2020 [21].

One of the most important key principles of the LEADER approach is the bottom-up approach; it aims to encourage participatory decision-making at the local level for all aspects of development policy. Local actors, including the community as a whole, economic and social interest groups and representative public and private institutions need to be involved.

The bottom-up approach is based on two major activities ("animating" and forming local communities). LEADER believes that the locals are the best experts to lead the development of their territory. This bottom-up approach means that actors and the local community can help define a development path for their area in line with their needs, expectations, and plans. Doing so through a collective approach with delegated decision, allows them to take control of the future of their area. They make decisions about the local strategy and the selection of priorities to follow. Active participation is encouraged at every stage throughout the process, during the development, implementation, evaluation, and modification of the LAG's strategy. The involvement of local actors should be fair and transparent, including the general population, economic, civic, and social interest groups and representative public and private institutions. This bottom-up approach is enshrined in EU regulations with provisions on animation and decision-making to ensure that no interest group can have a majority.

The European Commission's study has concluded that "budgets squeezed by increased administrative burdens and limited funds leading to low resources for animation and facilitation actions, have compromised beneficiary demand and project quality" and "Achieving wide participation of multiple actors through application of the bottom-up principle and promotion and animation strategies including events, publications, web based and direct communications for further engagement with stakeholders and the wider public were effectively applied in all case studies except Romania". "The analysis highlighted that animation was crucial to ensure LAG performance and capacity to achieve good results. Animation proved essential both for effectiveness and efficiency." (European Commission, 2022) [7].

During the present programming period (2014- 2020), the launch for the selection of the Local Development Strategies (LDS) was made in March 2016, with the final results published in August 2016. The first financing agreements were signed by the authorised LAGs in November 2016, when their functioning for the present programming period has begun.

According to the national implementation framework, for the 2014-2020 programming period, the value of the Local Development Strategy depended on the area covered by the LAG and the population in that territory. The value of the running and animation costs is maximum 20% of the value of the Strategy, respectively maximum 25% in the case of the LAGs from the territory of the Danube Delta. Following the only session of selection of Local Development Strategies, the 239 authorized LAGs have an average population of 40,977 inhabitants and cover an average area of 889.82 km^2, which corresponds to an average value of a Strategy of 1,689,786.72 euros.

The calculations were made based on the entries in the Applicant's Guide for participation in the selection of local development strategies, according to which the calculated values in relation to population and area were 19.84 Euro/inhabitant and 985.37 Euro/km^2.

The 239 LAGs authorised by the Managing Authority cover 92% of the rural area and 86% of the rural population.

The 239 LAGs authorised by the Managing Authority for the 2014 – 2020 programming period had to implement each a Local Development Strategy with values ranging from 1,583,850.31 euros, the smallest, to 5,866,271.31 euros, the largest.

Starting with January 2017 until 31.07.2021 (date of reporting the degree of contracting and payment related to Local Development Strategies) (MADR, 2021) [12], the 239 LAGs authorized by the Managing Authority submitted payment claims under two subsequent financing agreements (subsequent financing agreement No. 1 covering the period 2016-2019 and the subsequent financing agreement No. 2 covering the period 2020-2021).

For the reimbursement of running costs, the rules imposed by the paying agency for the submission of payment claims are:

- **for the first Financing Agreement,** the running costs requested for payment were not to exceed the maximum percentage of running costs approved in the Strategy in relation to the total amount of public allocation approved under LDS;
- **for the second Subsequent Financing Agreement,** the percentage of running costs requested for payment were not to exceed the percentage of public value contracted under the LDS. (AFIR, 2016) [1].

During the second financing contract, 2 LAGs failed to submit payment claims within the legal deadline of maximum 12 months from the signing of the contract and, according to the procedures, their operating license was revoked.

The structure of the budget for running and animation costs for the 2014-2020 programming period is as follows:

Chap. I - staff costs

Chap. II - expenses with technical and financial consulting services, expertise related to the implementation of LDS and audit

Chap. III - logistical, administrative and travel expenses for the operation of the LAG

Chap. IV - expenses for training and skills development on LDS implementation

Chap. V - expenses for animation

Chap. VI - expenses for local events, themed festivals, traditional product fairs and other events promoting the territory covered by the LAG.

Table 1. Distribution of running and animation expenses for the period 2017 - 2021

Budget chapter	First financing contract			Second financing contract		
	No. Of LAGs submitting payment claims	Value authorised for payment (ROL)	% of the authorised amount	No. Of LAGs submitting payment claims	Value authorised for payment (ROL)	% of the authorised amount
Chap. I	239	222,746,795.88	78.22%	237	79,474,870.91	91.67%
Chap. II	239	17,026,171.35	5.98%	186	3,021,277.83	3.48%
Chap. III	237	30,654,856.64	10.76%	184	3,487,941.52	4.02%
Chap. IV	184	3,889,598.84	1.37%	13	74,730.15	0.09%
Chap. V	234	8,219,086.37	2.89%	110	595,470.65	0.69%
Chap. VI	129	2,229,249.20	0.78%	4	39,913.55	0.05%
TOTAL		**284,765,758.28**			**86.694.204.61**	

Source: own elaboration considering all the payment claims submitted.

The distribution of running and animation expenses for the 5 years of activity (2017 - 2021) within the 2 financing contracts can be found detailed in Table 1.

Analysing the expenditures made by the LAGs within the two subsequent financing contracts, it is noted that in the first period of operation (2017 - 2019) 78% of the expenditures were allocated to salaries, with an average of 5 employees/LAG, including the salary for the animator. The relatively high share of expenses related to chap. III during the first period of operation was due to the purchase of cars by the LAGs; about 3 quarters of the LAGs bought cars to cover the managed territory, considering that during the first programming period, such expenditure was not considered eligible. The need to buy transportation means to monitor the LDS implementation and to animate the territory was welcomed by the authorities, considering it an advantage to a better achievement of the LEADER principle. The 25% of the LAGs not buying cars have spent an average of 5% on chapter III.

Regarding the second period of operation, it is noted that most of the expenditures were directed to salaries (over 90%), but also to administrative expenses (7.5%).

There is a low proportion of spending on animation, training of employees and local leaders and organizing events to promote the territory, although not all funds from the LDS have been contracted, and the purpose of LAGs in the territory is to value the endogenous potential.

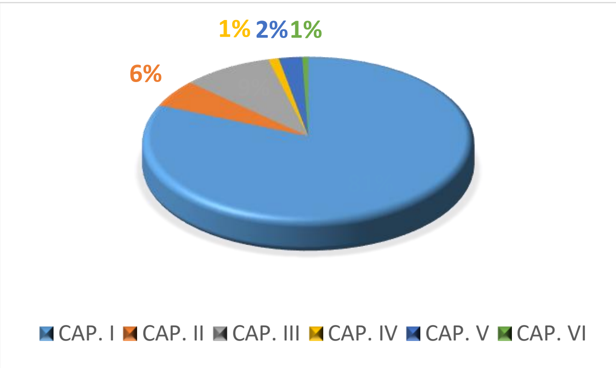

Fig. 2. Distribution of running and animation costs by budget chapters

Source: own elaboration considering all the payment claims submitted.

On average, until 31.07.2021, LAGs have requested to payment 71.03% of the running costs allocated for the entire period of implementation of the LDS.

Centralized, the situation of expenditures made by LAGs, according to the budget chapters in the period 2017 - 2021 is illustrated in Figure 2.

In order to ensure the continuity of the LDS' implementation process, in the transition period to the next programming period (2021-2022), Romania decided to provide additional funds to the selected Local Development Strategies, their distribution being made according to the related performance criteria: of the cumulative fulfilment of the percentages of minimum 70% contracted value and minimum 30% paid value on July 31, 2021 (MADR, 2021) [13].

Analysing the situation published by the Managing Authority, regarding the degree of contracting and payment of the 237 active LAGs, shows an average degree of contracting of 89.71% and an average degree of payment of 63.36%, as well as a non-fulfilment of performance criteria by 20 LAGs.

Of these, 15 LAGs did not meet the criterion of a minimum 70% contracting rate, with an average contracting value of 65.47%, and 5 LAGs did not meet the criterion of a minimum percentage of 30% payment, having an average payment value of 25.31%. The 20 LAGs considered non-performing on 31.07.2021, requested for reimbursement operating expenses of 68.97% of the allocated value, below the average threshold mentioned above.

From the point of view of the covered population and of the non-fulfilment of the degree of performance imposed by the Managing Authority on 31.07.2021, the situation of the LAGs in Romania is presented in Table 2.

It is observed that more than half of the LAGs in Romania have a population below the average size of 40,977 inhabitants, and 13.74% of them failed to reach the performance indicators, compared to 5.56% of the LAGs from the other categories.

Table 2. Situation of LAGs from the point of view of non-compliance with the performance criteria, distributed according to the population covered

Population (no. inhabitants)	No. Of LAGs	Average value of LDS (euro)	Average no. of employees	Average of running costs reimbursed (% related to approved amount)	No. of LAGs not compliant with the criterion min. 70% contracting	No. of LAGs not compliant with the criterion min. 30% payment	No.of LAGs dissoluted	Proportion of non-performing LAGs
under 20,000	34	1,554,342.51	4	70.95%	4	2		17.6%
20,001 – 40,000	97	2,136,145.74	5	69.84%	8	2	2	12.4%
40,001 – 60,000	67	2,717,514.11	5	71.22%	2	2		6.0%
60,001 – 80,000	33	3,296,873.55	6	74.56%	1	1		6.1%
above 80,000	8	4,237,593.87	6	69.45%	0	0		0.0%
TOTAL	239				15	7	2	10.0%

Source: own elaboration using the payment claims submitted for reimbursement.

We have calculated Pearson correlation coefficient between the performance indicators of all 239 LAGs, as defined by the Managing Authority (contracting degree over 70% and 30% paid amount), the number of inhabitants covered by LAG, the population's density, the surface, the amount spent for animation and the cost of animation per inhabitant, the amount spent for running and animation and the number of employees.

According to the calculations made, there is a moderate indirect correlation between the population's density and the cost of animation per inhabitant (*r=-0.34*) and between the population's density and the amount spent for running and animation (*r=-0.33)*. There is also a moderate direct association between the number of LAG's employees and the total population (*r=0.36)*, and an obvious strong correlation between the degree of contracting and the degree of payment (*r=0.56)*. There are low or negligible correlations between all the other data series.

The analysis of the payment claims submitted by LAGs according to the structure of the budget shows that only 2.37% of the total expenditures made by the LAGs were made for animation, the remaining 97.63% being expenses related to the effective functioning of the LAG (salary expenses, expenses of training and public relations, costs related to monitoring and evaluation of the strategy), although according to the requirements of the regulation the animation costs should represent a significant share in the LAG's spending structure.

It is also worth noting that in the years 2020 - 2021, only 110 LAGs had expenses related to animation in a percentage of 0.69%.

In order to assess how the administrative burden can be reduced, in order to allow the LAGs to better concentrate on specific LEADER activities (i.e. animation and training), for the next programming period 2023 – 2027, a questionnaire was sent to all 237 functioning LAGs. The questionnaire contained several identification items (e.g. name of LAG, region of implementation, programming period of LAG establishment, e-mail address), closed questions (yes/no questions), such as: "Do you consider that introducing simplified cost options (SCO) would be a simplification for the LAGs activity?" or "Do you consider that introducing simplified cost options (SCO) would be a simplification for the Paying Agency activity?" or with multiple choices, such as: "From the options below, which do you consider to be most useful for a real simplification: a) Flat-rate financing for indirect costs from all eligible direct staff costs or b) flat rate of up to 40 % of eligible direct staff costs." or "Considering your experience, which do you consider to be a correct rate for covering the indirect expenditure: 8% of all direct staff costs; 10% of all direct staff costs; 12% of all direct staff costs; 15% of all direct staff costs; other (please mention)". Also, the questionnaire contained open questions, such as: "Please specify in which way the LAG's activity will be simplified by introducing SCO", or "Please specify in which way the Paying Agency's activity will be simplified by introducing SCO". The main question is "Do you consider necessary the administrative simplification of the reimbursement process for the running and animation expenditures of LAGs by introducing simplified cost options (SCO)?" If the answer was NO, the LAGs were requested to explain the reasons and to propose other types of simplification. If the answer was YES, they were requested if they consider the simplification is for the LAG or for the Paying Agency, and to choose, according to their experience, the best option of simplified cost from the following:

- flat rate for indirect costs – with the specification of the necessary percentage,
- flat rate of eligible direct staff costs– with the specification of the necessary percentage.

There were received 116 answers, from all the regions of Romania, almost 64% of the answering LAGs being founded in the first programming period, 2007 – 2013.

Only 6 LAGs responded that the introducing of the SCO for the administrative simplification is not necessary, because there were no problems related to the reimbursement of the expenditures according to the current procedure.

From the 110 LAGs that considered necessary the introducing of the SCO, 3 of them do not consider it a simplification either for the LAGs activities, nor for the Paying Agency.

When asked what the best option from the simplified costs presented is, 66.4% of the LAGs have chosen the flat rate of eligible direct staff costs, and 33.6% have marked the flat rate for the indirect costs.

Of the 71 LAGs that have chosen the flat rate of eligible direct staff costs: 40.8% of them consider that 30% of the personnel expenditures cover the all the other expenditure, 25.4% of the LAGs considering that 25% is enough and 11.3% that 20% is the right amount.

52.8% of the 36 LAGs that have chosen the flat rate for indirect costs consider that 15% of the personnel costs should be enough to cover the indirect costs, followed by 13.9% of them requiring 10% of the personnel costs and 11.1% of the LAGs considering 12% of the personnel costs.

Based on the historical data from the payment claims analysed, and according to the answers to the questionnaire submitted, **we propose 2 variants of simplification, using simplified costs options:**

VARIANT 1, respecting the provision of art. 56 of EU Regulation 2021/1060 [9] Flat rate financing for eligible costs other than direct staff costs concerning grants**, parag. (1) „*A flat rate of up to 40 % of eligible direct staff costs*** *may be used in order to cover the remaining eligible costs of an operation. The Member State shall not be required to perform a calculation to determine the applicable rate.*", we propose the following budget structure:

Chap. I – costs with LAG staff – 76.92% of the total budget

Types of eligible costs: salaries and fees related to the LAG team (manager, evaluator, etc., including the animator).

Chap. II – costs for the LDS implementation (other than the costs with the LAG staff)

Chap. III – costs related to cooperation projects (other than the costs with the LAG staff)

Chap. II + Chap. III – flat rate financing of 30% of the eligible direct staff costs (simplified cost option).

The option chosen by most of LAGs, i.e. 30% of the personnel expenditures cover all the other expenditure, partially confirms the historical data. According to the payment claims submitted, the total costs with the LAGs personnel is on average 81.32% of the total amounts. The frequency distribution of the LAGs regarding the costs of the operation, except for the personnel costs, is shown in Table 3.

Table 3. Distribution of LAGs according to the percentage of the staff costs used for all the LDS implementation

Percentage of the staff costs used for all the LDS implementation	No. of LAGs
less than 10%	21
10% - 20%	77
20% - 30%	70
30% - 40%	44
over 40%	27

Source: own elaboration using the payment claims submitted for reimbursement.

VARIANT 2, respecting the provision of art. 54 of the EU Regulation 2021/1060 [9] Flat-rate financing for indirect costs concerning grants**, lett. b) „*up to 15 % of eligible direct staff costs,*** *in which case the Member State shall not be required to perform a calculation to determine the applicable rate***”**, we propose the following budget structure:

Chap. I – costs with LAG staff, except for expenses with the animator - maximum 75% of the total budget

Types of eligible costs: salaries and fees related to the LAG team (manager, evaluator, etc.).

Chap. II – indirect costs – 15% of direct eligible staff costs, which represents maximum 11.25% of the total budget – simplified cost option.

Types of eligible costs:
- costs for office supplies;
- communication costs, including telephone and postal costs and costs for access to necessary information/services (ONRC, REVISAL, notaries, etc.);
- information technology costs, including website management costs, purchase, rental and leasing of office equipment, and maintenance and repair costs of servers, networks, and office equipment;
- LAG office space utilities costs, including heating, water and electricity costs and cleaning costs;
- renting the office space of the LAG;
- expenses for security services;
- service fee for banking operations;
- travel expenses;
- maintenance and repair costs of a vehicle owned or leased by the LAG;
- motor insurance;
- expenses for the purchase, rental, hire and leasing of office furniture;
- expenditure on the acquisition of digital certificates required for the day-to-day running of the LAG;
- accounting expenses and auditing.

Chap. III – costs for training and skills development of the LAG team and LDS beneficiaries

Types of eligible costs:
- authorised courses for development the skills of LAG’s employees;
- training of local leaders from the LAG territory regarding the implementation of the LDS through seminars and working groups;
- training the beneficiaries from the LAG territory regarding the implementation of their own projects, eligible only on the Romanian territory.

Chap. IV – costs for animation: minimum 5% of the total budget

Types of eligible costs:
- salary costs with the animator(s). According to the EC guidelines set out in "5.3.9 LEADER tool", good practice includes the allocation of minimum staff for animation and the definition of indicators that reflect its results. The actual resources dedicated to animation will have to be established considering the number of people covered by the LDS and the size of the area to allow the animator the necessary closeness and familiarity with the inhabitants.
- costs on animation and promotional materials (including personalized clothing);
- expenditure on the purchase or rental of pavilion-type tents bearing the logo of the LAG;
- expenses for the purchase/ rental of chairs, tables, stands for the promotion/ information activity regarding the LDS;
- expenditure on ensuring the transparency of the allocation of European funds (information board, billboard, stickers);
- expenses for the organization of animation events, including local holidays, themed festivals, traditional product fairs and other

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events promoting the territory covered by the LAG.

Chap. V – Other types of costs related to LDS implementation

Types of eligible costs:

(a) technical and financial advisory services and expertise related to the implementation of the LAG strategy, respectively:

- elaboration of evaluation, selection and appeals procedures, of the Beneficiary's Guides for the LDS interventions;
- project evaluation;
- monitoring the LDS strategy;
- evaluation of LDS implementation;
- management (including aspects related to procurement procedures);
- evaluation of compliance of payment claims;
- legal services related to LDS implementation.

(b) Expenditure on the purchase of a single means of transport by each LAG (only for LAGs that did not purchase in the 2014-2020 programming).

(c) Expenditure on organizing LAG meetings (transport and meals/day, as well as (if necessary) renting the necessary space) - General Assembly and Board of Directors, Selection Committee;

(d) Expenditure on participation in the activities of the National Network for Rural Development and the European Network for Rural Development or other events related to rural development.

(e) Expenditure specific to cooperation projects (excluding indirect costs - which will be included in Chapter II, and costs for LAG staff involved in projects – included in Chapter I).

For this variant, the direct eligible costs are considered the personnel costs associated with the implementation of the supported activities, included in Chapter I and the costs with the salaries of the animators within Chapter IV.

The option chosen by 17% of the LAGs answering the questionnaire, i.e. 15% of the personnel expenditures to cover the indirect costs, confirms the historical data.

Moreover, we have decided to maintain the amount of the salaries (approx. 75% of the budget), considering that the animator's salary was integrated to animation costs, and in order to confirm the importance given to fulfilling the bottom-up principle, also in terms of financial allocation, we consider important establishing a minimum of 5% for the animation costs.

According to the survey presented by the European Commission, "The data suggest that the use of SCOs particularly for preparation, animation and running costs, brings significant efficiencies to LAG operations." (European Commission, 2022) [7].

CONCLUSIONS

Following the above analysis, the first hypothesis was partially confirmed, in the sense that the degree of contracting and absorption of LAGs in Romania does not depend on how the funding allocated for running is spent, in the sense that a bigger allocation for certain budget chapters does not have a direct effect on performance, but rather on the actual spending of this funding.

Lopolito, A., Giannoccaro, G., & Prosperi, M. (2011) [10], who by applying the DEA method, have agreed that „*less efficient LAGs are also undersized. Therefore, in order to address this problem, the structure of the LAG should be changed accordingly, eventually by enlarging the existing structure (e.g. increasing the population or the economic size) or by merging two contiguous LAGs*". The correlation coefficients calculated cannot confirm the conclusion, but it provides further research ideas for identifying the factors that lead to performance.

Finally, following the analysis of the structure of running expenses, considering the need for administrative simplification, based on the new regulatory provisions, and on the study carried out among the Romanian LAGs, we proposed 2 variants of budget structures that can be applied in the next programming period.

The advantages of applying any of these options are valid both for the paying authority which would benefit from a reduction in administrative effort and for LAGs which would have more freedom in managing the allocated funds, as well as in concentrating their activities towards the territory.

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MODELING FARMERS' INVOLVEMENT IN THE PARTICIPATORY COCONUT PLANTING PROJECT OF THE PHILIPPINE COCONUT AUTHORITY

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Abstract

Participatory Coconut Planting Project (PCPP) is one of the programs implemented by the Philippine Coconut Authority (PCA) that aims to achieve the increasing productivity and income of coconut farmers. The study was conducted to find out the level of involvement of 145 coconut farmers, from the three selected municipalities of Northwestern Leyte, in the PCPP and determine the factors that influenced their participation. Descriptive statistics like percentages, frequency counts, means, and ranges were employed. Moreover, regression analysis was used to determine the relationship between the socio-demographic/economic characteristics and other factors that influenced farmers' involvement in PCPP. Findings revealed that most of the respondents were middle-aged, males, and married. They had low educational levels and annual income and the majority of them did not attend pieces of training. They were land owners cultivating an average area of 1.5 hectares. Moreover, the majority of the respondents had fully taken part in the overall activities of PCPP which indicates genuine participation. Factors that have a high level of significance to the level of involvement were the following: educational attainment, number of training attended, benefit satisfaction, and perceived satisfaction towards the project. Other significantly related factors were sex, age, benefits awareness, and effectiveness of the Coconut Development Officer (CDO) in the delivery of services. Apparently, the most common problem encountered by the farmers was coconut pest infestation. Hence, regular monitoring from the CDO staff and provision by PCA of sufficient pesticides to control infestations are hoped to prove the productivity of coconut farms.

Key words: *Coconut farmers' participation, extension services, perceived satisfaction, benefits*

INTRODUCTION

The coconut industry in the country Philippines plays a vital role in national economic development [18]. In fact, this industry is one of the top ten exports as exhibited by the good export performance of both traditional and non-traditional coconut products in the country. The Philippines is the second-largest producer of coconuts globally, ranking directly behind Indonesia [6]. Coconut provides a sustainable income source for many Filipinos by giving service through its many programs [21].
Coconut (*Cocos Nucifera L.*) is considered the lifeblood of Philippine agriculture because of the assortment of products and by-products made from the coconut tree utilized for food and in industry. Coconut is one of the country's most important crops that has played a relevant role in global competitiveness and the country's primary agricultural export. Indeed, the Philippines remain the uppermost producer and exporter of coconut throughout the world [17],[21]. Although there are numerous coconut plantations in the Philippines, still the productivity levels remain relatively low [4]. The low productivity of the coconut plantations can be attributed to the lack of information on appropriate technologies for coconut farming; fruit-bearing trees are senile and need replanting [6]. Seemingly, there is low participation of farmers in the decision-making process, especially in marketing which they do not have much control over. This results in a major problem in the export of coconut commodities due to a declining quantity of production [18]. Moreover, when Typhoon Haiyan (topically known as Yolanda) affected the Philippines on November 8, 2013, an estimated 33 million

coconut trees were battered or damaged, negatively impacting around 1 million coconut farmers [6], [25].

The devastation brought by the calamity was deeply felt by the workers in the agricultural sector, especially the coconut farmers in Eastern Visayas who were badly hit. The region experienced a significant decline in coconut production, which gravely affected demand at local and national levels. Some provinces like Leyte and Samar have suffered setbacks due to massive infestation [25]. More significantly, despite the adverse impact on the industry's contribution to the economy and its vast economic potential, coconut farmers are considered poor in the country. Their poverty can only be explained by the inability of producers to reinvigorate the production [22].

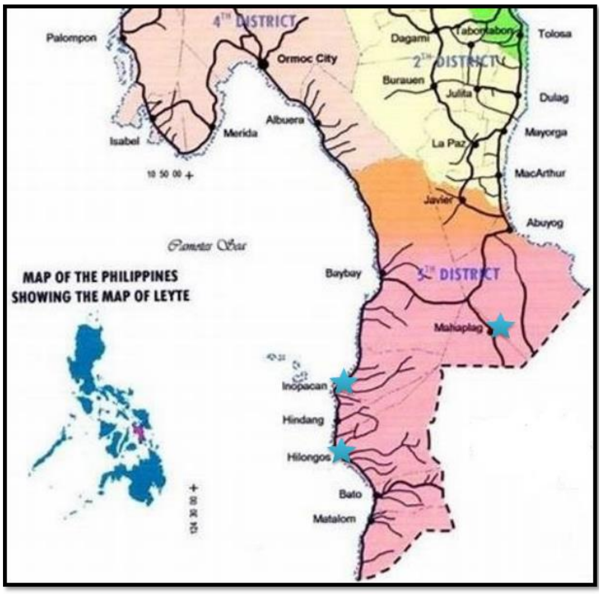
The Philippine Coconut Authority (PCA), an attached agency under the Department of Agriculture (DA), is mandated to revitalize the coconut industry by increasing coconut production and farm productivity to ensure economic stability among the coconut farmers [22]. PCA leads the farmers to help them be adequately trained, motivated, and challenged to transform coconut farms into entrepreneurial entities. PCA enhances the farmers' capability to identify demand-driven crops that should be planted in greater volume to generate more income. Moreover, farmers are also taught about marketing to be able to sell their crops at a competitive price [13], [22].

To achieve the increasing productivity and income of coconut farmers, one of the programs implemented by PCA is the Participatory Coconut Planting Project (PCPP). PCPP aimed to uplift the living standard of coconut farmers and the coconut industry. Participation implies a widening redistribution of opportunities among the people to involve them in all the phases of development activities, especially in the coconut replanting and plantation rehabilitation program. It asserts one's right to establish through their involvement in the development processes since it also affects them and ultimately the community. Furthermore, it emphasized that the user's perspective is vital in sustainable development programs. Although the PCA personnel has done their best for the coconut farmers to get involved in the PCPP, the extent of their participation in this program is not yet well studied. The farmers' involvement in rehabilitating and improving productivity could be influenced by various factors which can affect their full participation. This study was anchored on the Ladder of Citizen Participation Theory [3] adapted and developed by Farshid Aref [2]. Citizen participation is a kind of procedure that provides reclusive individuals a chance to impact the public decision-making process.Thus, it was hypothesized that the participation of farmer-beneficiaries in the PCPP was influenced by four major variables: 1) socio-demographic and economic characteristics of the farmer respondents, 2) other selected factors that are associated with farmers' involvement in the project, 3) the perceived satisfaction of farmers towards PCPP and 4) the effectiveness of CDOs in delivery of extension services. The results of this study could provide valuable insights to rural development planners and policymakers in planning and implementing policies and strategies that would improve the mobilization of farmers in any development project. The information would be useful for guiding the future policies that shall form the guidelines to improve the present programs. It can also be useful to program implementers and frontline extension agents to analyze and improve extension strategies and methodologies, find solutions to whatever problems they will encounter in implementing the project, and determine the course of action to make farmers more actively involved in the project for their development and benefits.

MATERIALS AND METHODS

Study site and respondents

The study covered three municipalities of Northwestern Leyte under the Participatory Coconut Planting Project, namely: Mahaplag, Inopacan, and Hilongos, Leyte (Map 1). These municipalities are also the coconut top growers in Northwestern Leyte and have the most significant number of farmers involved in PCPP.



Legend: ★ - Locale of the study

Map 1. The location where the survey was conducted.
Source: [8].

The following barangays in these municipalities were selected using purposive sampling: Brgy. Sta. Cruz and San Isidro in Hilongos, Brgy. Caminto and Hinabay in Inopacan, and Brgy. Mabuhay and Palanogan in Mahaplag, Leyte. The respondents of the study were the coconut farmers involved in the PCPP from the year 2015 to 2017. A total enumeration of respondents from the selected barangays in three municipalities was used to elicit a response. The distribution of the respondents by municipalities is shown in Table 1.

Table 1. Distribution of farmers by municipality

Municipality	Barangay	Farmers
Mahaplag	Mabuhay	16
	Palanugan	14
Hilongos	Sta. Cruz	20
	San Isidro	19
Inopacan	Caminto	40
	Hinabay	36
Total		**145**

Source: Source: Authors' owntally (2022).

Data Gathering and Research Instrument

A list of coconut farmers involved in the PCPP was obtained from the Provincial Office of the Philippine Coconut Authority-Northwestern Leyte. Personal interviews were conducted by the researcher in the respondents' respective residences and were kept confidential to protect their privacy. During the interviews, the interview schedule was translated into the Cebuano dialect to make the conversations more understandable. To substantiate the data gathered, three Focus Group Discussions (FGDs), one for each municipality, were also conducted.

A research's developed structured questionnaire adapted from the study by Aref [2] and Arnstein [3] was employed for the scheduled interview. The interview schedule was pretested among selected coconut farmers who were not included in the research coverage. A five-part interview schedule was used in data gathering.

Part I dealt with the socio-demographic and economic characteristics of farmer respondents.

Part II included other selected factors that could affect their participation and involvement in the project.

Part III focused on the perceived satisfaction towards the PCPP (7 areas) and the effectiveness of CDO staff in the delivery of extension services (5 areas). This part is considered a 5-point rating scale.

Table 2 shows the range of scores in perceived satisfaction and effectiveness of CDO staff.

Table 2. Scoring guidelines for Part III

Perception scores	Adjectival rating	
	Satisfaction	**Effectiveness**
1.00 – 1.80	Very unsatisfied	Highly ineffective
1.81 – 2.60	unsatisfied	Ineffective
2.61 – 3.40	Undecided	Uncertain
3.41 – 4.20	Satisfied	Effective
4.21 – 5.00	Very Satisfied	Highly effective

Source: Authors' ownguidelines (2022).

Part IV was on the level of farmers' involvement in the different activities (7 activities involved, two phases) of PCPP. In each activity, each farmer has to choose the following options: 1-Not at all, 2-Partially taken part, 3-Fully taken part.

Table 3 presents the scoring guidelines for farmers' involvement.

Table 3. Scoring guidelines for Part IV

Perception scores	Level of involvement
1.00 – 1.80	Not at all
1.81 – 2.60	Partially taken part
2.61 – 3.40	Fully taken part

Source: Authors' own guidelines (2022).

Lastly, Part V dealt with the problems encountered in relation to the project and suggested solutions and recommendations to solve these problems.

Data Analysis

Descriptive statistics such as percentages, frequency counts, means, and ranges were used to describe farmer respondents' socio-demographic characteristics, including their perceived satisfaction and participation in the program. The data gathered through selected farmer interviews were presented in descriptive form and tables. Linear regression analysis was employed using a specified model (ordinary least square (OLS)) to elucidate the influencing determinants (socio-demographic, economic characteristics, and other personal factors of farmer-respondents) of farmers' involvement in PCPP. For the dependent variable, the total farmers' perception scores (summed up) in involvement in the different activities were computed. Data were coded and analyzed using the STATA version 14.0 and employed some diagnostic test that is subjected to a 5% level of significance.

RESULTS AND DISCUSSIONS

Profile of the PCPP Respondents

Almost half of the farmers (45%) were middle-aged, where the average age is 55. These findings indicate that age does not limit individuals in doing farm activities. The majority of the respondents were males (66%). This result confirmed Nnadi and Akwiwu's [19] study that males are usually the decision-makers and, therefore, are well placed to involve in agricultural projects. A majority (79%) of the farmers were also married: Most respondents had low education, with one to four household members.

Most of the farmers (53%) were members of one or more organizations in their respective barangays. A majority (70%) of them have not attended training for the following reasons: they were either not informed or aware of the training, busy on their farm/work, or had no training conducted for them. However, some had attended one or more coconut-related training such as on PCA-PCPP Program (21%), PCA- Planting/replanting and Integrated Pest Management (8%), and other related training.

The majority of the respondents (74%) were landowners/heirs who were more involved in PCPP. According to Philippine Statistics Authority [21], Eastern Visayas currently pegs the poverty threshold at Php9,063.75 a month for a family of five or Php108,765.00 income in a year. This reveals that the coconut farmers in the study sites were below the poverty line, further indicating that their income cannot provide all the basic needs for their families. Although all of the respondents (100%) were mainly dependent on farming, some of them had other sources of income coming from small-scale businesses (17%), as a driver (5%), government/private employment (13%), relied on the remittance from their family/relatives (5%), and other sources.

On average, the respondents cultivated 1.5 hectares which ranged from 0.25 to 6.0 hectares which shows that the majority of the farmers qualified on the requirements of PCPP to cultivate an area of 0.5-5.0 hectares. However, there were farmers (60) who did not qualify based on this requirement but were allowed to participate in the program. On the other hand, the same percentage of respondents (23%) have a long farming experience, between 13- 23 years and 24- 34 years. Generally, the respondents had an average farming experience of 28 years.

Factors Influencing Participation

Most of the respondents (77%) got information about the PCPP from personal sources. The study revealed that they got more reliable information from the CDO staff. This shows that the CDOs assigned in the respective areas effectively disseminated reliable information about the project.

Although the PCPP did not use radio, television, and printed materials, a few respondents (9%) availed the mass media where they considered the radio as an effective source of information over television (4%) and printed materials (0.7%).

One of the influencing factors why people participate in government/private activities is the benefit they receive from their involvement [24], [27]. Almost all (95%) of the respondents were aware of the benefits gained from joining the project. Seventy percent (70%) indicated satisfaction since they perceived that the program helped them financially.

Perceived satisfaction toward PCPP Project

The FGD results affirmed that the project positively affected farmers' lives because these were very useful in their livelihood. Generally, the respondents rated the project satisfactorily, as indicated in the grand mean score of 4.12.Among the favored areas listed, the project's effect and usefulness in their livelihood had the highest mean scores (4.28), indicating farmers' high satisfaction with these aspects (Table 4).

Table 4. Perceived satisfaction of the farmers

Areas	M	SD	Adjectival rating[a]
General assessment of the project	4.20	0.760	Satisfied
Sourcing own seed nuts	4.25	0.769	Satisfied
Usefulness in their livelihood	4.28	0.768	Satisfied
Dissemination of the concept of the program	3.97	0.931	Satisfied
Relevance to their needs	4.21	0.754	Satisfied
Process of application in the access to the project	3.63	1.296	Satisfied
Effect of the project on their lives	4.28	0.750	Satisfied
Grand Mean and Std dev(M±SD)		4.12±0.86	Satisfied

Note: a-See Table 2 for details.
Source: Authors' own analysis based on data gathered (2022).

The process of application for the access to the project and dissemination of the concept of the program was still satisfactory, although with low mean scores of 3.63 and 3.97, respectively. The respondents favored other areas such as sourcing their seed nuts, relevance to their needs, and general assessment of the project.

Effectiveness of CDO staff

The CDOs' performance in the delivery of extension services in specific project areas was effective, with an overall grand mean of 3.98 as preferred by the respondents (Table 5).

This implies their trust in the CDO staff for the reliability of the information they received from a sense of responsibility, seriousness, and dedication to services has been rated highest (4.20).

Although the implementation of a monitoring system (3.68) was low, it was understandable because of the wide coverage of responsibility and lack of CDO staff responsible for the regular monitoring of the project.

This result is consistent with the study of Aguda et al. [1] that the agricultural project's staff in Baybay City, Leyte, Philippines has room for improvement to satisfy the participation of farmers.

Table 5. Effectiveness of the CDO staff

Areas	M	SD	Adjectival rating[a]
Technical capability of CDO staff	4.11	0.746	Effective
Sense of responsibility, seriousness, and dedication to services	4.20	0.742	Effective
Giving clear instructions to participants	4.14	0.782	Effective
Implementation of a monitoring system	3.68	1.033	Effective
Settling/handling problems effectively	3.79	0.980	Effective
Grand Mean and Std dev(M±SD)		3.98±0.85	Effective

Note: a-See Table 2 for details.
Source: Authors' own analysis based on data gathered (2022).

Level of involvement of Farmers

PCPP had seven activity areas which were divided into two phases (Table 6).

Farmers' level of participation was measured using a 3- point attitudinal scale with 3- fully taken part, 2-partially taken part, and 1-not at all. This 3 -point attitudinal scale was derived from Arnstein's [3] ladder of citizen participation theory, adapted and developed by Farshid Aref [2], which categorized participation into three levels only. In the Phase 1 activities, half of the respondents (50%) did not attend the awareness seminar and partially took part based on the overall level of involvement (1.82). Findings revealed that some of the respondents were not aware/informed of the PCPP seminar because no formal pieces of training/seminars were conducted in their respective areas. However, the rest of Phase 1 activities were fully taken part by the majority of the respondents. This reveals that the participants had made conscious decisions to participate in these activities and were not influenced by others.

Table 6. Respondents' rating on their level of participation in various PCPP activities

ACTIVITIES	MEAN (±SD)	Over-all response[a]
Phase I Activities		
a.Awareness seminar	1.82 (±0.23)	Partially taken part
b.Seed nuts selection	2.35 (±0.43)	Fully taken part
c.Nursery preparation and establishment	2.37 (±0.37)	Fully taken part
d.Seedbed preparation	2.39 (±0.24)	Fully taken part
e.Sowing and propagation of seed nuts	2.38 (±0.43)	Fully taken part
Phase II Activities		
a.Production of good quality seedlings	2.38 (±0.29)	Fully taken part
b. Field planting of coconut seedlings	2.39 (±0.35)	Fully taken part

Note: a - See Table 3 for details.
Source: Authors' own analysis based on data gathered (2022).

The same results were also revealed in Phase 2 activities, wherein most respondents at varying levels of participants took part in the production of good quality seedlings (61%) and field planting (62%). This was also stressed in the findings of Aguda et al. [1] and Red et al. [24] that farmer-beneficiaries have varying levels of participation at the different stages of the project.

The results of Phase 1 and 2 were affirmed by the respondents during the conducted FGD as they expressed satisfaction with the different activities of PCPP because they have received monetary benefits from participating in the project. For every seedling they have planted, they received Php40.00. Their participation was largely influenced by the monetary incentives they received. Although their participation appeared to be a token passion because it was extrinsically motivated, they claimed that their involvement in the project would benefit them [20], [14], [26].

Factors that Influenced the Level of Involvement of Farmers in PCPP

Table 7 depicted that the regression model (F_c=3.77, p-value<0.001) is significant at a 1% level of significance. Additionally, the R-squared (goodness-of-fit) shows that (R^2=0.16) there are significant predictors that influence the farmers' level of involvement in the project. The diagnostic test for the model suggests that the model does not suffer from heteroskedasticity, multicollinearity problems, and non-normality of residuals. The model showed that only age (p-value=0.077), sex (p-value=0.018), and education (p-value=0.007) significantly influenced the respondent's level of involvement in the PCPP. Other factors showed no significant relationships (Table 5).Among the three factors mentioned above, the respondent's education showed high significance at a 1% level, indicating that the more educated the farmer, the more likely they will participate in agricultural development projects.This result conforms with Nnadi and Akwiwu's [19] notion that farmers participate in order to apply the knowledge they learn. If the farmer is more knowledgeable, then farmers possess a good attitude in practicing innovative production technologies in agriculture [24]. Moreover, based on the number of beneficiaries participating in PCPP activities, males were predominant, which revealed high significance at a 5% level. This result is parallel to the findings of Rahman et al. [23], that farming is a masculine work and dominated by male workers. On the other hand, age was negatively correlated with the level of involvement at a 10% level which means that the older the farmer, the lesser they will participate in these kinds of activities. It is worth noting that farming is exhausting work, hence most of the farmers are young and motivated [10].

Table 7. Regression analysis (Model 1) for farmers' level of involvement in PCPP

Determinants	Coefficient	Std Error	p-value
Age	-0.067*	0.038	0.077
Sex	2.221**	0.926	0.018
Civil Status	0.429^{ns}	1.022	0.675
Tenurial status	0.372^{ns}	1.067	0.728
Education (in years)	0.856***	0.313	0.007
Household size	0.156^{ns}	0.206	0.449
Farm size	0.298^{ns}	0.317	0.348
No. of years in farming	0.040^{ns}	0.038	0.290
Constant	16.427***	3.282	<0.001
N	145		
F-computed	3.77		
P-value	<0.001		
R-squared	0.160		

Note: ns- not significant; * - significant at 10%;
** - significant at 5%
*** - highly significant at 1%.
Source: Authors' own analysis based on data gathered (2022).

Table 8 reveals that the second constructed model (F_c=3.77, p-value<0.001) is highly significant. It can be shown also in the R-squared of the model (R^2=0.617) that there are several strong predictors that influenced the farmers' involvement in coconut farming. Plus, the diagnostic test declares that the model is not heteroskedasticity, no multicollinearity problem among predictors, and the residuals are closed to normality.Interestingly, among the eight (8) other selected factors subjected to regression analysis on their influence on the level of involvement of PCPP beneficiaries, five (5) showed significant relationships with training attended, benefit satisfaction, and perceived satisfaction towards the project indicating high significance at 1% level (Table 8).

Table 8. Regression analysis (Model 2) for farmers' level of involvement in PCPP

Determinants	Coefficient	Std Error	p-value
Annual income	$-1.74e-06^{ns}$	2.65e-06	0.513
Training attended	2.959***	0.647	<0.001
Members in Organization	-0.689^{ns}	0.590	0.245
Information sources	0.058^{ns}	0.102	0.572
Benefits awareness	2.318*	1.367	0.092
Benefits Satisfaction	2.504***	0.468	<0.001
Perceive satisfaction	0.237***	0.081	0.004
Effectiveness of CDOs	0.161*	0.095	0.094
Constant	-2.629^{ns}	2.816	0.352
N	145		
F-computed	26.01		
P-value	<0.001		
R-squared	0.617		

Note: ns- not significant; * - significant at 10%;
** - significant at 5%
*** - highly significant at 1%.
Source: Authors' own analysis based on data gathered (2022).

In fact, training is vital in knowledge acquisition and stimulating farmers' involvement in the agricultural project [24], [27]. Moreover, benefits awareness and effectiveness of CDO's performance were found significant at 10%. These results explained that the more they were exposed to training, the more satisfied they were with participating in the project because they were more aware of the benefits derived from it [27]. In the study of Aguda et al. [1], farmers must be provided appropriate information and the right training to fully comprehend the benefits they can get. And this motivates the farmer's eagerness to participate the government projects. Furthermore, respondents' perceived satisfaction with the project can be attributed to the effectiveness of CDOs in the delivery of extension services. These results were also expressed during the FGDs conducted among selected groups of PCPP participants stating that the CDOs' responsibility and dedication to the delivery of extension services contributed to their satisfaction with the project. It is worthy to note that farmers' satisfaction is associated with some indicators that include availability, relevance, accessibility, and even effectiveness [11], [15], [16]. However, the other factors such as annual income, membership in organizations, and information sources did not influence the respondents' level of involvement in PCPP significantly (p-value>0.10).

Problems Encountered by the Farmers and Suggested Solutions

The most common problem encountered by the respondents who participated in PCPP was pest infestation (58%) in their coconut plantations. One of the reasons they experienced this kind of problem was the lack of knowledge on preventing pests/diseases such as *the Brontispa longissima Gestro,* also known as the coconut leaf beetle and rhinoceros beetle. In addition, they could not afford to buy pesticides for their farm. The result is parallel to the studies in the literature that one of the problems in coconut farming is pests [5], [7], [9], [12]. This problem also emerged during the FGD, stating that they did not do something about it because they could not afford to buy pesticides because of the very low price of copra.The respondents identified two distinct problems concerning the implementation of PCPP. One was on the application of the requirements of PCPP (27%) due to the unavailability of proof of land ownership where owners did not authorize tenants to participate in the PCPP. This happened because requirements in the access of the project changed from time to time. Although there were those (23%) who never encountered problems in the PCPP implementation, others (5%) claimed of having encountered these problems: delay in giving of cash incentives (5%) which caused some frustrations on the part of the beneficiaries, and the low market price of copra (4%). To address the problems identified by the respondents, they (74%) recommended the following solutions: there should be regular monitoring of their farms by the CDOs to assist farmers in solving the pest infestations, and the PCA should provide enough pesticides so that they can have better harvest and increase in their income.To remedy problems of PCPP application requirements, their suggested solutions were to have easy access in getting requirement forms and proper dissemination of information on how to access the needed requirements (36%). Other respondents recommended that there should be a quick and easy way of giving cash incentives so that they will be encouraged to participate and be motivated to join the project (6%).

On the other hand, only a few (5%) of the respondents felt the need that the government should take action on the low market price of copra because this was one of their barriers to participating in the coconut planting project.As expressed by the respondents during the FGD, regular monitoring of their farms by the CDO and providing enough pesticides were a big help to prevent or control pest infestation, which was one of the major problems besetting the coco-farms.

CONCLUSIONS

Based on the data results presented, most of the respondents in the selected municipalities of Mahaplag, Hilongos, and Inopacan belonged to the middle-age category, the majority of which were males and married. They have low educational levels, an average of four household members, and low annual income, and are below the poverty line. More than half of them were members of one or more organizations in their respective barangays, and a majority of them have not attended the training. Most of the respondents were owners/heirs, cultivated an average area of 1.5, and had an average farming experience of 28 years. It was also revealed that coconut farming was their primary source of income. Using the Ladder of Citizen Participation, it was found that the majority of the respondents had fully taken part in the overall activities of PCPP, which indicated genuine participation.

Highly significant factors influencing the level of respondents' project involvement were educational attainment, the number of training attended, benefit satisfaction, and perceived satisfaction towards the project. Other significantly related factors were sex, age, benefits awareness, and effectiveness of the CDO in the delivery of services. It was found that the following variables have no significant relationship to the level of involvement in the project: civil status, tenurial status, household size, farm size, experience in farming, annual income, membership in the organization, and information sources. Coconut pest infestation was the most common problem on the farm, which requires regular monitoring of CDO staff with the provision of enough pesticides to address for farmers to better harvest and increase their income.Hence, the government should formulate policies to address the volatile price of copra. Farmers should also be encouraged to find alternative means like engaging in crop diversification, processing products and by-products of coconut, and many others to increase their income and not just depend on copra. A similarly comprehensive study with more variables covering broader scope in other parts of the region in the Philippines may be conducted to have more reliable results.

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ECONOMIC EFFICIENCY OF CORN GRAIN CULTIVATION WITH THE NEW TECHNOLOGIES OF TILLAGE AND IRRIGATION

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Abstract

In the context of climate change, there is a growing need to study the impact of environmental factors on plant life. This, in turn, will allow the reasonable use of agricultural techniques, to form high-yielding crops, and increase crop productivity. The following variants of tillage and irrigation technologies were included in the research scheme (i) conventional tillage without irrigation; (ii) no-till without irrigation; (iii) no-till with drip irrigation system; (iv) no-till with system of subsoil drip irrigation. Corn yield varied significantly from the studied factors of cultivation technology. The highest productivity of 12.1 t/ha was obtained under no-till with a system of subsurface drip irrigation and 12.0 t/ha under no-till with drip irrigation system. During the statistical processing of the obtained experimental data, no significant difference between the studied variants was found. Carrying out an economic analysis of corn growing in the arid climate of the Southern Steppe of Ukraine testifies to the high efficiency of application of the new tillage and irrigation systems in the cultivation technology. The application of no-till with drip irrigation system allowed to obtain grain with a cost of 3.72 UAH/t, to obtain a profit of 50.13 UAH/ha with a level of production profitability of 112.2%. It should be noted that the use of no-till with system of subsoil drip irrigation led to slightly lower indicators of economic efficiency of corn cultivation, under which the level of production profitability was 109.0%.

Key words: *corn, soil tillage, subsurface drip irrigation, economy, efficiency*

INTRODUCTION

Today, the most important task that society must constantly solve is to increase the production of food and various raw materials by intensifying the agricultural sector, which includes improving the existing and justifying the new, modern structure of sown areas, taking into account market conditions and raw materials; improving tillage technologies, minimizing or moving to no-till; optimization fertilizer system and plants protection from pests; introduction of a set of reclamation and soil protection measures; introduction of new technologies for growing crops, taking into account advances in genetics, breeding, biotechnology.
In the context of climate change, there is a growing need to study the impact of environmental factors on plant life. This, in turn, will allow the proper application of agricultural techniques, the formation of high-yield crops, increased the productivity of both crop production, and, if possible, the restoration of livestock. In recent years, climatic conditions have changed dramatically, so it is impossible to grow crops under a single scheme. This requires a differentiated approach, taking into account all weather conditions. The main component of crop production technologies is the choice of a tillage system, so inefficient tillage can lead to the disruption of plant life factors that affect soil fertility.
Currently, the level of the plowed area in Ukraine is one of the largest in the world and consists of 53.9%, while in Poland it is 36.5%, Germany is 34.1%, the United States

is 17.5%, China is 12.0%. According to FAO estimates, 20% of agricultural land in Ukraine has already undergone significant degradation, and the rest is under threat. Over the last 130 years, Ukrainian soils have lost almost 30% of their organic matter (humus). According to the National Academy of Agrarian Sciences of Ukraine estimates, the economic damage from soil degradation is about 40 billion UAH/year [19, 43].

Traditional management practice shows results when the harvest is almost 80% dependent on nature, in turn, no-till can reduce to 20% the impact of weather and climate [3, 19, 43]. In general, in conventional tillage, six groups of microbiological cenoses are present in the soil, and when plowing is abandoned after 3–5 years, three more groups are gradually added, which corresponds to microbiological cenoses of virgin soils [35]. Thus, it gets a biologically active soil that can decompose, process, and redistribute all the organic matter that remains in it. It was also found that five minutes after cultivation in the layer of 0-10 cm is three times less carbon dioxide than before cultivation [20].

Currently, for European countries, the selection of tillage technologies is a very important issue. Impressive results and the rapid introduction of no-till in North and Latin America, and Southeast Asia are not an example for European countries, so the spread of these technologies is slow. Based on long-term unparalleled field trials in Latin America in the United Kingdom, Germany, Norway, Denmark, Estonia, France, and other countries, the benefits of these technologies have been established, but no large-scale implementation has been reported [28].

To choose a tillage system, it is necessary to take into account natural and climatic conditions, soil diversity in the fields of the economy, and the financial capabilities of the owner to introduce new technologies. Restrictions on the use of soil herbicides to control weeds in strip-till and no-till systems involve the application of active ingredients of continuous action before sowing, or after sowing to the seedlings of the main crop. Increased levels of chemical and biological control of diseases and pests in these systems are offset by high yields due to preserved moisture in the upper soil layers, especially in the dry Steppe zone in Ukraine.

In modern agriculture, there are several basic tillage systems as conventional with moldboard, minimum tillage (mini-till), tape (strip-till), without plowing (no-till) [2, 4, 5, 10, 24, 27, 31].

Conventional tillage provides for shelf plowing with a turn of the layer, which creates a clean arable surface, plant remains are wrapped to a depth of 20-30 cm. The advantages of the technology are creating comfortable conditions for pre-sowing cultivation for friendly seed germination; ensuring optimal impregnation of moisture along to the soil profile and the distribution of minerals in the arable layer; relatively low pressure on the ground by mechanical units; possibility of applying high rates of organic and mineral fertilizers; optimization of chemical plant protection. The disadvantages of the technology are the creation of a dense plow sole, which prevents penetration into the lower layers of water and complicates the development of the root system in depth. This technology is not recommended for soils prone to drying, wind, and water erosion. Periodic deep loosening, once every 3-4 years is mandatory.

No-till is a modern system of agriculture, which does not carry out plowing, herewith the land surface is covered with a layer of especially crushed plant residues (mulch). No-till is the sowing of the crops in previously untreated soil, by opening a narrow opening, a strip only for sufficient width and depth for proper placement of seeds, with no other preparation [33]. The advantages of the technology are a minimal number of passes of heavy units in the field, lower energy and financial costs per unit area during cultivation; under the layer of plant remains, winter moisture is stored for a long time and there is limited evaporation during droughts; prevents all types of soil erosion and excessive overheating of the top layer during periods of high temperatures. The disadvantages of the technology are restrictions on the control of harmful vegetation without mechanical intervention, increased risk of fungal diseases (especially saprophytic fungi) and pests that overwinter in plant remains; limited early sowing in the spring, as the heating and drying of the topsoil is slow due to the presence of a layer of plant residues, so the optimal sowing time is very short; application of high rates of mineral fertilizers is limited and it is necessary to use additional special equipment; the content of phosphorus, potassium, and acidity must be equalized before the introduction of technology; requires the use of special sowing equipment with high opener pressure on the soil, which involves additional financial costs. The use of vertical tillage (deep loosening) is necessary for 5-6 years, as there is significant compaction on the tracks of heavy machinery. In arid steppe areas, dry plant residues on the soil surface can be a material for fire both before and after sowing [37, 42]. It represents a modern model of tillage, according to which it is not affected by traditional mechanical impact, but leaves crushed plant remains, covering the surface and forming mulch [32, 34, 43]. The "zero" method of agriculture (no-till) should not be taken lightly, only as a refusal to plow, because this method is primarily a complex technological model that requires special knowledge and the availability of highly qualified specialists and special equipment, so the positive effect of its application can be obtained only using integrated and systematic approaches [9, 13, 18]. Thus, in the United States, where this technology is currently used on 25% of arable land, in 16 years there has been an increase in organic matter from 2.0 to 3.5% [14]. The farmer Non Pereira in Brazil switched to use of no-till 30 years ago when the amount of organic matter in the soil was 1%, and today it's close to 4%. During this time, corn yield increased from 4.0 to 8.0 t/ha, and the number of fertilizers applied decreased from 400 to 260 kg/ha while the price of land was twice as high as with conventional technologies [3, 39]. According to foreign researchers, the effect of inhibiting seed germination begins with the number of crop residues of 3,000 kg/ha and increases to about 12% for every additional 1,000 kg/ha of residues [16, 20, 36]. Although the soil is not cultivated with constant use of no-till, special tillage is often required to switch to this system [30]. The main requirement for the field, when using no-till, is a flat soil surface [15, 25], only, in this case, can special drills work properly, otherwise, they will sow some seeds too deep or, conversely, too shallow, which will affect yields [23, 30]. Unlike traditional farming, stubble is not burned or plowed into the ground, straw is not removed from the fields. Non-commodity residues, such as straw, are crushed to a certain size after harvest and then evenly distributed over the field [16, 26]. The surface forms a soil-protective coating, a mixture of soil and crushed crop residues, which resists water and wind erosion, preserves moisture, prevents weed growth, enhances soil microflora, and is the basis for the reproduction of the fertile soil layer and further increases yields [8, 17]. Proper management of the system of no-till requires as much mulch [1, 7, 16]. Accordingly, when growing crops take into account not only the yield of the commodity part but also the cultivation of maximum biomass, for example, it is desirable to grow tall rather than low wheat varieties, to introduce crop rotation with a large amount of biomass such as corn, etc. Also, sowing for no-till requires special drills that are significantly wider than conventional ones [38], which significantly saves fuel, and working time for people and machines.

According to research, prices for fuel, machinery, fertilizers, and pesticides are rising every year or even quarterly, and agricultural products are growing very slowly. Therefore, to ensure stability, the necessary system of agriculture and technology will ensure a high level of profitability of crop production, while not leading to soil degradation and allowing future generations to leave a fairly fertile soil. According to many farmers and scientists, this technology is no-till, in which crop production is manageable, predictable, and cost-effective [1, 12, 39].

In 2003, at the Second World Congress, three basic no-till principles were formulated which are still actual as the minimal mechanical impact on the soil, permanent vegetation, and maximally adapted crop rotations. Adherence to these principles allows, on the one hand, to preserve and increase the fertility and microbiological activity of the soil, improve its structure, ensure maximum preservation and increase the level of soil moisture, and reduce energy consumption. On the other hand, there is an opportunity to reduce investment, as well as the cost of fuel and lubricants, repairs, and reduce working hours [11, 41].

In this context, the purpose of the paper is to comparatively analyze the impact of climate change on corn crop economic efficiency in an experiment including four variants of tillage and irrigation technologies: (i) conventional tillage without irrigation; (ii) no-till without irrigation; (iii) no-till with drip irrigation; (iv) no-till with subsurface drip irrigation in 2021 at the State Enterprise "Research Farm "Velyki Klyny" of the Institute of Water Problems and Land Reclamation of the National Academy of Agrarian Sciences of Ukraine.

MATERIALS AND METHODS

The research farm "Velyki Klyny" of the Institute of Water Problems and Land Reclamation of the National Academy of Agrarian Sciences of Ukraine is located in the Black Sea lowland of the Left Bank of the Dnipro within the second floodplain terrace, and a plain with a total slope from north to south and administratively belongs to the Velykyi Klyn village of Kherson region, Ukraine (46°19'48"N lat. 32°36'05"E long.).

The general microclimate of the territory is semi-desert, but temperate, with signs of subtropical continental. In summer, the sand of the adjacent desert heats up to + 70ºC, and hot rising streams from the sands disperse rain clouds. During the growing season the total amount of productive precipitation on the farm rarely exceeds 200 mm, and the hydrothermal coefficient is 0.40-0.45. The extreme natural phenomena also should be noted frequent dry spells, which in some years last up to 60 days, and dust storms lasting up to 20 days a year. The average annual air temperature is + 9.9ºC, and the sum of effective temperatures is 3,300-3,400ºC. The average duration of the growing season is 225-230 days.

Precipitation during the year falls unevenly. The amount of precipitation that falls during the growing season is not enough to compensate for the amount of total evaporation during the growing of crops. To reduce the impact of adverse climatic factors and replenish moisture, the soil needs irrigation [6, 21, 22]. One of the most important meteorological indicators for agricultural science is the amount of precipitation during the growing season of the studied crop. Effective precipitation is one of the components in the future calculation of total water consumption and unit formation. It is important to consider not only their number, but also the distribution of time, intensity, efficiency, and so on.

The research compared the data obtained from Internet meteorological stations on precipitation and temperature, with long-term averages for the May-September period (Table 1).

During the growing season, in 2021 there were 227.1 mm of precipitation, which is 29.1 mm more than the long-term average for this period and their distribution over the growing season was uneven. The 45% of precipitation fell in the first decade of July with an amount of 102.9 mm, which is 87.9% more than the long-term average; 22% in the second decade of June; 13% in the first decade of August. In other periods of vegetation, precipitation was almost not observed. Summer was hot with rainfall, which was torrential in nature and fell unevenly in intensity. June was hot with precipitation in the second and third decades (in general amount was 61.1 mm).

The average monthly air temperature is 22.8ºC, which is 2.5ºC above the norm. Heavy rains with strong winds were observed in July. The average air temperature for the period of May to September was 21.5ºC, which is higher than the norm by 2.0ºC. The maximum air temperature rose to 35°C (on June 23), which was the absolute maximum temperature for the entire observation period (Table 1).

Table 1. Average long-term and actual values of climatic indicators

Indicators	Months															Sum of precipitation
	May			June			July			August			September			
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
Temperature of air, ºC																
Long-term	15.8	15.8	15.8	20.3	20.3	20.3	23.0	23.0	23.0	22.2	22.2	22.2	16.5	16.5	16.5	19.6
2021	18.2	18.7	15.6	20.6	23.2	24.8	26.1	22.8	23.9	24.2	21.7	23.4	22.9	19.7	17.4	21.5
Relative humidity, %																
Long-term	67.0	67.0	67.0	64.0	64.0	64.0	59.0	59.0	59.0	59.0	59.0	59.0	66.0	66.0	66.0	63.0
2021	72.7	70.9	77.5	62.6	68.1	59.4	50.6	52.4	62.1	49.8	55.7	50.6	54.0	45.0	52.5	58.9
Precipitation, mm																
Long-term	13.0	13.0	13.0	17.0	17.0	17.0	15.0	15.0	15.0	11.0	11.0	11.0	10.0	10.0	10.0	198.0
2021	0.0	0.0	0.0	0.0	49.4	11.7	102.9	6.0	0.0	29.0	6.4	0.0	0.0	15.7	6.0	227.1

Source: official data of the Ukrainian Hydrometeorological Center [40], Internet metrostation of Davis, and original data calculated based on the data obtained.

The research site is located in the Dry Steppe of Prysyvashia Province and is represented by agricultural production groups with the following soils dark chestnut slightly deflated sandy, meadow-chernozem slightly saline light loam, meadow-chestnut gleyed light loam.

The following variants of tillage and irrigation technologies were included in the research scheme (i) conventional tillage (CT) without irrigation; (ii) no-till without irrigation; (iii) no-till with drip irrigation (DI); (iv) no-till with subsurface drip irrigation (SDI).

The placement of options in the experiment is consistent. Repetition is three times. The yield was determined by manual harvesting followed by weighing and analysis of parameters. Data from all records analyses and observations were processed using statistical processing. Statistical processing of the obtained results was performed using the program StatSoft Statistica 6.0.

Technological operations were carried out using specially designed equipment depending on the methods of tillage. With no-till, no mechanical operations were performed except for sowing. Conventional tillage technologies included plowing up to 27 cm, and double cultivation up to 10 cm. Corn was sown on April 27, 2021, using of machine complex as New Holland TD5.110 and Marisa-Maschio Gaspardo with a sowing rate of 6.5 pieces/run m (92.86 thousand pieces/ha), row spacing 70 cm to a depth of 5-6 cm. Simultaneously with sowing, urea was applied with a mass fraction of nitrogen equal to 46.2% at the rate of 100 kg/ha. Used for sowing medium-ripe corn hybrid DM Skarb (FAO 330). At the experimental landfill, according to the variants of the experiment under DI and SDI, the moisture regime in the layer of 0-50 cm was observed, equal to 75-80% of the lowest moisture content. Drip irrigation was carried out with the irrigation pipelines on the soil surface at a distance of 1.0 m from each other; SDI with irrigation pipelines at a depth of 0.2 m and a distance of 1.0 m from each other.

RESULTS AND DISCUSSIONS

Positive changes in environmental impact are usually due to the accumulation of plant residues on the surface and in the upper layers of the soil, which reduces surface and internal soil runoff, improves the balance of carbon and other nutrients, and inhibits dehumidification, gas emissions, downstream redistribution. The results of point experiments indicate the effectiveness of no-till and require further study and objective evaluation [29]. The productivity of corn is determined by its genetic potential, the realization of which is achieved by the purposeful, cooperative implementation of technological techniques in accordance with the natural and climatic conditions of the growing area. In arid climatic conditions, irrigation is the most important factor in ensuring the viability of agrocenosis and, accordingly, a factor in obtaining guaranteed crop yields. The results of experimental studies showed that the use of no-till had an advantage over conventional tillage (Figure

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1). The lowest productivity of corn was obtained on the variants of CT in conditions of natural moisture and consisted of 7.1 t/ha. The variant of no-till without irrigation increased the grain yield of corn by 0.4 t/ha, which is significant and was confirmed by the results of statistical cultivation (LSD_{05} is 0.35 t/ha).

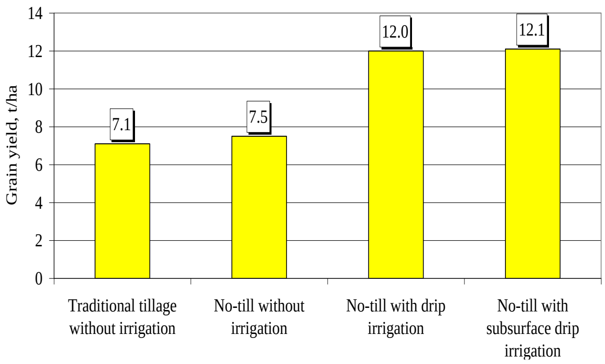

Fig. 1. Corn yield depending on the studied factors
Note: LSD_{05} (tillage) is 0.35 t/ha; LSD_{05} (irrigation) is 0.45 t/ha.
Source: original data calculated based on the data obtained.

A comparison between DI and SDI under no-till showed the absence of a significant difference of 0.1 t/ha and it was within the experimental error. The higher yield was under SDI with no-till and consisted of 12.1 t/ha. There are several reasons for the introduction of no-till as an economic (saving costs for spare parts, fuel and lubricants, and wages), agronomic (improving the water regime of the soil) environmental (reducing CO_2 emissions from the soil by binding carbon to soil organic matter, as well as reduction of soil degradation due to stabilization of erosion processes). The formation of the products price consists of many elements, one of the main of which is the cost of production. Each element of technology used in the cultivation of crops has an ambiguous effect on the value of the cost. Under the conditions of growing corn using CT in the conditions of natural moisture, the cost of production was the highest and amounted to 4,972 UAH/t (Table 2).

Table 2. Economic efficiency of corn cultivation with different methods of tillage and irrigation

Indicators	Conventional tillage without irrigation	No-till without irrigation	No-till with DI	No-till with SDI
Cost of grain, UAH/t	4,972	4,534	3,722	3,780
Growing costs, UAH/ha	35,301	34,008	44,669	45,732
Cost of production, UAH/ha	56,090	59,250	94,800	95,590
Profit, UAH/ha	20,789	25,242	50,131	49,858
The level of production profitability, %	58.9	74.2	112.2	109.0

Source: original data calculated based on the data obtained.

Growing crops in areas where modern technology was used, the figure decreased. This is due to the optimization of conditions for growth and development of culture and, consequently, increase yields. Thus, in areas where no-till was used in the conditions of natural moisture, the cost of corn decreased by 9.7% and amounted to 4,534 UAH/t. Irrigation is a major factor in intensifying agricultural production and a key element in increasing crop productivity in arid climates. The use of no-till with DI made it possible to obtain the main corn products with a cost of 3,722 UAH/t, which is 21.8% less than the previous combination. No-till with SDI slightly increased the cost of grain compared to the no-till with DI by 58 UAH/t is up to 3,780 UAH/t. Net profit, as part of the balance sheet profit of the farm, which remains at its disposal after taxes, fees, deductions, and other mandatory payments to the budget has changed significantly depending on the studied factors. Profit was obtained on all variants of the experiment. The largest profit was obtained on the variants of the experiment, which used no-till with DI and consisted of 50,131 UAH/ha. Also, a slightly lower indicator was obtained on the variants of no-till with SDI of 49,858 UAH/ha, which is less than the previous variant by 273 UAH/ha. The lowest profit of 20,789 UAH/ha was obtained under conventional technologies in non-irrigated conditions, which is 2.4 times less in comparison with other variants. In the conditions of application of no-till without irrigation, the indicator of profit made 25,242 UAH/ha. The level of profitability characterizes the economic efficiency of production and the feasibility of introducing new elements of cultivation technology. According to calculations, growing corn without irrigation provides an indicator of 58.9%, which is 26.0 percentage points less than the use of no-till, where it was 74.2%. The maximum values of the production profitability when growing crops under no-till with DI were determined and consisted of 112.2%. When the irrigation technology was replaced by SDI, the level of production profitability decreased by 3.2% and consisted to 109.0%.

CONCLUSIONS

Corn yield varied significantly from the studied parameters of cultivation technology. The highest productivity of 12.1 t/ha was obtained in a variant of no-till with SDI and 12.0 t/ha of no-till with DI. During the statistical processing of the obtained experimental data, no significant difference between the studied variants was found. Carrying out an economic analysis of corn cultivation in the arid climate of the Southern Steppe of Ukraine testifies to the high efficiency of application of the new technologies of tillage and irrigation system. The application of no-till with drip irrigation system allowed to obtain grain with a cost of 3.72 UAH/t, to obtain a profit of 50.13 UAH/ha with a level of production profitability of 112.2%. It should be noted that the use of no-till with the system of subsoil drip irrigation led to slightly lower indicators of economic efficiency of corn growing, under which the level of production profitability was 109.0%.

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THE DEMOGRAPHIC DEVELOPMENT OF RURAL LOCALITIES IN THE SOUTH MUNTENIA REGION-CASE STUDY- TWO COMMUNES IN CALARASI COUNTY, ROMANIA

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Abstract

An opportunity for the rural environment is the sustainability of agricultural activities, a concept that has recently emerged in rural areas, which is difficult to implement, as development in these areas is not uniformly achieved and requires significant investment to achieve sustainable village development. The purpose of the study was to identify the factors affecting population decline in the two regions studied to find solutions that could help to stop the decline. Data collection was carried out in accordance with current law (Law 544/2001), where birth, mortality and natural growth rates were determined and calculated using SPSS software, Pearson coefficients. The development of a landscape monitoring platform involving local authorities, academia, and business is an absolute necessity. It is absolutely necessary to develop a platform for monitoring the countryside, involving local authorities, the academic world and the business world. In this way, authorities can identify the localities where investments are needed to develop these areas.

Key words: *South-Muntenia region, rural localities, population, Romania*

INTRODUCTION

Calarasi County is located in the South-East of Muntenia region, to the left of the Borcea arm and the Dunăre river. The county has an area of 133,22 km^2, a population of 65,181 inhabitants with a density of 551.79 inhabitants/km^2[8].
According to Iova (2013), Calarasi County in 2012 was agriculturally rich, with 84% of the county's surface being represented by land, agriculture being the county's basic activity [13]. The revival of the rural environment from an economic perspective can be achieved through the revival of crafts and traditions of the area, as well as tourism, construction and financial transactions [18], [19].
The demographic analysis of the countryside can provide information on demographic change, causes, and solutions to mitigate demographic decline [11].
According to Dumitru (2019), the South-Muntenia region shows a decreasing population trend in the period 2014-2018, although it ranks second nationally in terms of population, in 2018 the decrease was 4% compared to the population recorded in 2014 [4]. According to Dumitru (2021), with Romania's accession to the European Union, the rural environment has seen many changes due to the support measures allocated. Even through these measures, the development of areas where there are natural resources is difficult to achieve due to dysfunctional infrastructure [3, 17]. An opportunity for the rural environment is the sustainability of agricultural activities. This term has recently emerged in rural areas and is difficult to implement because the development of these areas has not been uniformly achieved and substantial investment is needed to achieve sustainable development in villages. Improving sustainable behavior in rural areas

can be achieved by training young people to produce food whilec onserving natural resources [6]. In terms of food security, the most favoured countries are those with agricultural potential that can supply large quantities of agricultural products and food beyond their national needs. These countries, including Romania, have a rich agricultural potential. This comparative advantage represented by Romania is under used because, according to estimates by national and international experts and institutions, about 70% of the total demand for food, Romania's current market profile can cover the import of suchproducts [7], [5].

În recent years, people's diet has changed due to global challenges, among them we can mention the need for food increases with the changing diet of emerging populations. With biofuel production, as well as the impact of climate change on agriculture, food production, and supply, even in the EU is no longer an issue, food security has become an issue at a highly vulnerable EU level [1], [16]. Food insecurity in both the medium and long term is one of the food security issues, given the progress in climate change, the main global concern is: land, water and other agricultural resources, population growth, increasing market and trade vulnerabilities and poverty in many areas, especially in rural areas [12]. Given the need to increase agricultural production by 70% by 2050, action is needed to ensure food security in the way that the world can reach the right level of food. Solutions could be to encourage and fund agricultural research to find solutions which are environmentally friendly and suitable to maintain human health [22, 24].

The analysis of the global food security situation is based on a comparison of global food security levels, disparities between agricultural production and importance in different developing and developed countries. It compares the share of major sectors, taking into account, highlighting disparities and uneven distribution of agricultural production, the main sources of food security [9, 21].

Organic farming can be an opportunity for rural development, with an emphasis on the idea of process rather than product per se when it comes to organic farming; sustainable development can positively influence renewable energy and rural development through the integration of biological cycles [2]. Youth entrepreneurship must be stimulated to encourage the creation of innovative businesses, promote a culture favourable to entrepreneurship and the development of SMEs and medium-sized enterprises. The important role of education in promoting attitudes and facilitating entrepreneurial behaviour that started in elementary schools is now well known [14, 23]. The aim of the study is to identify the factors influencing the demographic decline in the two localities analysed, with a view to find solutions that could contribute to halt the demographic decline.

MATERIALS AND METHODS

Steps that led to the determination of the two localities:

1.Identification of the development region with the highest proportion of rural population in the total. Therefore, at the 2020 level, it was identified as the South-Muntenia region (Figure 1) [20].

2. Identification of the county in the South-Muntenia Region with the highest value of agricultural production, taking into account that agriculture is the main activity of rural localities. Therefore, at the 2020 level, Calarasi County was identified (Figure 1)[10].

3.Taking into account the main aspect that influences the demographic evolution, the localities with the highest birth rate have been identified (Figure 1).

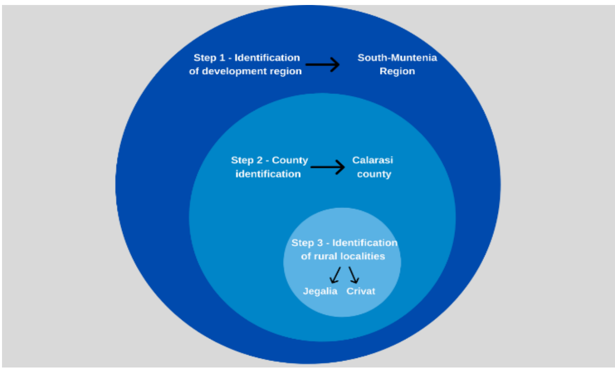

Fig. 1. Steps underlying the selection of the two rural localities analysed
Source: ownprocessing [10, 20].

The paper is based on official data provided by the municipality of Jegălia and Crivăț by means of law 544/2001, with the help of which the following indicators were calculated [15]:

- Birth rate RGN = $\frac{D}{P}$*100, where

N - number of newbirths;
P - population.

- General mortality rate RGN = D/P*100, where:

D - number of deaths;
P – population.

- Natural surplus SN = RN - RGN, where:

RN - birth rate;
RGN - overall death rate.

Additionally, using the SPSS statistical processing program, the Pearson coefficient was calculated and the relationship between variables was determined.

$$R = \frac{\sum(x-\overline{x)(y-\bar{y})}}{\sqrt{\sum(x-\overline{x})^2\sum(y-\overline{y})^2}}$$

RESULTS AND DISCUSSIONS

The population of Jegălia commune shows a downward trend according to the information provided by the Jegălia townhall. In 2015, the commune had a population of 4,503 inhabitants, reaching in 2020 a population of 4,095 inhabitants, representing a decrease by 9%. Contrary to the population trend, the number of households is increasing during the analyzed period, so in 2019 a number of 1,682 households was reached, increasing by more than 60% compared to 2015 (1,032 households) (Table 1).

The number of newborns fluctuated during the period under review, the average for the period was 53 newborns, and in the case of deaths, the average was 24 deaths, with a positive natural increase. The number of people receiving social assistance shows a decreasing trend, from 48 in 2015 to 34 people in 2020. The number of dispensaries has been constant from 2015 to 2019, with 2 dispensaries unitsregistered in Jegălia commune, and another dispensary will be established in 2020 (Table 1).

Comparing the number of inhabitants per household, it is found that in 2015 one household had the highest number of inhabitants in the period under analysis, that is, 4 inhabitants/household, while in 2020 there were only about 2 inhabitants/household.

Table 1. Main demographic indicators of Jegălia commune

An	Population	Number of households	Number of newborns	Number of deaths	Number of people on social aid	Number of dispensaries	Number of economic agents	Economic agents agriculture
2015	4,503	1,032	61	22	48	2	27	6
2016	4,407	1,580	52	20	45	2	32	6
2017	4,315	1,611	61	35	36	2	43	8
2018	4,279	1,638	39	28	37	2	40	9
2019	4,229	1,659	46	17	37	2	35	11
2020	4,095	1,682	63	23	34	3	35	11

Source:processed data, provided by the Jegălia commune.

The birth rate shows increased values in the period 2015-2020; thus in 2018, Jegălia commune presented 9.11 live newborns, the lowest number, while in 2020 it registered 15.38 live newborns, representing the highest number in the period 2015-2020. Regarding mortality, in 2015, the overall mortality rate was 0.49, while in 2020 it reached 0.56, meaning an increase by 14%. The number of people who receive social assistance as a percentage of the population is increasing, with a percentage of 8.3% in 2020, down by 2.36% compared to 2015 (10.66%).

Table 2. Main demographic indicators of Jegălia commune

An	Place/ households	Birth rate %	Overall mortality rate, %	Natural rate of return, %	% people Social aid/population
2015	4.36	13.55	0.49	13.06	10.66
2016	2.79	11.80	0.45	11.35	10.21
2017	2.68	14.14	0.81	13.33	8.34
2018	2.61	9.11	0.65	8.46	8.65
2019	2.55	10.88	0.40	10.48	8.75
2020	2.43	15.38	0.56	14.82	8.30

Source: processed data, provided by the Jegălia commune.

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The natural increase recorded by Jegălia is positive in the period 2015-2020, in 2015 the natural increase was 13.06%, reaching 14.82% in 2020, an increase by 1.76% (Table 2).
The population of the commune of Crivat decreases in the period 2015-2020, thus, in 2015 there were 2,243 people, reaching in 2020 a population of 1,943 people, representing a decline by 13%. Furthermore, the number of households decreases by 3% in 2020 (896 households), compared to the number of households registered in 2015 (930 households) (Table 3).

Table 3. Main demographic indicators of the Crivat commune

An	Population	Number of households	Number of newborns	Number of deaths	Number of people on social aid	Number of dispensaries	Number of economic agents	Economic agents agriculture
2015	2,243	930	14	38	50	1	35	3
2016	2,243	930	11	33	47	1	40	6
2017	2,200	912	14	35	44	1	47	8
2018	2,160	903	9	29	38	1	48	8
2019	1,943	896	11	30	31	1	51	8
2020	1,943	896	12	30	28	1	63	8

Source: processed data, providedby The Crivăț commune.

In the Crivăț commune, the number of newborns and deaths oscillates during the period under analysis, the birth rate being lower than the death rate, and the natural increase being negative. The number of people receiving social assistance decreases significantly, in 2020 the number of socially associated persons was 28, down by 44% compared to the number of socially assisted persons in 2015 (50 persons). In the Crivat commune, only one dispensary was registered in the period 2015-2020 (Table 3).
From the above table it can be seen that the number of inhabitants of Crivăț in relation to the number of households shows a period average of 2.32 inhabitants/household, in the first 3 years thenumber remained constant (2.4 inhabitants/household), reaching 2.17 inhabitants/household in 2020 (Table 4).
The birth rate of Crivat is positive in the period 2015-2020, in 2015 the birth rate was 6.24 live
births, in 2018 it was the lowest number of live births, namely 4.17. Subsequent years show increases, reaching 6.18 live births in 2020.
The overall mortality rate is also positive; in 2015 it was 1.69%, reaching 1.54% in 2020, meaning a decrease of 0.15%.
In the period 2015-2020, in terms of natural increase, the Crivat locality shows positive values, in 2015 it was 1.69%, and in 2020 it reached 4.63% (Table 4).

Table 4. Main demographic statistical indicators of the Crivat commune

An	Place/ households	Birth rate	Overall mortality rate	Natural rate of return	% people Social aid/population
2015	2.41	6.24	1.69	4.55	22.29
2016	2.41	4.90	1.47	3.43	20.95
2017	2.41	6.36	1.59	4.77	20.00
2018	2.39	4.17	1.34	2.82	17.59
2019	2.17	5.66	1.54	4.12	15.95
2020	2.17	6.18	1.54	4.63	14.41

Source: processed data, provided by the Crivăț commune.

Analyzing the Pearson correlation coefficient for the dependent variable as the population of Jegălia commune, and the independent variables as the number of households, number of newborns, number of social associations, number of dispensaries, number of economic agents and number of economic agents operating in agriculture, results in weak links and strong links directly proportional and inversely proportional.
Correlating the dependent variable population and the independent variable number of people receiving social assistance results in a weak relationship, with a Pearson coefficient of 0.911. In terms of strength, the link is strong, thus the decrease in population directly influenced the decrease in the number of people receiving social assistance.

For the dependent variable population and the independent variable number of economic agents operating in agriculture, a Pearson coefficient of -0.911 shows a weak, inversely proportional relationship (Table 5).

Table 5. Main demographic indicators of Crivat commune

		Population	Number of households	Number of newborns	Number of deaths	Number of people on social aid	Number of dispensaries	Number of economic agents	Economic agents agriculture
Population	Pearson Correlation	1	-0.78	0.052	-0.012	.911*	-0.725	-0.482	-.927**
	Mr (2-tailed)		0.067	0.922	0.982	0.012	0.103	0.333	0.008
	N	6	6	6	6	6	6	6	6
No. of households	Pearson Correlation	-0.78	1	-0.356	0.133	-.814*	0.293	0.711	0.655
	Mr (2-tailed)	0.067		0.488	0.802	0.049	0.574	0.113	0.158
	N	6	6	6	6	6	6	6	6
No. of newborns	Pearson Correlation	0.052	-0.356	1	0.187	0.117	0.471	-0.248	-0.192
	Mr (2-tailed)	0.922	0.488		0.723	0.825	0.346	0.636	0.716
	N	6	6	6	6	6	6	6	6
No. of deaths	Pearson Correlation	-0.012	0.133	0.187	1	-0.357	-0.089	0.743	-0.117
	Mr (2-tailed)	0.982	0.802	0.723		0.487	0.867	0.091	0.825
	N	6	6	6	6	6	6	6	6
No. of pers. socially assisted	Pearson Correlation	.911*	-.814*	0.117	-0.357	1	-0.48	-0.784	-.860*
	Mr (2-tailed)	0.012	0.049	0.825	0.487		0.335	0.065	0.028
	N	6	6	6	6	6	6	6	6
No. of dispensaries	Pearson Correlation	-0.725	0.293	0.471	-0.089	-0.48	1	-0.029	0.542
	Mr (2-tailed)	0.103	0.574	0.346	0.867	0.335		0.957	0.266
	N	6	6	6	6	6	6	6	6
No. eco. ag.	Pearson Correlation	-0.482	0.711	-0.248	0.743	-0.784	-0.029	1	0.405
	Mr (2-tailed)	0.333	0.113	0.636	0.091	0.065	0.957		0.425
	N	6	6	6	6	6	6	6	6
Ag echo. Agri	Pearson Correlation	-.927**	0.655	-0.192	-0.117	-.860*	0.542	0.405	1
	Mr (2-tailed)	0.008	0.158	0.716	0.825	0.028	0.266	0.425	
	N	6	6	6	6	6	6	6	6

*. Correlationissignificant at the 0.05 level (2-tailed).
**. Correlationissignificant at the 0.01 level (2-tailed).
Source: Own results.

When analysing the dependent variable number of households with the independent variable number of people receiving social assistance, a weak relationship results with a coefficient of 0.814. The relationship is inversely proportional, the number of households shows an increase over the period analysed, while the number of people on social assistance decreases (Table 5).

Analyzing the dependent variable population and the independent variable number of households, a weak Pearson coefficient relationship is shown. The relationship between the two variables is directly proportional (0.872), so the number of households decreases due to the population reduction (Table 6).

Regarding the analysis of the dependent variable population and the number of people on social assistance of the independent variable, the coefficient is closely related, directly proportional (0.961). Thus, the number of people on social assistance decreases due to the reduction in population.

The Pearson coefficient resulting from the analysis of the dependent variable population and the independent variable number of economic agents shows a weak, inversely proportional relationship.

The strength of the link is strong, so although the population decreases, the number of economic agents increases (Table 6).

Table 6. Main statistical indicators of Jegălia commune

		Population	Number of households	Number of newborns	Number of deaths	Number of people on social aid	Number of dispensaries	Number of economic agents	Economic agents agriculture
Population	Pearson Correlation	1	.872*	0.248	0.676	.961**	.c	-.852*	-0.584
	Mr (2-tailed)		0.023	0.635	0.141	0.002		0.031	0.223
	N	6	6	6	6	6	6	6	6
No. of households	Pearson Correlation	.872*	1	0.394	0.796	.944**	.c	-.882*	-.821*
	Mr (2-tailed)	0.023		0.439	0.058	0.005		0.02	0.045
	N	6	6	6	6	6	6	6	6
No. of newborns	Pearson Correlation	0.248	0.394	1	.837*	0.414	.c	-0.253	-0.463
	Mr (2-tailed)	0.635	0.439		0.037	0.414		0.629	0.355
	N	6	6	6	6	6	6	6	6
No. of deaths	Pearson Correlation	0.676	0.796	.837*	1	.823*	.c	-0.727	-0.796
	Mr (2-tailed)	0.141	0.058	0.037		0.044		0.102	0.058
	N	6	6	6	6	6	6	6	6
No. of persons in social assistance	Pearson Correlation	.961**	.944**	0.414	.823*	1	.c	-.931**	-0.733
	Mr (2-tailed)	0.002	0.005	0.414	0.044			0.007	0.098
	N	6	6	6	6	6	6	6	6
No. of dispensaries	Pearson Correlation	.c	.c	.c	.c	.c	.c	.c	.c
	Mr (2-tailed)								
	N	6	6	6	6	6	6	6	6
No. eco. ag.	Pearson Correlation	-.852*	-.882*	-0.253	-0.727	-.931**	.c	1	0.775
	Mr (2-tailed)	0.031	0.02	0.629	0.102	0.007			0.07
	N	6	6	6	6	6	6	6	6
Ag echo. Agri	Pearson Correlation	-0.584	-.821*	-0.463	-0.796	-0.733	.c	0.775	1
	Mr (2-tailed)	0.223	0.045	0.355	0.058	0.098		0.07	
	N	6	6	6	6	6	6	6	6

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
c. Cannot be computed because at least one of the variables is constant.

Source: Own results.

CONCLUSIONS

Halting or slowing the decline of the population in rural areas seems beyond remedy, especially as state interventions are timid. There are very few quality economic activities that generate jobs, which prevents young people from staying in these areas. At the same time, without significant contributions to local budgets, local authorities cannot make investments for their citizens or bring investors to the area.

The localities in the low land areas (such as the ones analysed) do not offer the possibility of tourism or leisure activities, so economic activities are mainly agricultural. A solution in this sense can be found in family farms through government incentives, which have a social effect by keeping young people in the countryside, as well as an economic effect bycreating viable jobs.

It is absolutely necessary to develop a platform for monitoring the countryside, involving local authorities, academics and the economy. In this way, authorities can identify the localities where investments are needed to develop these areas. The academic world, through research based on the available data, can also come up with solutions to remedy any problems detected, and last but not least, the academic world can identify the localities where they can invest, based on criteria determined by them.

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COMPARATIVE PERFORMANCE AND STABILITY OF SOME MAIZE HYBRIDS IN THE AGROCLIMATIC CONDITIONS OF CRAIOVA, DOLJ COUNTY, ROMANIA

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Abstract

Profitable and sustainable maize production is based on the use of stable and performing hybrids, suitable for contrasting environmental conditions. This paper presents the behaviour of three commercial maize hybrids at ARDS Șimnic- Craiova, Dolj County, in the period 2017-2020. The results of the ANOVA showed that the hybrid, year, and interaction H Y had significant effects on grain yield. The major variation of grain yields (80%) was caused by the year, the highest yields being obtained in 2018 and 2020, while the lower grain yields were obtained in 2017 and 2019. Average grain yields, variation coefficients (CV), regression coefficients (b), intercept values (a) and determination coefficient values (R^2) of hybrids were examined as stability parameters. The yield stability analysis indicated that the Iezer hybrid has a good adaptability to unfavourable environmental conditions from the study area, the P 0216 hybrid has a good adaptability to favourable environmental conditions, and the P 9637 hybrid has a good adaptability to contrasting environmental conditions.

***Key words**: grain yields, intercept value, regression coefficient, variation coefficient*

INTRODUCTION

In 2020, maize *(Zea mays* L.) was the second most produced crop in the world (after wheat) with a cultivated area of 201.9 million hectares, and the most produced cereal in Romania (1st place) with a cultivated area of 2.6 million hectares [5]. This is due to the fact that maize has a wide range of uses such as animal feed, food industry, pharmaceutical industry, obtaining biodiesel, etc.

Romania plays an important role in the international cereal market [15, 16] and its performance in maize cropping is based on the use of high-yielding hybrids with a grain quality required for processing and with resistance to biotic and abiotic stresses [18].

Obtaining maize hybrids adapted to the specific conditions from the Oltenia area and sustainable maize production raises some particular problems determined by the drought and heat that occur frequently [2, 3, 25]. Thus, maize breeding activity to obtain high-yielding and stable hybrids is very important for crop management in this area.

Current climate changes and the use of older registered maize hybrids reduce genetic progress in grain yield [8].

The more recently registered cultivars (after 2000) are more tolerant to climate changes, especially through the improved yield traits following the selection of these genotypes under stress conditions [9].

Seed Companies and Research Institutes own maize hybrids with high genetic potential for grain yield. For increase stability, these hybrids must combine a genetically high yield potential and a good resistance to different environmental conditions [19].

The determination of yield stability and the degree of expression of improved traits is done by testing maize hybrids in comparative cultures located in different pedoclimatic conditions [20].

Evaluation of the interaction of each cultivar with environmental factors (year, location, soil type, applied technology, etc.) is a very important aspect for plant breeders.

This paper presents the behavior of three commercial maize hybrids in terms of yield

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performance and stability in different climatic conditions from ARDS Simnic-Craiova.

MATERIALS AND METHODS

In the experimental field of Maize Breeding Laboratory from Agricultural Research and Development (ARDS) Șimnic - Craiova, in the 2017-2020 period, multiple maize tests were carried out in order to identify the most adapted and performing genotypes, so as to reduce genetic vulnerability and obtain the highest and most stable yields. The site is located in the center of Oltenia region.

The data in this paper comes from comparative cultures with maize hybrids.

The trials were carried out according to the randomized blocks method in three repetitions and placed on a reddish preluvosoil with pH = 5.6; humus = 1.8, medium supplied with NPK. The technology applied was specific to maize cropping for non-irrigated conditions from the Craiova area. The previous plant was wheat. The commercial hybrids evaluated were: Iezer (hybrid created by NARDI Fundulea, FAO 401-500), P 0216 (created by PIONEER Company, FAO 450) and P 9537 (created by PIONEER Company, FAO 350). These maize hybrids were widely cultivated by farmers in the Oltenia region and in Dolj county, respectively. They were analyzed in each of the four years, both from the point of view of the grain yield, as well as some yield and quality traits (hectoliter weight, 1000-grain weight, plant height, protein content and oil content). Protein and oil contents were determined with the apparatus PERTEN Inframatic 9140. Characterization of hybrid stability for the grain yield was achieved using the following statistics parameters: average grain yields and coefficients of variation (CV) according to [7]; regression coefficients (b) and intercept values (a) according to [6]; and coefficients of determination (R^2) according to [17].

The obtained data for grain yield were processed by the analysis of variance (ANOVA).

All statistical analyses were performed using the Microsoft Office Excel.

Precipitation and temperature data for studied period were collected from Weather Station Craiova (Table 1).

In the study period (2017-2020) during the maize growing season (April-September) there was a great variation in the water and thermal regime.

Table 1. Deviations from the multiannual average of precipitations and temperatures recorded in the period 2017-2020 at ARDS Simnic-Craiova

Year	April	May	June	July	August	September	April-September
			Precipitation (mm)				
2017	+10.9	-0.7	-49.6	+25.8	-38	-12.8	-64.4
2018	-42	-20.7	+67.4	+52.8	-19	-17.8	+20.7
2019	-11.1	-39.7	+62.4	+23.2	-38	-61.8	-111.4
2020	-53.1	-0.7	-2.6	+7.8	-21	-59.8	-129.4
Multiannual average	53.1	71.7	73.6	82.2	47	61.8	389.4
			Temperature (°C)				
2017	-0.6	-0.2	+1.7	+0.4	+2.5	+7.2	
2018	+4.4	+1.7	+0.1	-1.2	+1.2	+1.4	
2019	+0.3	-1.3	+1.2	-0.9	+2.6	+2.4	
2020	-0.2	-1.3	-0.2	-0.6	+2	+4.8	
Multiannual average	12.2	17.5	21.5	23.8	22.5	17.8	

Source: Own processing based on data from Craiova Weather Station.

Thus, in 2017, larger precipitation deficits were recorded in the months of June (-49.6 mm), August (-38 mm) and September (-12.8 mm), also in the months of June, July, August and September, the temperatures were above the multiannual average by +1.7°C, by +0.4°C, by +2.5°C and by +7.2°C, respectively.

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In 2018, precipitation deficits were recorded more in the vegetative period, in the months of April (-42 mm), May (-20.7 mm) and less in the reproductive period (August with -19 mm), and the temperatures exceeded the multiannual average in April (+4.4°C), May (+1.7°C), August (+1.2°C) and September (+1.4°C).

The year 2019 recorded precipitation deficits in April, May, August and September (-11.1 mm, -39.7 mm, -23.2 mm, -38 mm and - 61.8 mm, respectively, also the temperatures in the months of June, August and September were above the multiannual average by +1.2°C, by +2.6°C, and by +2.4°C, respectively.

The year 2020 recorded a larger precipitation deficit in the months of April, August and September (-53.1 mm, -21 mm and -59.8 mm, respectively) and temperatures above the multiannual average in August (+2°C) and September (+4.8°C).

RESULTS AND DISCUSSIONS

The fluctuations of the environmental factors during the four years of testing determined a large variability of grain yield from one year to another and from one hybrid to another. The amount of precipitation and temperatures during the critical periods of maize growth, namely the flowering-pollination and grain-filling stages, had a major role on grain yield levels. Similar results were reported by [9] for the ARDS Turda area.

Combined analysis of variance (ANOVA) for grain yield showed statistically significant differences ($p<0.05$) between years (Y) and between hybrids (H). Also grain yield was significantly affected by HY interaction (Table 2).

The proportion of the explained sum of squares showed that the variation of the grain yield was determined, in the first place by the effect of the year (80%), then by the effect of the hybrid (15%) and in the end by the effect of the HY interaction (3%) (Figure 1).

The small influence of the HY interaction shows that these hybrids are part of the category of modern hybrids that tolerate climate changes, especially through improved yield traits following the selection of these genotypes under stress conditions [9].

Table 2. Analysis of variance (ANOVA) for grain yield

Source of variance	Degrees of freedom	Sum square	F test
Hybrid (H)	2	17201896	106.2*
Year (Y)	3	93408191	384.5*
Interaction H x Y	6	3717698	7.6*
Erorr	24	1943223	

* = significant at 5% probability level, by F test
Source: Own calculation.

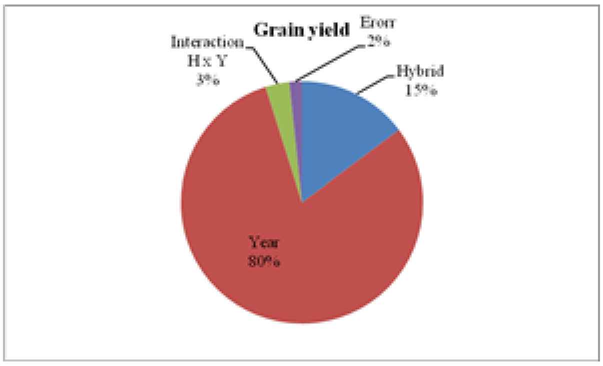

Fig. 1. Share of genotype, year and their interaction in the variation of grain yield
Source: Own design and processing.

The highest grain yields were obtained in 2018, followed by 2020, when drought and heat occured at the end of the grain-filling stage and the distribution of precipitation was more uniform. The low grain yields were obtained in 2019 and 2017 when drought and heat were more severe (Table 3).

According to [12], drought stress in one week before and two weeks after flowering cause yield losses of 20% to 50%, and drought stress in the grain-filling stage cause a yield loss of 10%.

In the dry year 2017, the average yield was 5,744 kg/ha (control), noting the hybrid P 0216 with a grain yield of 6,180 kg/ha and a significant difference of +436 kg/ha, and the hybrid P 9537 with a grain yield of 6,075 kg/ha and a significant difference of +331 kg/ha compared to the control. The Iezer hybrid obtained the lowest grain yield of 4,977 kg/ha with a significant difference of -767 kg/ha compared to the control.

In 2018, an average yield of 9,486 kg/ha was obtained, the hybrid P 9537 being noted with a grain yield of 10,489 kg/ha and a significant

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difference of +1,003 kg/ha compared to the control. The hybrid P 0216 obtained a grain yield of 9,890 kg/ha statistically similar to the control, and hybrid Iezer obtained the lowest grain yield of 8,079 kg/ha and a significant difference of -1,407 kg/ha compared to the control.

Table 3. The grain yields of the maize hybrids during the testing period, 2017-2020, at ARDS Şimnic-Craiova

Hybrid	2017		2018		2019		2020	
	kg/ha	±difference to control	kg/ha	±difference to control	kg/ha	±difference to control	kg/ha	±difference to control
Iezer	$4,977^0$	-767	$8,079^0$	-1,407	$4,699^0$	-664	$6,212^0$	-725
P 0216	6,180*	+436	$9,890^{ns}$	+404	$4,918^{ns}$	-445	$6,935^{ns}$	-2
P 9537	6,075*	+331	10,489*	+1,003	6,478*	+1,115	7,664*	+727
Average (control)	5,744		9,486		5,363		6,937	
LSD 5%		176		850		492		548

* = significant positive; ^{0} = significant negative; ns = non-significant, at 5% probability level
Source: Own calculation.

The lowest average yield, namely 5,363 kg/ha, was obtained in 2019, a year characterized by severe drought in July and August (during the flowering and grain-filling stages). The hybrid P 9537 was noted with a grain yield of 6,478 kg/ha and a significant difference of +1,115 kg/ha compared to the control. The hybrid Iezer obtained the lowest grain yield (4,699 kg/ha) with a significant difference of - 664 kg/ha compared to the control, and the hybrid P 0216 obtained a grain yield of 4,928 kg/ha statistically similar to the control.

In 2020, the average yield was 6,937 kg/ha, the hybrid P 9537 being noted, which achieved a grain yield of 7,664 kg/ha and a significant difference of +727 kg/ha. The lowest grain yield of 6,212 kg/ha and a significant difference of -725 kg/ha compared to the control was obtained by the hybrid Iezer, and the hybrid P 0216 obtained a grain yield of 6,935 kg/ha statistically similar to the control. Many reports showed that drought stress decreased significantly grain yield of maize and yield traits [2, 14, 21].

On average over the four years of testing, the grain yield obtained by the three commercial hybrids studied was 6,883 kg/ha. The hybrid P 9,537 was noticed with an average yield of 7,655 kg/ha, significantly higher than the control. Hybrid P 0216 obtained an average yield of 6,981 kg/ha statistically similar to the control, and hybrid Iezer obtained an average yield of 5,992 kg/ha significantly lower than the control (Table 4).

The maximum level of grain yields (10,689 kg/ha) was recorded for the hybrid P 9537 in 2018, and the minimum level of grain yields (4,428 kg/ha) was recorded for the hybrid Iezer in 2019. The biggest difference in grain yield in contrasting environmental conditions (5,864 kg/ha) was recorded in the P 0216 hybrid, and the smallest difference (4,069 kg/ha) was recorded in the Iezer hybrid (Table 4). Regarding the coefficients of variation, they showed a high yield variability in the studied hybrids (<30%), according to [23]. The lowest coefficients of variation were recorded in the hybrids P 9537 (23.5%) and Iezer (23.6%) Grain yield stability estimated by combining the use of coefficient of variation and average grain yields (Figure 2) according to [7], showed that the hibrid P 9537 is located in the group I of stability (with hight yield and small variation), the hybrid P 0216 is located in the group II of stability (with hight yield and large variation), and the hybrid Iezer is located in the group III of stability (with low yield and small variation).

Yield stability evaluated by regression coefficients (b) according to [6], showed that the hybrid Iezer is adapted to unfavorable environmental conditions (b<1), and the hybrids P 0216 and P 9537 are adapted to favorable environmental conditions (b>1). Also, the higher R^2 value for the hybrid Iezer (R^2=0.994) indicate its favorable response to environmental changes, according to [17] (Table 4).

Table 4. Maximum, minimum and mean yields and stability parameters to the variation of environmental conditions, ARDS Şimnic-Craiova, 2017-2020

Hybrid	Average (kg/ha)	Minimum (kg/ha)	Maximum (kg/ha)	Amplitude (kg/ha)	Stability parameters			
					Coefficient of variation (CV%)	b	a	R^2
Iezer	$5,992^{0}$	4,428	8,497	4,069	23.6	0.82	+315.5	0.994
P 0216	$6,981^{ns}$	4,597	10,461	5,864	27.7	1.18	-717.8	0.972
P 9537	7,677*	5,957	10,689	4,732	23.5	1.05	+409.7	0.971
Average experiment (control)	6,883				24.9			
LSD 5%	3,692							

* = significant positive; ^{0} = significant negative; ns = non-significant at 5% probability level
Source: Own calculation.

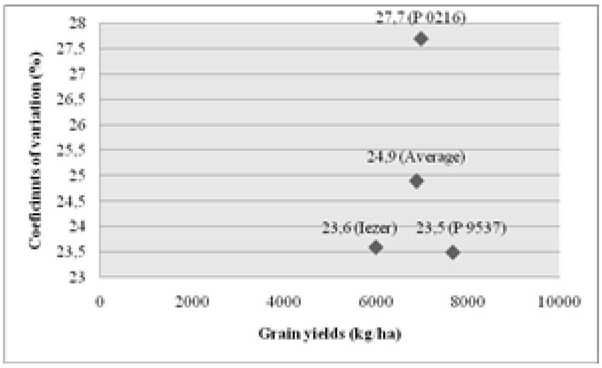

Fig. 2. Grain yields and yield stability expressed by the coefficient of variation
Source: Own design and processing based on the Francis and Kannenberg model [7].

The parallel analysis of both the regression coefficients (b) and the intercept values (a) allows a better characterization and also an identification of genotypes with wide adaptability to different environmental conditions [13, 26, 27].

According to [10], a genotype is adapted to unfavorable environmental conditions when the regression coefficient b<1 and "a" (intercept) has positive values; it is adapted to favorable environmental conditions when b>1 and "a" has negative values; it is adapted to contrasting environmental conditions when b>1 and "a" has positive values.

Therefore, based on these two parameters, the three studied hybrids can be classified as follows:

- the hybrid Iezer is a maize hybrid well adapted to unfavorable environmental conditions (b<1, "a" with positive values);
- the hybrid P 0216 is a maize hybrid well adapted to favorable environmental conditions (b>1, "a" with negative values);
- the hybrid P 9537 is a maize hybrid with wide adaptability to contrasting (different) environmental conditions (b>1, "a" with positive values).

The cultivation of genotypes with wide adaptability to contrasting environmental conditions can reduce the risks of yield reduction in unfavorable years [13].

Along with the analysis of the behavior of the three commercial maize hybrids in terms of grain yield, other productivity and nutritional value traits were followed, namely: hectoliter weight, 1,000-grain weight, plant height, protein content and oil content.

The grain yields of the maize hybrids were influenced by the values of these agronomic traits. Thus, we observed that in the hybrid P 9537, the high grain yield was influenced by hight 1,000-grain weight (278 g), by high hectoliter weight (69.3 kg/ha) and by high plant height (233.3 cm), these yield traits having coefficients of variability with low values (<10%) or with medium values (<20%) (Table 5). However, [19] showed that the hectoliter weight does not have a great influence on the grain yield. According to [22], 1,000-grain weight is a fundamental grain yield contributing trait and the genetic potential of a particular genotype can be judged by this trait. Previous findings have also reported that hybrids having highest plant height produced higher yield [11].

Regarding the nutritional value, we noticed that the hybrid Iezer which obtained the lowest grain yields during the years of testing, had a better nutritional quality due to the higher protein content (14.4%) and oil content

(5%) compared to the others two hybrids. Numerous researchers have confirmed that grain yield correlates negatively with protein and oil content [1, 4, 24].

Table 5. The values of the yield and quality traits and the coefficients of variation (CV),

Hybrid	Hectoliter weight		1,000-grain weight		Plant height		Protein content		Oil content	
	Average (kg/hl)	CV (%)	Average (g)	CV (%)	Average (cm)	CV (%)	Average (%)	CV (%)	Average (%)	CV (%)
Iezer	68.3	1.4	222.0	8.8	224.5	7.8	14.4	8.0	5.0	3.0
P 0216	67.8	2.2	247.3	19.9	220.5	11.4	13.3	5.6	4.3	9.3
P 9537	69.3	2.7	278.0	14.2	233.3	12.2	12.9	7.0	4.4	4.1

Source: Own calculation.

CONCLUSIONS

The major variation of grain yield in maize (80%) was caused by the year (different climatic conditions from the years of testing)

On average over the four years of study (2017-2020), the hybrid P 9537 obtained the highest grain yield (7,677 kg/ha) showing a good adaptability to the contrasting environmental conditions from ARDS Simnic – Craiova, Dolj County.

The Iezer hybrid, even if it obtained the lowest average grain yield (4977 kg/ha), had the best grain quality (protein content of 14.4% and oil content of 5%) and showed a good adaptability to the unfavourable environmental conditions that occur frequently in the study area .

The hybrid P 0216 obtained a good average grain yield (6,981 kg/ha), showing good adaptability to favourable environmental conditions in the study area.

The grain yields obtained were determined by the values and the specific variation of the yield and quality traits to the fluctuation of environmental conditions.

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COST BENEFITS ANALYSIS OF BROILER PRODUCTION IN DELTA STATE, NIGERIA: IMPLICATION FOR LIVELIHOOD SUSTAINABILITY

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Abstract

The main aim was to x-rayed broiler profitability in the surveyed area. Multi-stage sampling method was used in respondents' selection. Questionnaires were utilized to obtained data which were analysed employing descriptive statistics and benefit cost ratio model. The study witnessed moderate family size with secondary school level in their productive age. Broiler enterprise was engaged upon as a minor occupation with low mean broiler size of 100 birds and 10 years rearing experience. The findings indicated that broiler income and production cost were ₦285,000 ($693.84) and ₦239,800 ($583.80) respectively. Benefit cost ratio of 1.2 was realized which indicated 20% profit per cycle (five to six weeks). Considering the rate of quick turn-over the broiler production business is profitable. It recommends that flock size should be increased and effective management of resources to cut down production cost

Key words: *broiler, cost, livelihood, production, returns*

INTRODUCTION

In Nigeria, the agricultural sector play a vital role in poverty reduction, economic development, income generation, employment among others [11]. Livestock contributes substantially to Agricultural Sector in Nigeria. Poultry is integral part of livestock sector that is consist of Turkey, quails, guinea fowl, chicken, ducks etc. but chicken contributes about 95% of [7] entire poultry kept. In Nigeria, broiler farming play significant role in human protein supply accounted for about 21-50% as against beef and rabbit which were 18% and 21-22% respectively [5].

Poultry rearing in Nigeria is vital as it creates employment and food sustainability [9]. Also broiler meat is rich in mineral nutrients, cheap and culturally accepted in Nigeria [6]. This survey dwell on profitability of broiler as literatures indicated that minimum research have been carried out in this field.

Objectives of the survey were to determine the socio economic features of broiler farmers, determine mean income of broiler production per cycle, examine the average broiler production cost per cycle, analyse the broiler production profitability.

MATERIALS AND METHODS

Delta State with latitude 5.7040^{o}N and 5.9339^{o}E with total population of 5.7 million persons and average population density of 320 kilometer square [8] was chosen for the survey. Delta State is comprises of twenty five local government areas (LGAs) that are mostly agrarian in nature. The major occupation of the state is agriculture engaging in livestock, crops and fisheries among others. The data were got through planned questionnaires administered to respondents. Descriptive statistics and benefit cost ratio model were employed to analyse the data. Sampling procedure adopted for the work was multi-stage. Firstly, six LGAs were randomly chosen. Secondly, four communities each were randomly selected from the six LGAs earlier selected to amount to 24 communities and lastly, six (6) households each were selected purposively from the 24 communities earlier selected giving a sum of 144 broiler producers.

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RESULTS AND DISCUSSIONS

Socio-economic features of broiler farmers

The variables in Table 1 indicates that persons with mean age of 42 years who were mostly female engaged in broiler enterprise in a minor occupation status. Most respondents were married households with secondary school educational status having 10 years rearing experience and 100 birds' size of flock averagely. This agreed with [3] research that productive aged farmers who were mostly married with moderate family size engaged in livestock (pig) production in Niger Delta area.

Table 1. Socio-economic features of broiler farmers

	Frequency (n = 144)	Percentage (%)	Mode/Mean
Age (years)			
23 – 33	37	25.7	
34 – 44	50	34.7	
45 – 55	35	24.3	42 years
56 – 66	22	15.3	
Gender			
Male	65	45.1	
Female	79	54.9	Female
Household Size (persons)			
2 – 5	23	16.0	
6 – 9	49	34.0	
10 – 13	39	27.1	10 persons
14 – 17	33	22.9	
Occupation			
Major	08	05.6	Minor
Minor	136	94.4	occupation
Educational Status			
Primary school	50	34.7	
Secondary school	73	50.7	Secondary
Tertiary school	21	14.6	
Marital Status			
Married	75	52.1	Married
Single	08	05.6	
Divorced	16	11.1	
Widow	45	31.2	
Production Experience (years)			
1 – 6	42	29.2	
7 – 12	60	41.7	10 years
13 – 18	26	18.0	
19 – 24	16	11.1	
Size of flock			
1 – 33	8	5.6	
34- 66	9	6.2	
67 – 99	26	18.1	
100 – 132	101	70.1	100 birds

Source: Field data.

This also collaborates the works of [1] which stated that a moderate household size and low educational level with many years of farming experience were engaged in goat production in Nigeria.

Mean income of broiler production per cycle

The study has examined an average of 95 broilers raised to maturity as indicated in Table 2. The average meat selling price per kilogram was ₦1,500 thereby raising the total income per cycle of broiler production to be ₦285,000 ($693.84) This agreed with [2] that total income from livestock (goat) production was substantial in Aniocha North LGA of Delta State.

Table 2. Mean Income of broiler production (per cycle)

95 broilers	
Quantity Sold (kg)	190
Selling Price per kg (₦)	1,500
Total Income (₦)	285,000

Source: Field data.

Average production cost of broiler per cycle

The study x-rayed the average cost of production of 100 broilers from a day old to point of sales as contained in Table 3.

Table 3. Average Production cost of broiler production

Cost of 100 broilers (₦)	**Amount (₦)**
(i)Variable cost	
Cost of day-old chicks (100)	25,000
Labour cost	40,000
Wood shaven	4,000
Feeds	149,600
Transportation cost	4,500
Medication	6,500
Fuel	4,000
Miscellaneous expenses	2,000
Total Variable cost (TVC)	**235,600**
(ii)Fixed Cost	
Depreciation on:	
Feeders	1,200
Building	3,000
Total fixed cost (TFC)	**4,200**
Total cost of production (TVC+TFC)	**239,800**

Source: Field data.

It shows that the production total variable cost (₦235,600) were labour, purchase of wood shaving, medication, transportation, fuel and total fixed cost (₦4,200) were depreciation on building, and feeders which resulted to ₦239,800 ($583.80) as total cost of production.

This research is in consonant with the findings of [3] that most cost of animal (pig) production falls within variable cost in Niger Delta Region. Further in agreement with [10] that variable expenditure is higher in the production of broiler in Lagos State. This is also agreed with [4] that the major obstacle to broiler business is high production cost in Nigeria.

This is also agreed with [4] that the major obstacle to broiler business is high production cost in Nigeria.

Profitability of broiler production

The research survey clearly indicated that the total income averagely and total cost of production averagely was ₦285,000 ($693.84) and ₦239,800 ($583.80) respectively. It also revealed that gross margin and net returns from broiler production was ₦49,400 and ₦45,200 respectively which indicates business profit. The broiler production benefit cost ratio was 1:2 stating 20% profit per cycle of five to six weeks as indicated in Table 4.

Table 4. Profitability of broiler production

Parameters	Amount (₦)
Total Income (TI_b)	285,000
Total Variable Cost (TVC_b)	235,600
Total Fixed Cost (TFC_b)	4,200
Total Cost of Production (TC_b)	239,800
Gross Margin (GM_b) = TI_b - TVC_b	49,400
Net Returns (NR_b) = GM_b - TFC_b	45,200
Benefit Cost Ratio (BCR_b) = TI_b/TCP	1:2

Source: Computed from field data.

CONCLUSIONS

The research study witnessed moderate family size of 10 persons with secondary school level of education in their productive age of 42 years.

Broiler production was engaged upon as a minor occupation with low mean broiler size of 100 birds and 10 years production experience. The research findings indicated ₦285,000 ($693.84) and ₦239,800 ($583.80) for broiler production income and production cost respectively.

Furthermore, benefit cost ratio of 1:2 was realized which indicated 20% profit per cycle (five to six weeks). Considering the rate of turnover the broiler production business is profitable.

It recommends that flock size should be increased and effective management to reduce the cost of production especially the variable cost.

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A STUDY ON MICRO BUBBLES AERATION METHOD ON WATER TURBIDITY AT AQUACULTURE EARTHEN PONDS UNDER DIFFERENT OPERATIONAL PARAMETERS

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Abstract

The experiment was established at an earthen aquaculture private farm in Kafrelshikh Government, Egypt. During 2021. To study the effect of operational variables at tube diffusion aeration system on turbidity values corresponding to Secchi disk clarity. Experimental variables under study were five air flow rates (0.1, 0.18, 0.23, 0.28 and 0.33 $m^3.h^{-1}$), three tube wall thickness (4, 6 and 7 mm), three tube depth from water surface (0.3, 0.50 and 0.70 m) and two design shapes for aeration system (circular and Longitudinal). Aeration system consist of circular tube holder, an electric single-phase compressor, three models of rubber diffusion tubes (D25-4, D25-6 and D25-7), portable galvanic dissolved oxygen meter, Secchi disk, digital LCD anemometer and thermometer and digital vernier. The results showed that, the lowest value for Secchi disk clarity were 7 cm obtained at operational conditions of 0.33 m3.h^{-1} air flow rate, 0.70 m depth from water surface, 4 mm thickness of tube wall and circular shape design. While, the highest value for Secchi disk clarity were 41 cm obtained at operational conditions of 0.10 $m^3.h^{-1}$ air flow rate, 0.30 m depth from water surface, 7 mm thickness of tube wall and Longitudinal shape design. The permissible variables limits were (0.1, 0.18 and 0.23 $m^3.h^{-1}$) for air flow rate, (4, 6 and 7 mm) for tube wall thickness, (0.3, 0.50 and 0.70 m) for tube depth from water surface and both of (circular and Longitudinal) design shapes.

Key words: *aquaculture, water turbidity, Secchi disc, fine bubbles aeration*

INTRODUCTION

Bubbling aeration, which brings water and air into close contact, is the first phase in the public health or aquaculture water treatment process. Small bubbles need more effort to reach the top, stay inside the water for longer periods of time, and give more oxygen to the water body [10].

The microbubble aeration system was developed as aquaculture technology advanced. The microbubble aeration system differs from the millimeter-sized bubble aeration system in various ways [8]. The capacity to form micro-sized bubbles, which enhanced oxygen solubility [6].

Better-dispersed gas, bigger surface area interaction with water, slower bubble rise speed, and reduced energy usage are all advantages of microbubble aeration over conventional aeration [12].

Using a blower or a compressor, oxygen or air is injected directly into a body of water in the form of bubbles. Diffusion is the mechanism by which oxygen is transferred from the bubbles to the water body across the liquid film's boundary.

Blowers or compressors are utilized to feed air to diffusers in these systems. The diffusers' little pores produce bubbles at the pond's bottom. The bubbles that were discharged at the pond's bottom are still rising through the water column.

There is a relative motion between water and bubbles during the rising. This causes water circulation by bringing water molecules into contact with air bubbles on a regular basis [19].

Furthermore, analyzing gas bubble aeration is essential for numerous engineering applications, including wastewater treatment, sterilization, hydroponics, cultured fisheries, and fast oxygen (O_2) in therapies [17].

Smaller gas bubbles, for example, have higher Laplace pressures and a longer residence period in water than bigger bubbles, which could considerably boost the O_2 transfer rate in aeration [13].

However, fouling and clogging by bio-film and tiny particles cause fine-pore diffusers to lose their original performance after installation. Fouling reduces the efficiency of oxygen transport and necessitates higher operational pressure, lowering energy performance. Several studies have been conducted on the characterization (physical properties) of the membrane diffusion and the bubbles created at the flexible orifice [11].

The porous tube wall of the flexible tube may produce fine bubbles uniformly, resulting in a bigger interfacial area and a faster oxygen transfer rate. Because of its flexibility, the tube may be simply fitted and configured on a variety of surfaces.

During aeration, the produced bubbles at the top, side, and bottom provide shear stress and a sweeping effect on the tube shape. This shear force action can reduce foulant accumulation on the tube diffuser and increase lifetime. As a result, the flexible tube diffuser's clogging and scaling problems, which are caused by the operation itself, can be regarded a benefit.

However, there are no precise methods for constructing and optimizing the flexible aeration diffuser tube that is manufactured, as well as evaluating its performance. Furthermore, the impact of various installation patterns and prediction models should be thoroughly investigated in order to recommend appropriate design requirements and operating guidelines for scaling-up into the actual system [7].

Diffusers are not commonly utilized in aquaculture ponds because bubbles rise too quickly to be fully absorbed in shallow ponds. The water depth in a typical fish or shrimp pond will be around 1.0 m, with SAE values of less than 1.0 kg.O_2/kWh. Low airflow rates via diffusers with fine pores can boost efficiency even at shallow depths, but the pores are prone to clogging and require time-consuming maintenance [4].

Turbidity in water is caused by suspended particles, which might be organic or inorganic. The inorganic ones are mostly sediments, whereas the organic ones are mostly algae, microorganisms [9]. Water quality monitoring necessitates turbidity measurements. Because of the negative consequences on ecosystems, it is quantified in natural resources [15]. The main impacts of turbidity in ecosystems are (I) reduced visibility, (II) reduced penetration of light and photosynthesis, and (III) blockage of gills and other negative physical effects on fish and eggs [18].

Increasing turbidity in fish farming reduces the performance of the fish kept two fish species alive in a range of sediment concentrations from 0 to 500 mg/l for 21 days. Their findings revealed that Erimonax monachus had the maximum SGR at 0 mg/l, while Cyprinella galactura had it between 0 and 50 mg/l [16].

At various turbidity levels red tilapia kept alive for 56 days, ranging from 0 to 500 mg/l of clay. When the amount of turbidity was reduced, the fish had a higher weight at the end of the studies. From 0 to 50 mg/l, the highest survival rates were achieved [2].

Secchi disk, is a circular white and black disk with 30 cm diameter. It’s an old tool to estimate visibility of aquaculture waters [1].

Values from 30 cm and less for turbidity in water, may lead to minimizing plankton growth and production, 30 to 60 cm satisfy for aquaculture environment, in case of 60 cm and more there are shortage in oxygen production as plankton production reduces so light enters to deeper distances [5].

The turbidity range from 30-80 cm is appropriate for aquaculture requirements; 15-40 cm is appropriate for intensive aquaculture and less than 12 cm result in problems on fish health and growth [3].

The Secchi disk readings from 30 to 40 cm were the best for the aquaculture productivity [14]. Turbidity is one of the most important factors in the production of fish in earthen farms, so using aeration appropriately is one of the solutions to increase the quality of fish.

The aims of the research was determined the optimum operational limits for fish production under different experimental variables on aeration process and water turbidity.

MATERIALS AND METHODS

The experiment was established in an earthen aquaculture private farm at Kafrelshikh Government, Egypt. As indicated in Figure 1, an earthen pond filled up with water from Burullus Lake, as a local surface water sources and other water source from agriculture and industrial drainage, the water specifications analyzed at laboratories of Faculty of Agriculture, Kafrelshikh University were shown in Table 1.

The aeration system consists of circular tube holder of 30 cm diameter from stainless steel to fix and lift tubes above bottom sediments. An electric single phase compressor model APT (SGBM9037) of 1.5 hp, 25 Lit. capacity, maximum pressure of 8 bar and maximum air delivery up to 130 L.min^{-1} used as a source of air injection with regulator valve to control airflow rate.

Three models of rubber diffusion tubes D25-4, D25-6 and D25-7 which made from rubber for AirMMax Company, China with specification are indicated in Table 2. Portable galvanic dissolved oxygen meter of model HI9147 for HANNA company, USA used for estimating on dissolved oxygen in mg.l^{-1}, water temperature in Celsius degrees and water salinity in mg.l^{-1}. Secchi disk was used for estimating water turbidity in cm.

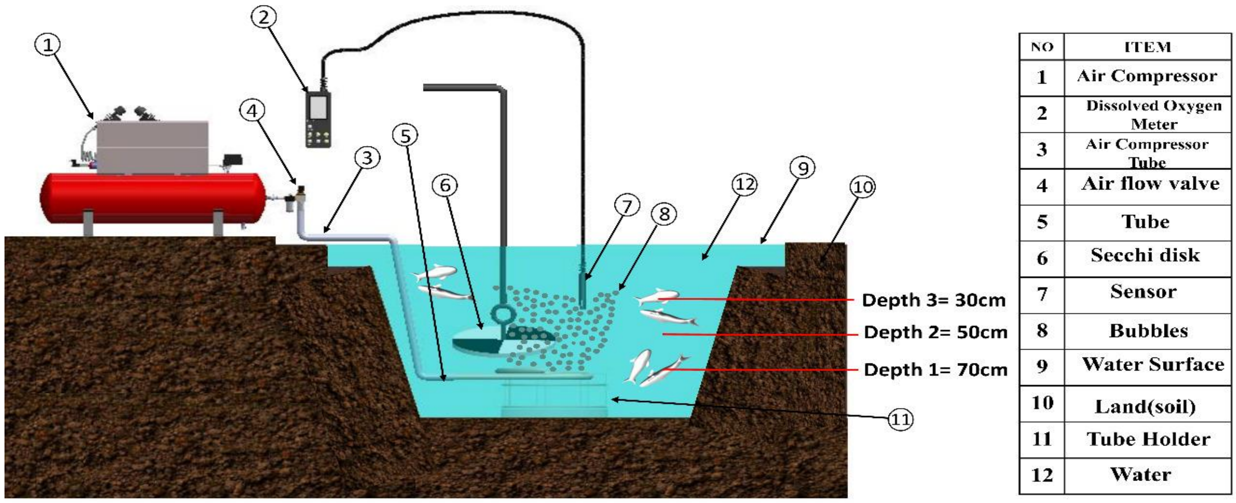

Fig. 1. Schematic diagram of the experiment.
Source: Authors' drawing.

Table 1. physical and chemical properties analysis for under study pond water

No	Test item	Value	Unit
1	Turbidity	42.0	cm
2	pH	7.36	-
3	EC	3.22	ds.m^{-1}
4	TDS	1.61	g.l^{-1}
5	Na	35.63	meq.l^{-1}
6	K	0.5	meq.l^{-1}
7	Ca	10.0	meq.l^{-1}
8	Mg	18.6	meq.l^{-1}
9	CO_3	0.00	meq.l^{-1}
10	HCO_3	10.0	meq.l^{-1}
11	CL	50.0	meq.l^{-1}
12	SO_4	4.73	meq.l^{-1}
13	Fe	Nd	mg.l^{-1}
14	Mn	Nd	mg.l^{-1}

Source: Authors' determination.

Table 2. Specification of different tubes models under study.

Model / Item	Unit	D25-4	D25-6	D25-7
Outer diameter (OD)	mm	25	25	25
Inner diameter (ID)	mm	16	13	11
Wall thickness (Wall)	mm	4	6	7

Source: Catalogue determination.

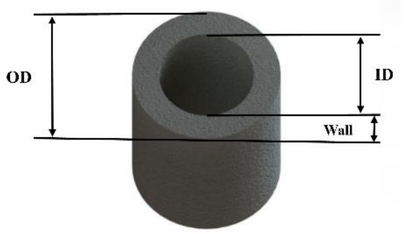

Fig. 2. Schematic diagram of rubber tube and its parts
Source: Authors' drawing.

Digital LCD anemometer and thermometer were utilized for measuring air wind speed and temperature. Digital vernier of model SM-453, Japan was used for estimating dimensions and diameters of experimental parts.

Variables under study were: (1) Five air flow rates of 0.102, 0.178, 0.229, 0.28 and 0.33 $m^3.h^{-1}$ (2) Three water depths of 0.3, 0.5 and 0.7 m. from water surface for aeration tube holder (3) Three tube wall thickness of 4, 6 and 7 mm (4) Two shapes design for aeration system position were longitudinal and circular.

RESULTS AND DISSCUSIONS

The results will be discussed under these items:

Effect of air flow rates on water turbidity

Air flow raters in rubber aeration tubes had a great effect on water turbidity as shown in Table 3 and Figures 3, 4 and 5. As indicated, inverse relationship occurred so values of Secchi disk clarity decreased with increase of air flow rates under all experimental variables.

Values for Secchi disk clarity were 38, 39, 37, 30 and 25 cm for air flow rates of 0.10, 0.18, 0.23, 0.28 and 0.33 $m^3.h^{-1}$, respectively at circular shape design, depth of 0.30 cm from water surface and 4 mm thickness of tube wall. At air flow rates of 0.10, 0.18 and 0.23 $m^3.h^{-1}$ under all treatments parameters values of Secchi disk clarity were at permissible limits for aquaculture. However, with increase values of air flow rates above 0.23 $m^3.h^{-1}$ to 0.28 and 0.33 $m^3.h^{-1}$ values of Secchi disk clarity were out of permissible limits for aquaculture causing more problems. These results may be due to the nature of pond sediments which consists of fine clay so increase of air flow rates or any excitement would load more of clay parts, decrease in visibility and increase turbidity. Permissible limits for turbidity value ranged from 30-60 cm determined by [3, 5, 14].

Effect of aeration depth from water surface on water turbidity

Depths from water surface in diffusion aeration by rubber tubes had a great effect on water turbidity as shown in Table 3 and Figures 3, 4 and 5. As illustrated, inverse relationship occurred so values of Secchi disk clarity decreased with increase of depths from water surface under all experimental treatments.

Values for Secchi disk clarity were 30, 24 and 21 cm for the depth from water surface of 0.30, 50 and 0.70 cm, respectively at circular shape design, air flow rate of 0.28 $m^3.h^{-1}$and 4 mm thickness of tube wall.

This result due to increase the effect of the air flow with closing to the clay sediments at the bottom.

Effect of tube wall thickness on water turbidity

Tube wall thickness in diffusion aeration by rubber tubes had a low significant effect on water turbidity as shown in Table 3 and Figures 3, 4 and 5.

As declared, positive relationship occurred so values of Secchi disk clarity increased with increase of tube wall thickness under majority of experimental treatments.

Values for Secchi disk clarity were 38, 39 and 40 cm for the thickness of tube wall of 4, 6 and 7 mm, respectively at circular shape design, air flow rate of 0.1 $m^3.h^{-1}$ and 0.30 cm depth from water surface.

This result compatible with previous results, as increase in wall thickness led to decrease of bubbles size and velocity so low excitement to soil.

Effect of shape design on water turbidity

Shape design in diffusion aeration by rubber tubes had a low significant effect on water turbidity as shown in Table 3 and Figures 3, 4 and 5.

As declared, values of Secchi disk clarity increased with changing shape design from circular to longitudinal under majority of experimental treatments.

Values for Secchi disk clarity were 38 and 39 cm for the circular and longitudinal shapes, respectively at air flow rate of 0.1 $m^3.h^{-1}$, 0.30 cm depth from water surface and 4 mm thickness of tube wall.

This result may due to increase the projected area at circular shape more than the longitudinal shape.

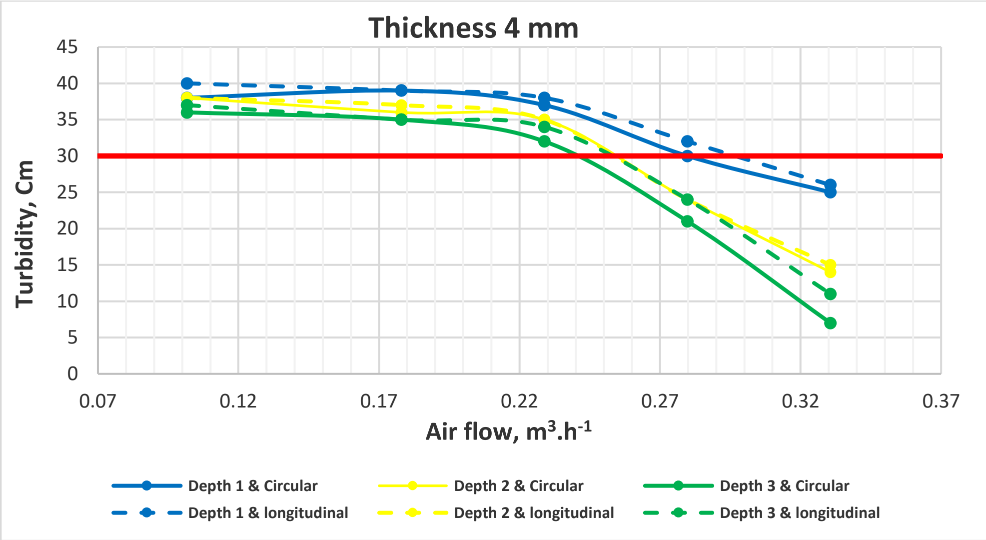

Fig. 3. Effect of air flow rate, aeration depth and shape design at 4 mm tube wall thickness on turbidity.
Source: Authors' drawing.

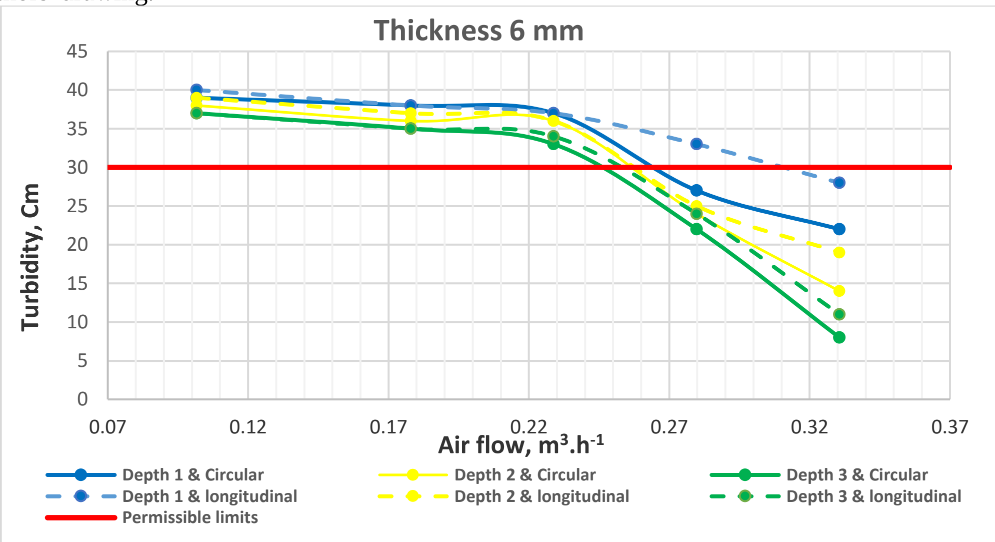

Fig. 4. Effect of air flow rate, aeration depth and shape design at 6 mm tube wall thickness on turbidity.
Source: Authors' drawing.

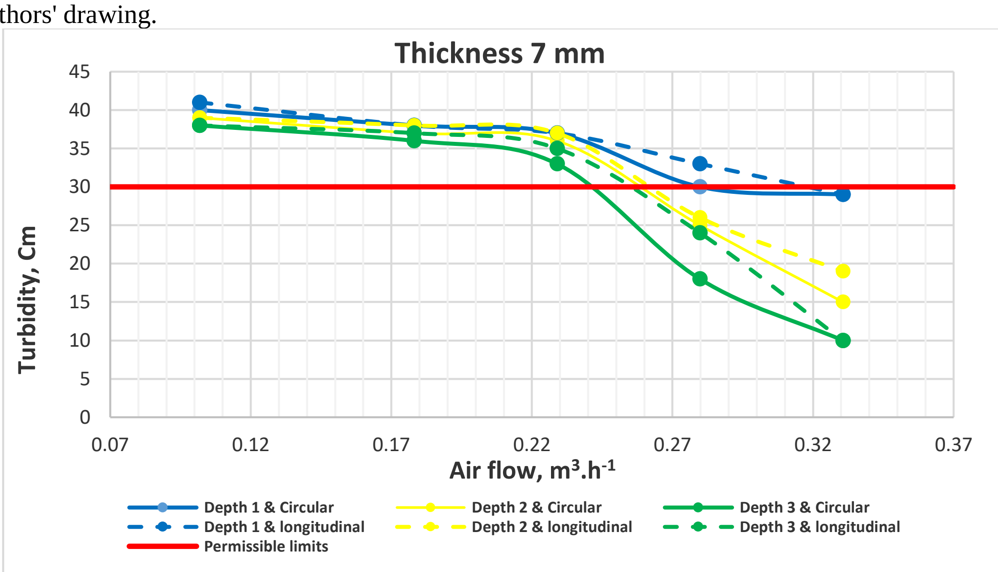

Fig. 5. Effect of air flow rate, aeration depth and shape design at 7 mm tube wall thickness on turbidity.
Source: Authors' drawing.

Table 3. Turbidity values on Secchi disk for different rates of air flow, design shape, tube thickness and depth under water surface.

Shape	Thickness, mm	4			6			7		
	Depth, m / Air flow, $m^3.h^{-1}$	0.30	0.50	0.70	0.30	0.50	0.70	0.30	0.50	0.70
Circular	0.10	38	38	36	39	38	37	40	39	38
	0.18	39	36	35	38	36	35	38	37	36
	0.23	37	35	32	37	36	33	37	36	33
	0.28	30	24	21	27	24	22	30	25	18
	0.33	25	14	**7**	22	14	8	29	15	10
Longitudinal	0.10	40	38	37	40	39	37	**41**	39	38
	0.18	39	37	35	38	37	35	38	38	37
	0.23	38	35	34	37	36	34	37	37	35
	0.28	32	24	24	33	25	24	33	26	24
	0.33	26	15	11	28	19	11	29	19	10

Source: Authors' determination.

CONCLUSIONS

Turbidity in water is caused by suspended particles, which might be organic or inorganic. The inorganic ones are mostly sediments, whereas the organic ones are mostly algae, microorganisms. Water quality monitoring necessitates turbidity measurements. Because of the negative consequences on ecosystems, it is quantified in natural resources. Increasing turbidity in fish farming reduces the performance of the fish and growth. The lowest value for Secchi disk clarity were 7 cm obtained at operational conditions of 0.33 $m^3.h^{-1}$ air flow rate, 0.70 mm depth from water surface, 4 mm thickness of tube wall and circular shape design. While, the highest value for Secchi disk clarity were 41 cm obtained at operational conditions of 0.10 $m^3.h^{-1}$ air flow rate, 0.30 mm depth from water surface, 7 mm thickness of tube wall and Longitudinal shape design.

The permissible variables limits were (0.1, 0.18 and 0.23 $m^3.h^{-1}$) for air flow rate, (4, 6 and 7 mm) for tube wall thickness, (0.3, 0.50 and 0.70 mm) for tube depth from water surface and both of (circular and Longitudinal) design shapes.

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DETERMINATION OF PHYSICAL PROPERTIES OF SOME SEEDS

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Abstract

The main objective of this research to determine of physical properties of seed related to help in safe passage for seed through cleaning and separation processes. Also investigate some seed properties can be used in design and development of multi-seed planting machine. Soya Bean, Wheat, Corn, Cotton Faba Bean and Sunflowers were tested at department of agriculture engineering, faculty of agriculture, Tanta university, Egypt. through 2022. From the results, it is clear that the little differences in the maximum of Length dimensions between Soya Bean and Wheat were 7.62 and 8.72 mm. ,it increased between Corn and Cotton to 15 and 10.12 mm. and Faba Bean and Sunflowers were 11 and 19 mm. the maximum of Geometric mean diameter recorded little differences between Soya Bean and Wheat were 2.76 and 2.81 mm. ,it increased between Corn and Cotton to 4.83 and 5.13 mm. and Faba Bean and Sunflowers were 8.47 and 6.86 mm.

Key words**:** *soya bean, wheat, corn, cotton, faba bean, sunflower, physical and color properties*

INTRODUCTION

Soya Bean, Wheat, Corn, Cotton, Faba Bean, and Sunflowers are a common food in many countries. For example, the Faba Bean area increased from 187,437 ha to 208,766 and productivity from 810 kg/ha to 1,203 kg/ha, similarly, the soybean area increased from 23,943 to 25,179 ha and productivity from 905 kg/ha to 1,254 kg/ha. Faba beans contain almost twice the protein content as that of cereal grains with globulins (60%), albumins (20%), glutelins (15%), and prolamins (8%), and soybean possesses high protein content from 20% to 41%; the wide variations are due to varietal differences and the source type, that is, fraction, fertilization method, growth season, and planting site [1], [8], [9] and [26].
The physical properties of agricultural materials, such as shape and size, volume, density, porosity, and surface area, are important and necessary engineering data in many problems related to machine design or analysis of the behavior of agricultural products in various processes [23].
At a moisture content of 8.85%, the principal dimensions of soybean seeds were 5.39mm, 4.76mm, and 3.98mm. respectively, and volume, geometric mean diameter, and arithmetic mean diameter were 55.8 mm3,4.66 mm,4.7mm. respectively. The sphericity and surface area was 86.94%, and 68.29 mm^2, respectively [13].
The average dimensions of faba bean seeds with moisture content 10% were, the length 15.077 mm., width 11.187 mm. Thickness 6.1873 mm. Volume 736.69mm^3. geometric mean diameter 10.142mm. The arithmetic mean diameter is 10.817 mm. and sphericity is 65.887%. Also, the surface area is 318.71.mm^2 [21].
The knowledge of physical properties is required for the design of equipment for handling, harvesting, processing and storing. The information related physical properties is not only pertinent to engineers but as well to food scientists, processors, and other scientists who may employ these resources [19].
Zea mays L, kKnown as maize, it is the third most important cereal crop in the world after wheat and rice. It has a very high yield potential and is commonly known as the "Queen of Cereals". Corn contains about 10% proteins, 4% oil, 70% carbohydrates, 2.3%

crude fibre, 10.4% albumen and 1.4% ash. It also contains significant amounts of vitamin A, nicotinic acid, riboflavin and vitamin E. The world produces about 856 million tons of corn, having been recognized as one of the most important crops for food, fodder and industrial purposes. In most parts of the world, corn production is considered one of the world's leading practices whose total production (1,104.88 million metric tons) and yield per unit area, and Egypt's total imports of corn in 2018 amounted to 101,800 metric tons, down 14,200 metric tons or 12% less than in calendar year 2017. Maize is also the staple food of choice for 900 million poor, 120-140 million poor farming families and about a third of malnourished children globally [2], [30], [20].

Maize can be grown successfully in a variety of soil types, ranging from loamy sand to clay loam. These events are influenced by seed interactions, soil moisture, seedling depth, sowing method, equipment type, and so on. Planting methods are critical for the successful establishment of crops in a variety of growing conditions [3].

The physical properties of seeds that play an important role in designing seed metering devices. the grain length, width, thickness, geometric mean diameter, surface area, sphericity, and volume increased linearly from12.53-12.85, 9.12-9.23, and 4.50-4.74 mm, respectively with an increase in moisture content from (12.8-29.0%w.b.). The bulk density and true density decreased from 768.7-665.1 kg m-3 and 1,321.7-1,231.5 kg m^3 respectively with increasing moisture content. The values of geometric diameter, surface area, sphericity, and kernel volume increased from 7.97- 8.21mm,199.87-212.14mm^2, 64.0-64.37%, and 268.25-293.73 mm^3 respectively for an increase of moisture content from12.8-29.0% [6].

Wheat (*Triticum aestivum* L.) is a major cereal crop grown all over the world. It is one of the most important cereal crops grown for human consumption in Africa, as it is classified as a strategic crop for food security and thus contributes about 16% of the needs of some countries, as it provides 21% of the total nutritional requirements to feed 4.5 billion people in developing countries. It covers about 220 million hectares with a production of 716 million tons of food grains with a productivity of 3.2 tons per hectare. It also accounts for nearly 30% of global cereal production and 50% of the global grain trade. According to FAO estimates, the world will need an additional 198 million tons of grain. wheat by 2050 to meet future demands, which will require an increase in wheat production by (77-80%) in emerging countries the need for wheat production has become more important, particularly in the last 50 years. According to figures from the United States Department of Agriculture (USDA), the total grain production rate is about 2.6 billion tons. Wheat accounts for 29% of this [7], [28], [31], [25].

The physical properties of various wheat grain varieties and the dimensions of wheat grain were changed from min to max, respectively, and the length was changed from 4.05 to 4.80 mm. width ranging from 0.10 to 1.22 mm The thickness varied between 0.10 and 1.15 mm. Volume ranged from 0.06 to 3.29 mm^3, geometric mean diameter ranged from 0.48 to 1.85 mm, arithmetic means diameter ranged from 1.53 to 2.36 mm, and sphericity decreased from 38.4 to 10.50 percent. In addition, the surface area increased from 0.72 to 10.70 mm2 at a constant moisture content of 12.2 % [14].

Cotton (Gossypium) seeds contain about 17-24% oil and 40-43% protein, African cotton producing countries are the largest cotton producing zones in the world, they supply from 12–15% of the world's fiber exports. In 2018–2019, these zones supplied 4.5% of the 26 million tons of the world's cotton fiber, almost 3.3 million tons of seed cotton. In 2019, annual seed cotton output ranged from 300,000 to 750,000 tonnes in Africa, which also has the highest yields for rainfed farming, with yields reaching 1 ton per hectare, some of the commercially grown cotton species are, *Gossypium hirsutum* about 90 % of the world is producing this type of cotton, also is grown on approximately 100 million family farms in 75 different countries. According to FAO [18], [10], [17], [24].

Physical properties of cotton seeds. The average length, width, and thickness of cotton seeds ranged from 9.02 to 9.19, 4.70 to 4.86, and 4.25 to 4.45 mm, the sphericity increased from 0.626 to 0.635, seed volume from 95.4 to 109.6 mm^3, and projected area from 35.89 to 40.14 mm^2 [4].

Image analysis was used to determine the physical properties of cotton seeds. The average value of length, width, thickness, geometrical and arithmetic mean diameters, volume, sphericity, coefficient of the contact surface, and surface area of cotton seeds were 9.47, 5.57, 4.68, 6.27, 6.58 mm, 129.55 mm^3, 66.37 %, 50.32 %, and 123.63 mm^2, respectively [5], [27].

Sunflower (*Helianthus annuus* L.) is a popular oilseed crop that is well-known for its high-quality edible oil. Sunflower production in the world is about 47.9 Mt. sunflower is one of the most important oilseed sources. The seeds have a high nutritional value containing moisture 5.50%, protein 18.72%, crude fat 37.47%, crude fiber 28.30%, ash 3.49% and carbohydrates 6.11%. The area under this crop has increased more than 15 times during the last fifteen years indicating strong motivation of the farmers for this crop because it produces 10% of oil in the world [11], [29], [15], [12].

The average of physical properties of sunflower seeds length, width, thickness, geometric and arithmetic mean diameters, volume, sphericity, and surface are 18.39mm, 7.07mm, 3.19mm, 7.41mm, 10.47, 219.04mm^3, 40.44%, 174.17mm^2 respectively [22].

The physical properties of sunflower seeds were evaluated as a function of moisture content. At 6·2% m.c.d.b., the average length, width, thickness and unit mass of the seed were 9·52mm, 5·12mm, 3·27mm, and 0·049g respectively. Corresponding values for the kernel were 8·28mm, 4·09mm, 2·43mm, and 0·034g. The mean equivalent diameter and sphericity of the seed were 5·39mm and 0·57 respectively, while corresponding values for the kernel were 4·32mm and 0·53 [16].

To construction modern device metering for small see drill required essay movement for seeds this is a critically moving during the filling of the feed disk, so must detriments of the small differences in the surface area and topography of the grains and determine some image analyses. The main objective of this research to determine of physical and color properties of seed related to the design of feed mechanism system.

MATERIALS AND METHODS

The experiment was carried out through 2022 at the department of agriculture engineering faculty of agriculture Egypt, to verify the physical and optical properties of different seeds. These characteristics are used in the design and development of a metering device plate. Seeds dimensions were tested under a moisture level of 8 %. The current study was devoted to certain types of grains, which are Faba bean, Soybean, Corn, Wheat, Cotton, Sunflowers which were obtained from the Agricultural Research Centre. Samples were randomly selected and cleaned by hand.

Measurements and determinations. Physical properties

The three axial dimensions of seed are namely length “L, in mm” (longest intercept), width “W, in mm” (equatorial width perpendicular to L) and thickness “T, in mm” (breadth perpendicular to L and W). measured by a manual Vernier-caliper with accuracy of 0.02 mm for randomly selected 100 seeds. Mean dimensions of soybean seeds, the arithmetic mean diameter (D a), mm, geometric mean diameter (D g), mm, surface area (A s), mm^2, volume (V), mm3 and sphericity (φ), % of grains were calculated as:

-Arithmetic mean diameter (Da), mm:

$$Da = \frac{(\mathbf{x+y+z})}{\mathbf{3}} \quad \ldots\ldots(1)$$

-Geometric mean diameter (Dg), mm:

$$Dg = (x.y.z)^{1/3} \quad \ldots\ldots(2)$$

-Surface area (A s), mm^2:

$$As = \pi.Dg^2 \quad \ldots\ldots(3)$$

-Volume (V), mm^3:

$$V = \frac{\pi}{6}(x.y.z) \quad \ldots\ldots(4)$$

-Sphericity (φ), %:

$$\varphi = \frac{(x.y.z)^{1/3}}{x} = \frac{Dg}{x} \quad \ldots\ldots(5)$$

-Area of flat surface, mm

$$Af = \frac{\pi}{4}(x.y) \quad \ldots\ldots(6)$$

-Area of transverse surface, mm

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$$At = \frac{\pi}{4}(x.z) \qquad (7)$$

-Aspect ratio, decimal

$$Ar = \frac{x}{y} * 100 \qquad (8)$$

- Shape index, mm

$$SI = \frac{L}{W} * 100 \qquad (9)$$

where:
x: length of grains (mm),
y: width of grains (mm) and
z: thickness of grains (mm)

RESULTS AND DISCUSSIONS

Physical properties of different grains (Faba bean, soybean, corn, wheat, cotton, sunflowers) were determined, statistically analysed.

Physical Properties

All the experiments for the physical properties of the previously mentioned seeds were carried out with a manual caliper with a precision of 0.02 to show the frequency distribution levels of the seeds at 8% moisture content.

-FABA BEAN

The results showed, the average dimensions of faba bean seeds length ranged from 11 to 22.16 mm., width ranged from 6.22 to 16.2 mm. Thickness ranged from 4.18 to 9.38 mm. Volume ranged from 320.91 to 1,462.9 mm^3. geometric mean diameter ranged from 8.47 to 14.05 mm.

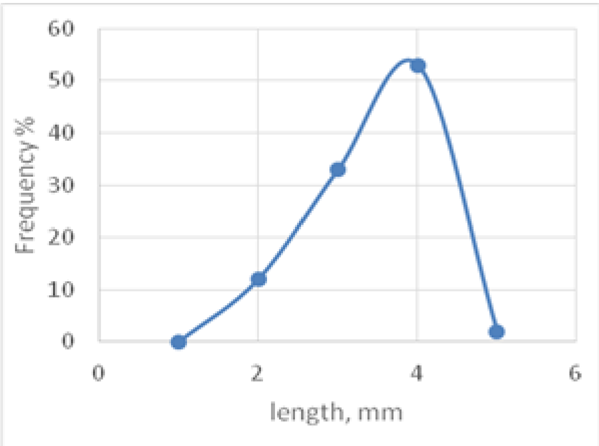

Fig. (A.1). Frequency distribution curves for the length of faba bean seed
Source: Authors' determination.

The arithmetic mean diameter ranged from 8.82 to 15.15 mm. and Sphericity, ranged from 55.33 to 77.85 %. Also, the surface area ranged from 225.67 to 619.8 mm^2.The area of flat surface ranged from 73.24 to 262.73 mm, the area of transverese ranged from 37.69 to 112.06 mm and aspect ratio ranged from 41.46 to 92.66 mm, and the shape index ranged from 107.9 to 241.2 mm.

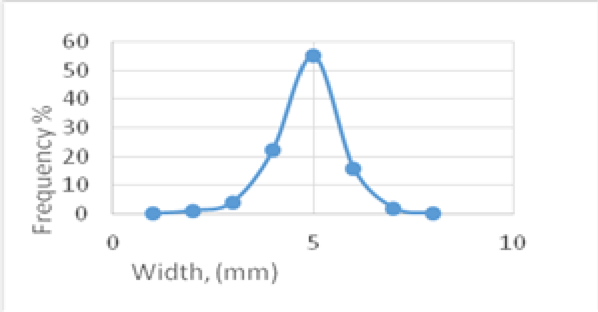

Fig. (A.2). Frequency distribution curves for the width of faba bean seed
Source: Authors' determination.

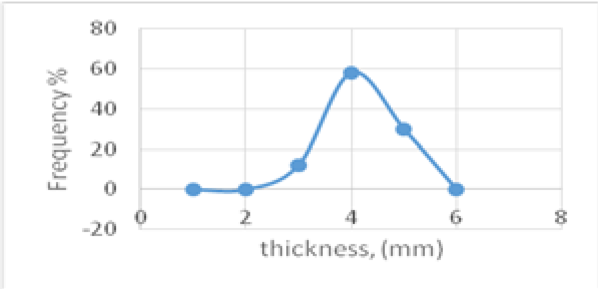

Fig. (A.3). Frequency distribution curves for the thickness of faba bean seed
Source: Authors' determination.

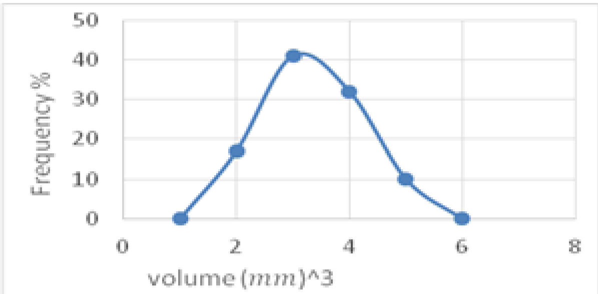

Fig. (A.4). Frequency distribution curves for the volume of faba bean seed
Source: Authors' determination.

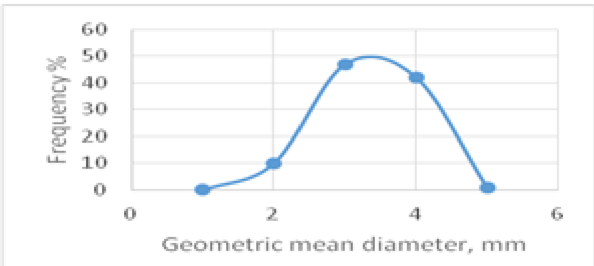

Fig. (A.5). Frequency distribution curves for the geometric mean diameter of faba bean seed
Source: Authors' determination.

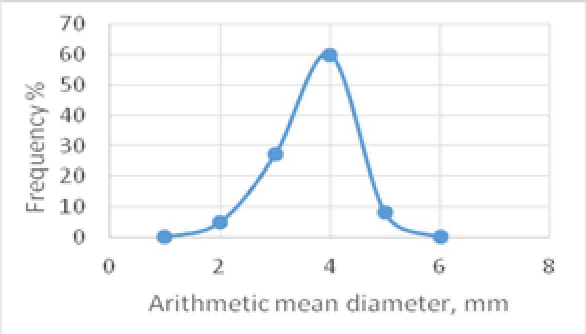

Fig. (A.6). Frequency distribution curves for the arithmetic mean diameter of faba bean seed
Source: Authors' determination.

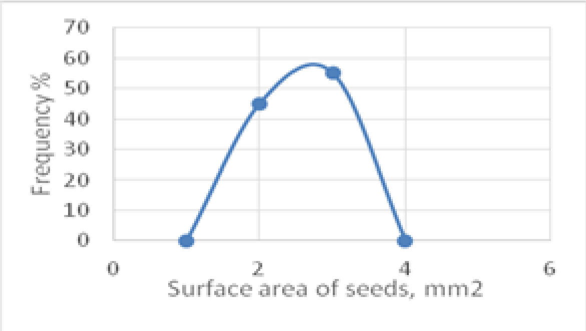

Fig. (A.7). Frequency distribution curves for the area of surface area of faba bean seed
Source: Authors' determination.

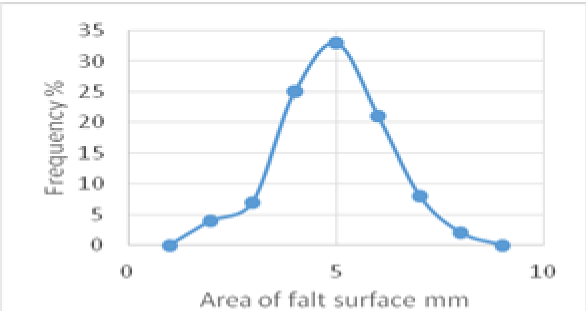

Fig. (A.8). Frequency distribution curves for the area of flat surface of faba bean seed
Source: Authors' determination.

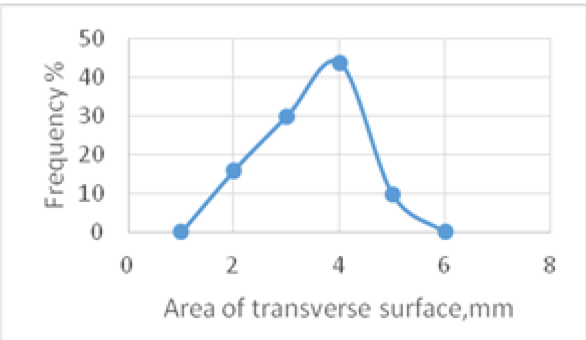

Fig. (A.9). Frequency distribution curves for the area of transverese of faba bean seed
Source: Authors' determination.

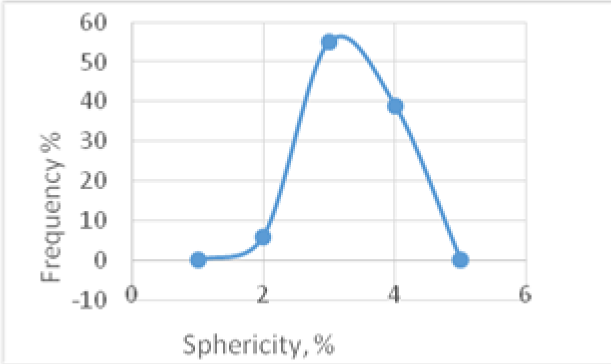

Fig. (A.10). Frequency distribution curves for the sphericity of faba bean seed
Source: Authors' determination.

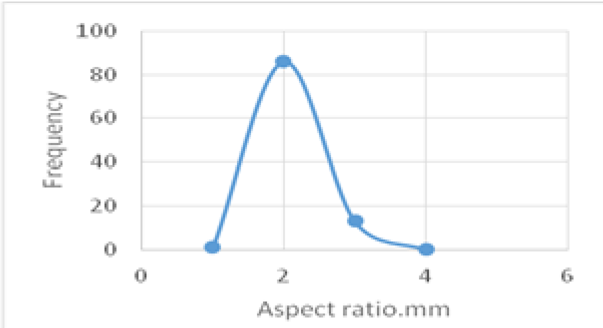

Fig. (A.11). Frequency distribution curves for the aspect ratio of faba bean seed
Source: Authors' determination

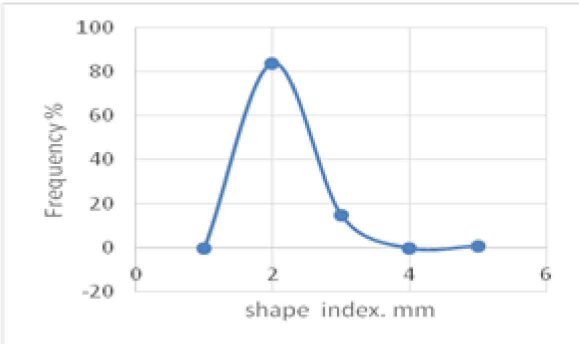

Fig. (A.12): Frequency distribution curves for the shape index of faba bean seed
Source: Authors' determination.

SOYABEAN

The results showed, the average dimensions of soybean seeds length ranged from 4.33 to 7.62 mm., width ranged from 2.46 to 6.33 mm. Thickness ranged from 1.57 to 5.9 mm. Volume ranged from 11.05 to 119.6 mm^3. geometric mean diameter ranged from 8.47 to 14.05 mm. The arithmetic mean diameter ranged from 3.10 to 6.20 mm. and Sphericity, ranged from 103 to 47.01 %. Also, the surface area ranged from 23.93 to 117 mm^2. The area of flat surface ranged from 10.04 to 35.89

mm, the area of transverse ranged from 3.18 to 26.34 mm, and aspect ratio ranged from 44.01 to 129.6 mm, and the shape index ranged from77.18 to 227.2 mm.

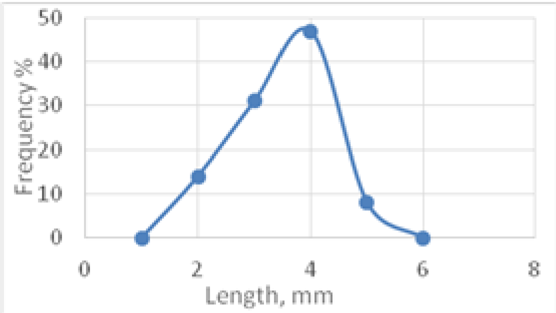

Fig. (B.1). Frequency distribution curves for the length of soya bean seed
Source: Authors' determination.

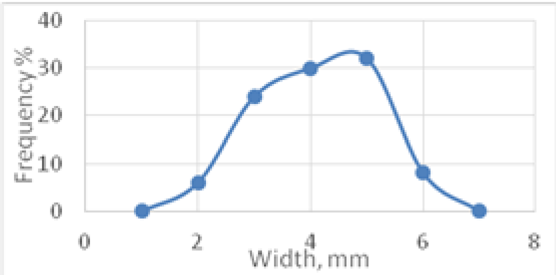

Fig. (B.2). Frequency distribution curves for the width of soya bean seed
Source: Authors' determination.

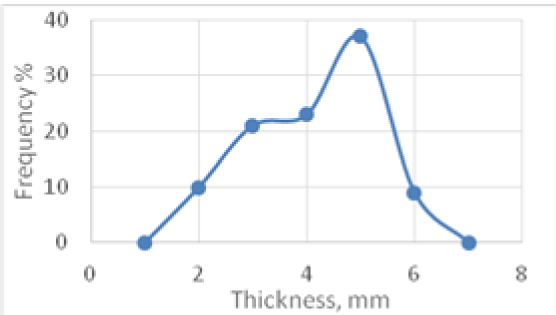

Fig. (B.3). Frequency distribution curves for the width of soya bean seed
Source: Authors' determination.

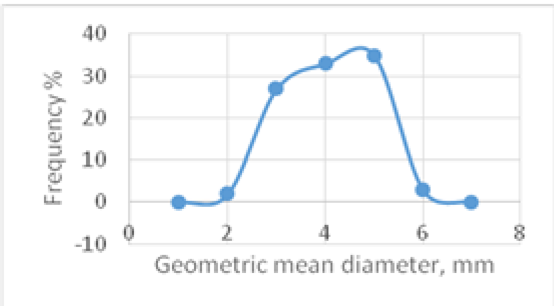

Fig. (B.4). Frequency distribution curves for the geometric mean diameter of soya bean seed Source: Authors' determination

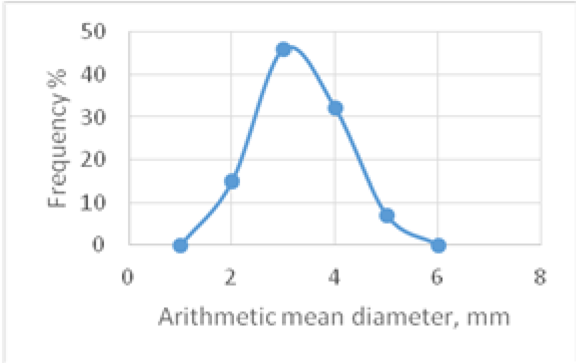

Fig. (B.5). Frequency distribution curves for the arithmetic mean diameter of soya bean seed.
Source: Authors' determination

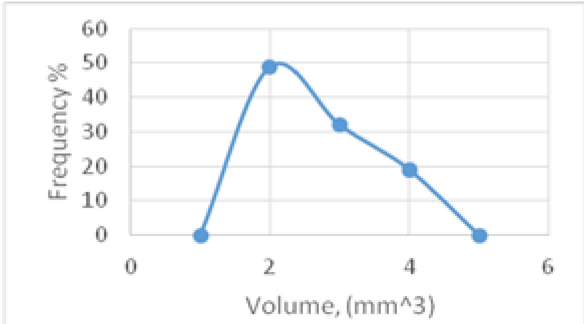

Fig. (B.6): Frequency distribution curves for the volume of soya bean seed
Source: Authors' determination.

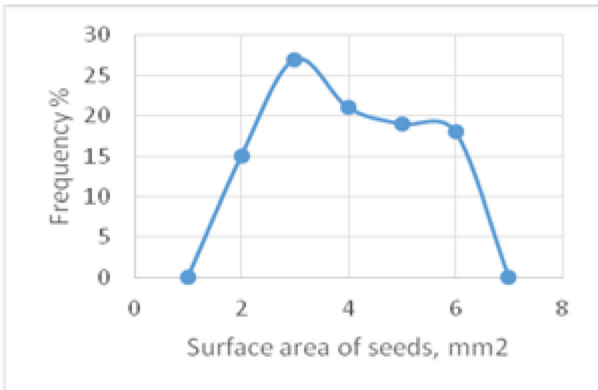

Fig. (B.7). Frequency distribution curves for the surface area of soya bean seed
Source: Authors' determination.

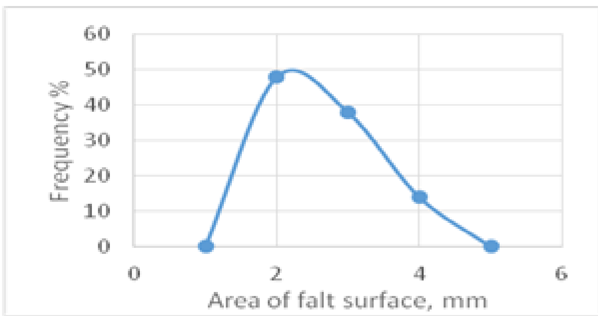

Fig. (B.8). Frequency distribution curves for the area of flat surface of soya bean seed
Source: Authors' determination.

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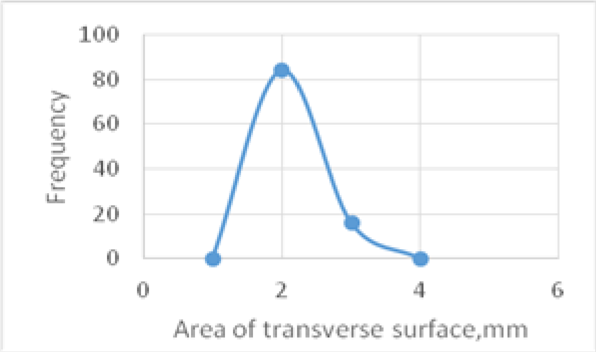

Fig. (B.9). Frequency distribution curves for the area of transverse surface of soya bean seed
Source: Authors' determination.

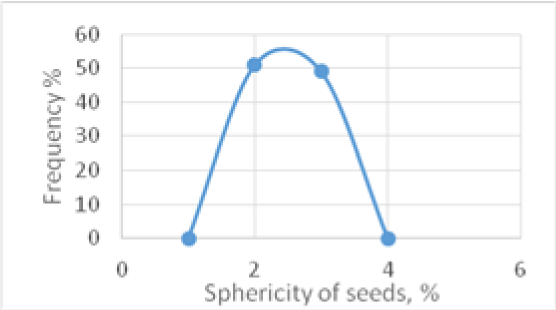

Fig. (B.10). Frequency distribution curves for the sphericity of soya bean seed
Source: Authors' determination.

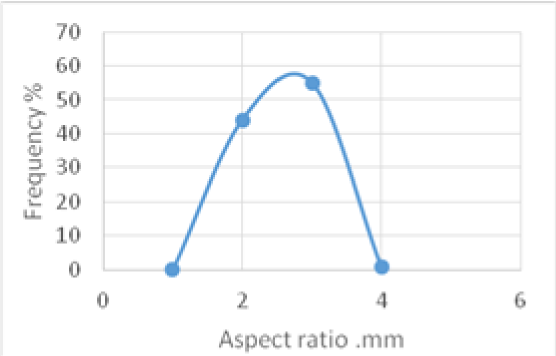

Fig. (B.11). Frequency distribution curves for the aspect ratio of soya bean seed
Source: Authors' determination.

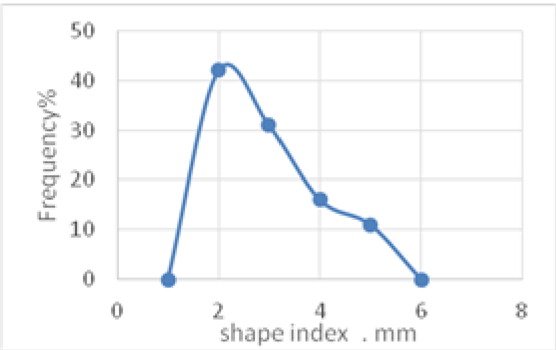

Fig. (B.12). Frequency distribution curves for the shape index of soya bean seed
Source: Authors' determination.

-CORN

The results showed, the average dimensions of corn seeds length ranged from 7.86 to 15 mm., width ranged from 3.7 to 10.12 mm. Thickness ranged from 2.56 to 7.42 mm. Volume ranged from 59.6 to 385.2 mm^3. geometric mean diameter ranged from 4.83 to 9.04 mm. The arithmetic mean diameter ranged from 5.53 to 9.66 mm. and Sphericity, ranged from 96.92 to 49.2 %. Also, the surface area ranged from 73.54 to 254.9 mm^2. The area of flat surface ranged from 28.29 to 106 mm, the area of transverese ranged from 9.17 to 56.54 mm ,and aspect ratio ranged from 37.98 to 100.2 mm, and the shape index ranged from 99.75 to 263.2 mm.

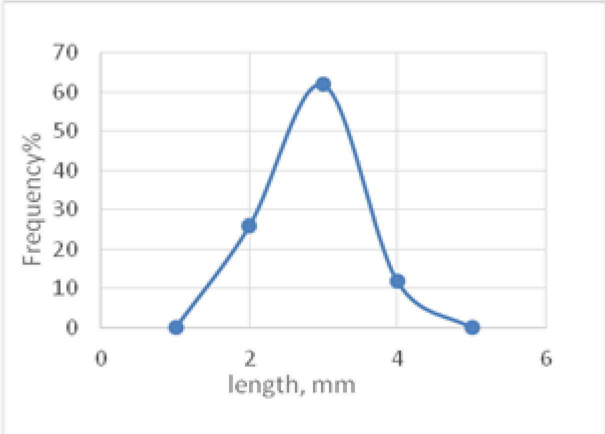

Fig. (C.1). Frequency distribution curves for the length of corn seeds
Source: Authors' determination.

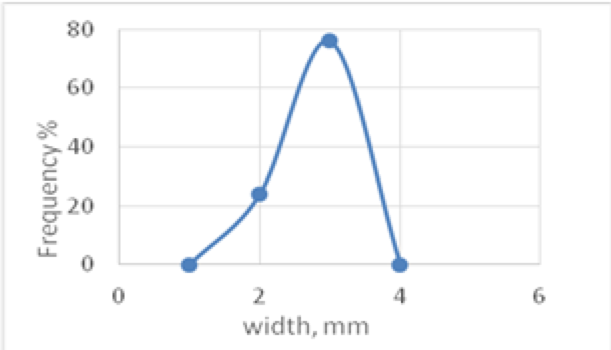

Fig. (C.2). Frequency distribution curves for the width of corn seeds
Source: Authors' determination.

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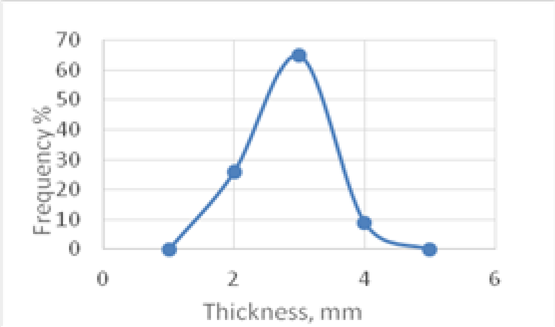

Fig. (C.3). Frequency distribution curves for the thickness of corn seeds
Source: Authors' determination.

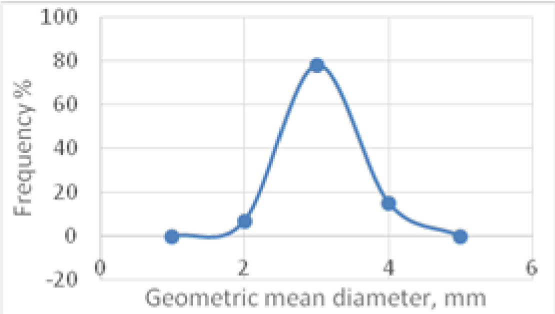

Fig. (C.4). Frequency distribution curves for the geometric mean diameter of corn seeds
Source: Authors' determination.

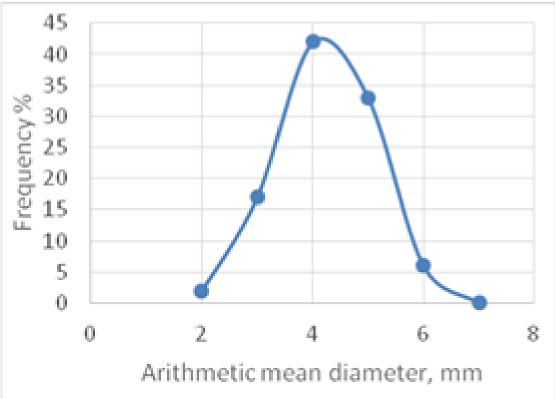

Fig. (C.5). Frequency distribution curves for the arithmetic mean diameter of corn seeds
Source: Authors' determination.

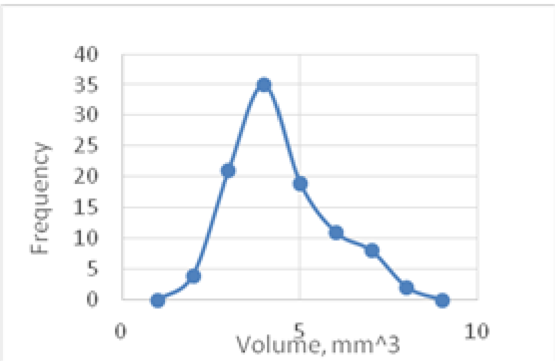

Fig. (C.6): Frequency distribution curves for the volume of corn seeds
Source: Authors' determination.

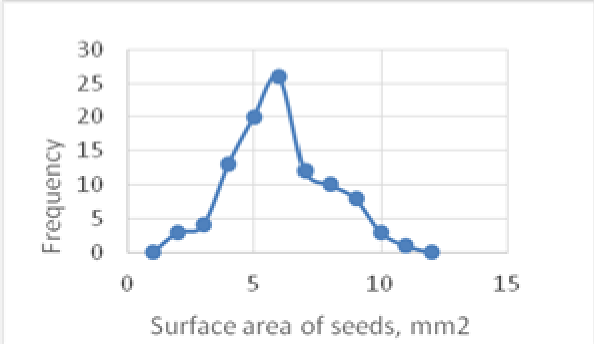

Fig. (C.7). Frequency distribution curves for the surface area of corn seeds
Source: Authors' determination.

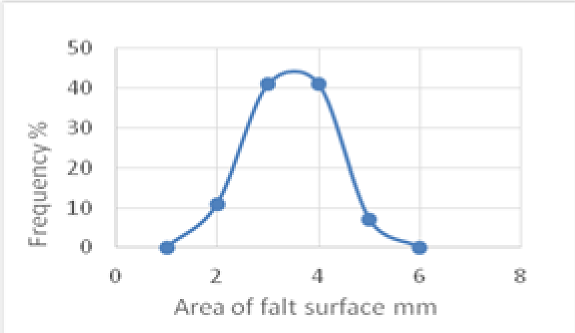

Fig. (C.8). Frequency distribution curves for the area of flat surface of corn seeds
Source: Authors' determination.

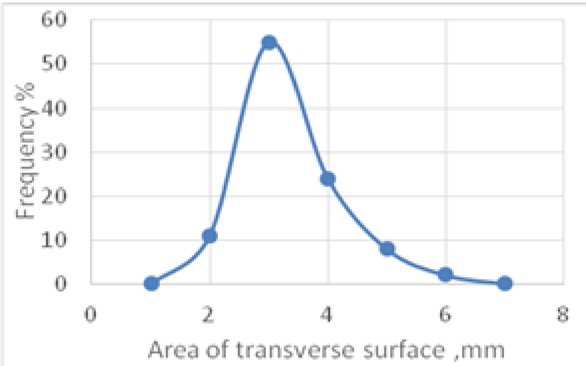

Fig. (C.9). Frequency distribution curves for the area transverse surface of corn seeds
Source: Authors' determination.

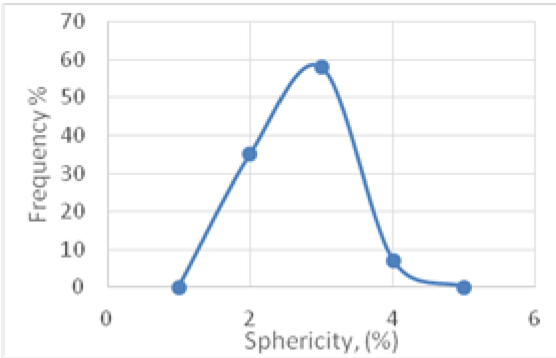

Fig. (C.10). Frequency distribution curves for the sphericity% of corn seeds
Source: Authors' determination.

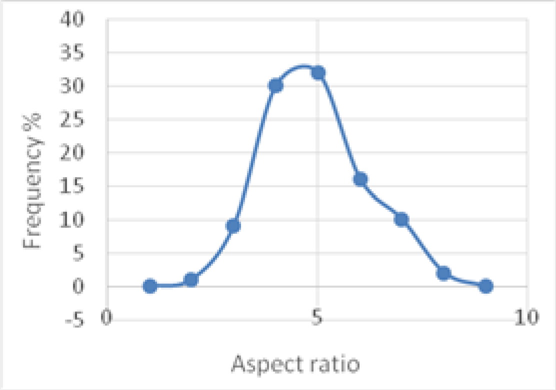

Fig. (C.11). Frequency distribution curves for the aspect ratio of corn seeds
Source: Authors' determination.

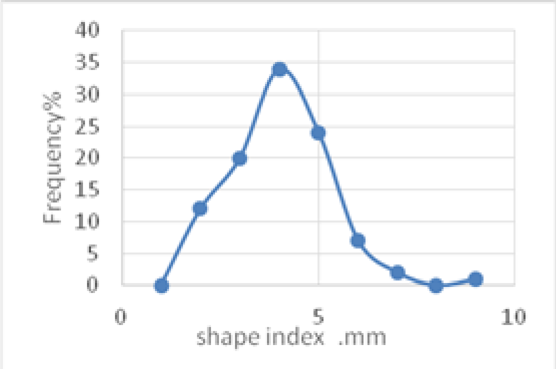

Fig. (C.12). Frequency distribution curves for the shape index of corn seed
Source: Authors' determination

-WHEAT

The results showed, the average dimensions of wheat seeds length ranged from 4.8 to 8.72 mm., width ranged from 2.34 to 5.74 mm. Thickness ranged from 1.68 to 4.98 mm. Volume ranged from 11.73 to 124.68 mm^3. geometric mean diameter ranged from 2.81 to 6.18 mm.

The arithmetic mean diameter ranged from 3.08 to 6.40 mm. and Sphericity, ranged from 79.63 to 45.59 %.

Also, the surface area ranged from 24.91 to 120.2 mm^2.

The area of flat surface ranged from 10.21 to 39.29 mm, the area of transverese ranged from 3.66 to 21.45 mm ,and aspect ratio ranged from 30.96 to 88.85 mm, and the shape index ranged from 112.5 to 323 mm.

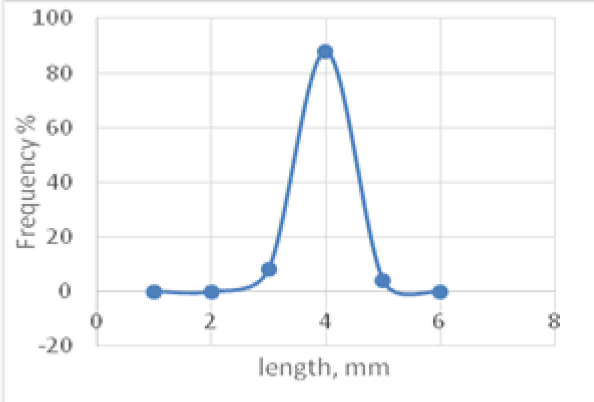

Fig. (D.1). Frequency distribution curves for the length of wheat seeds
Source: Authors' determination.

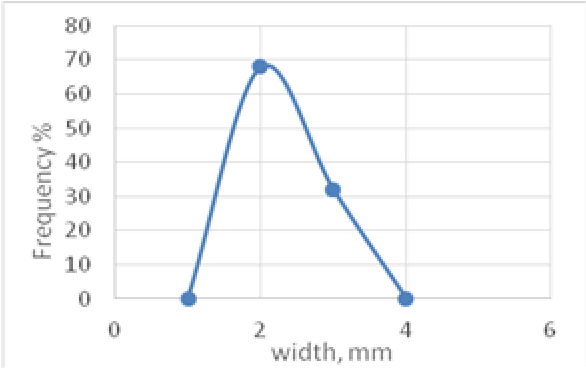

Fig. (D.2). Frequency distribution curves for the width of wheat seeds
Source: Authors' determination.

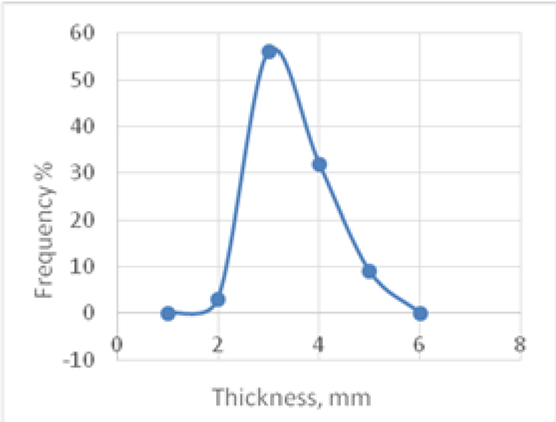

Fig. (D.3). Frequency distribution curves for the thickness of wheat seeds
Source: Authors' determination.

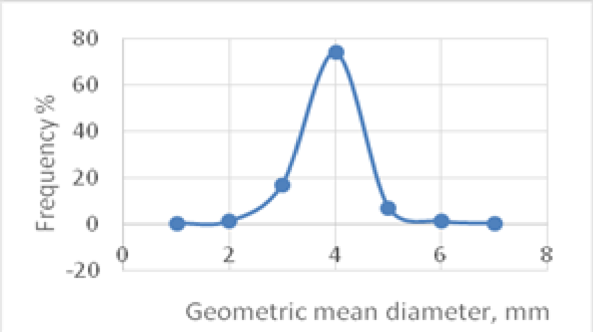

Fig. (D.4). Frequency distribution curves for the Geometric mean diameter of wheat seeds
Source: Authors' determination.

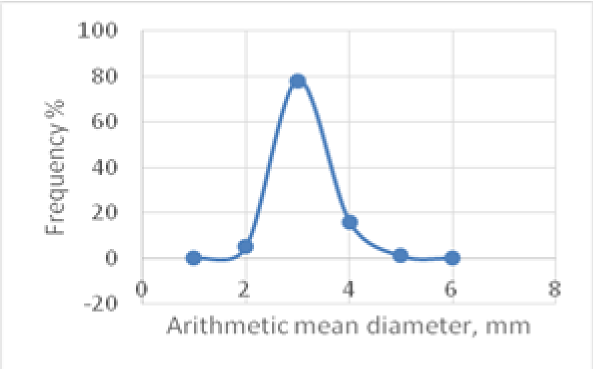

Fig. (D.5). Frequency distribution curves for the arithmetic mean diameter of wheat seeds
Source: Authors' determination.

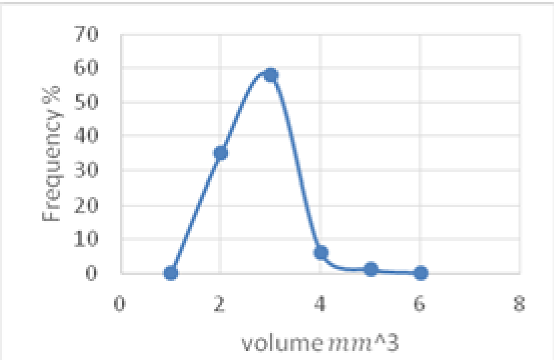

Fig. (D.6). Frequency distribution curves for the volume of wheat seeds
Source: Authors' determination.

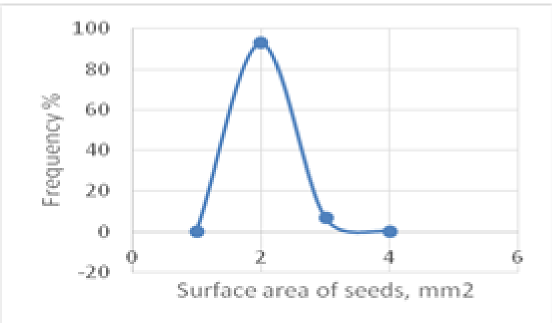

Fig. (D.7). Frequency distribution curves for the surface area of wheat seeds
Source: Authors' determination.

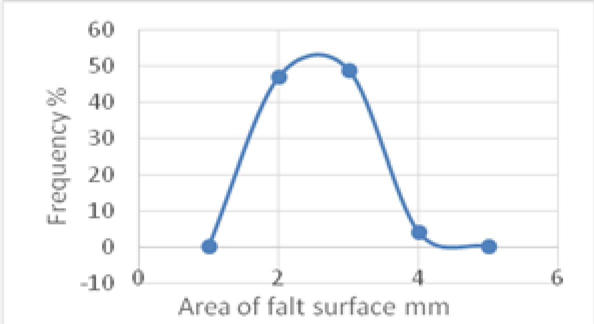

Fig. (D.8). Frequency distribution curves for the area flat surface of wheat seeds
Source: Authors' determination.

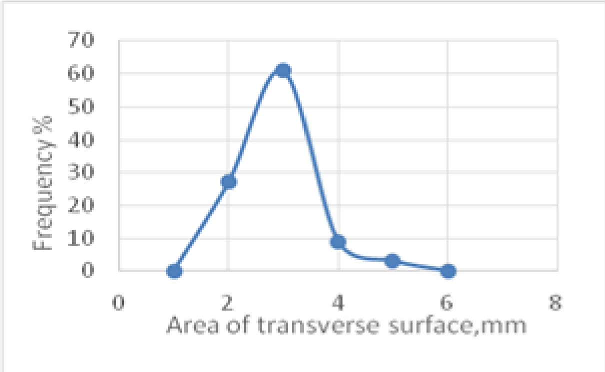

Fig. (D.9). Frequency distribution curves for the area transverse surface diameter of wheat seeds
Source: Authors' determination.

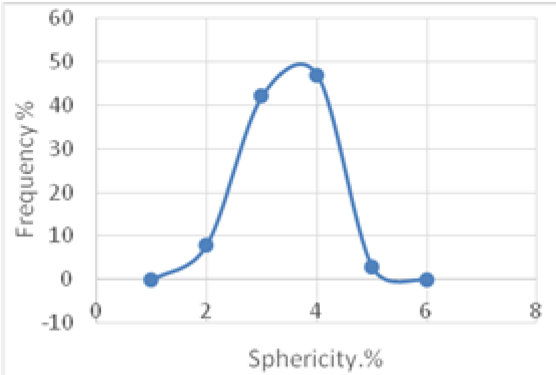

Fig. (D.10). Frequency distribution curves for the sphericity% of wheat seeds
Source: Authors' determination

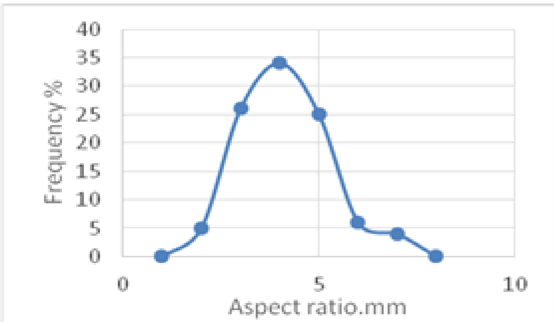

Fig. (D.11). Frequency distribution curves for the aspect ratio of wheat seeds
Source: Authors' determination.

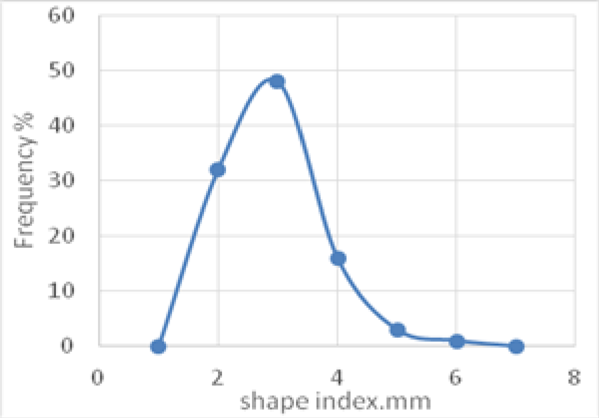

Fig. (D.12). Frequency distribution curves for the shape index of wheat seed
Source: Authors' determination.

-COTTON

The results showed, the average dimensions of cotton seeds length ranged from 7.16 to 10.12 mm., width from 4.42 to 6.92 mm. Thickness ranged from 3.72 to 6.44 mm. Volume ranged from 71.32 to 180.47 mm^3. geometric mean diameter ranged from 5.13 to 6.98 mm. The arithmetic mean diameter ranged from 5.3 to 7.24 mm. and Sphericity, ranged from 85.66 to 56.97 %. Also, the surface area ranged from 82.88 to 153.81 mm2. The area of flat surface ranged from 25.96 to 51.96 mm, the area of transverese ranged from 13.94 to 29.76 mm ,and aspect ratio ranged from 44.75 to 90.33 mm, and rhe shape index ranged from 110.69 to 223.42 mm.

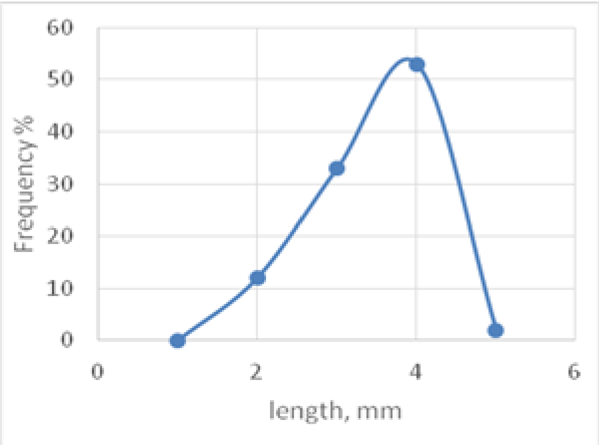

Fig. (E.1). Frequency distribution curves for the length of cotton seeds
Source: Authors' determination.

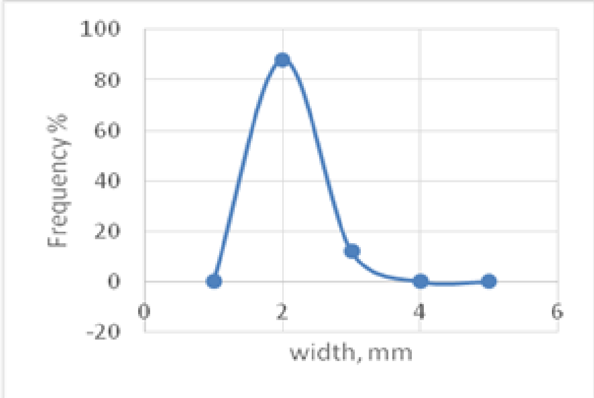

Fig. (E.2). Frequency distribution curves for the width of cotton seeds
Source: Authors' determination.

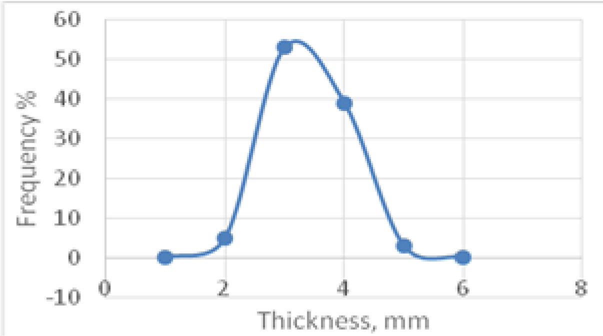

Fig. (E.3). Frequency distribution curves for the thickness of cotton seeds
Source: Authors' determination.

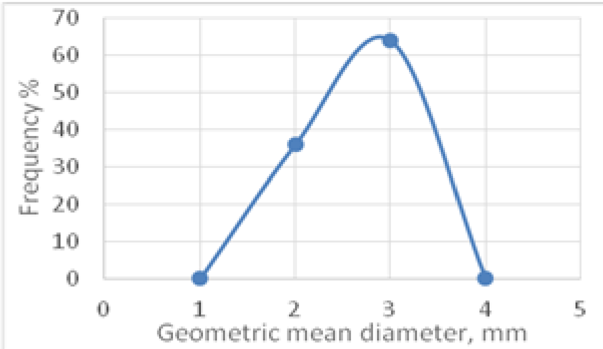

Fig. (E.4). Frequency distribution curves for the Geometric mean diameter of cotton seeds
Source: Authors' determination.

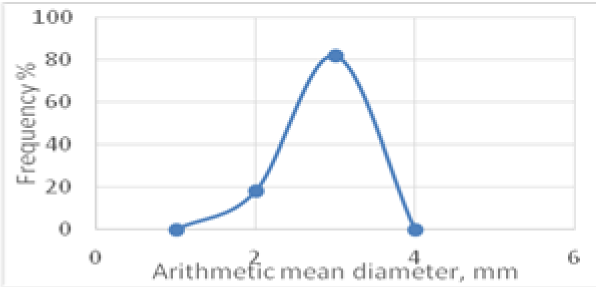

Fig. (E.5). Frequency distribution curves for the Arithmetic mean diameter of cotton seeds
Source: Authors' determination.

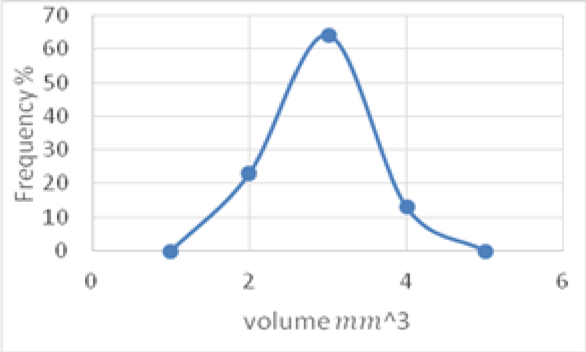

Fig. (E.6). Frequency distribution curves for the Volume of cotton seeds
Source: Authors' determination.

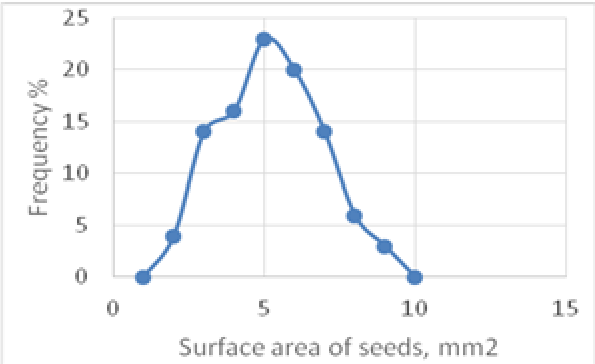

Fig. (E.7). Frequency distribution curves for the Surface area of cotton seeds
Source: Authors' determination.

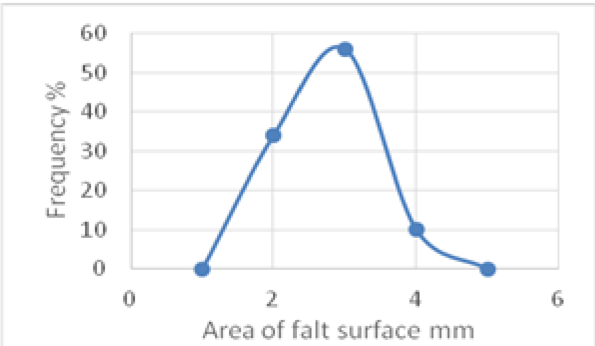

Fig. (E.8). Frequency distribution curves for the Area of flat surface of cotton seeds
Source: Authors' determination.

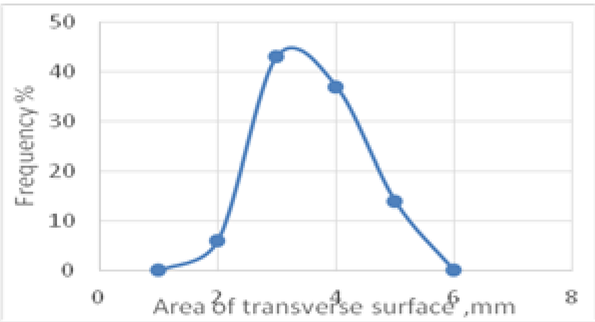

Fig. (E.9). Frequency distribution curves for the Area of transverse surface of cotton seeds
Source: Authors' determination.

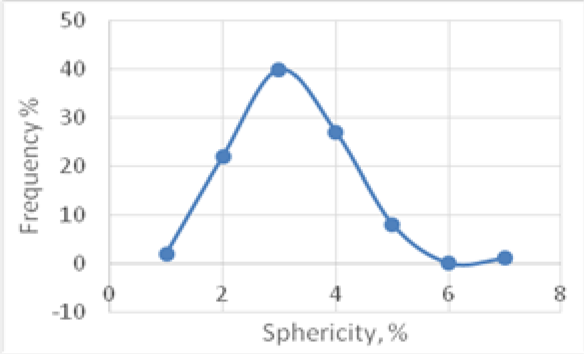

Fig. (E.10). Frequency distribution curves for the Sphericity of cotton seeds
Source: Authors' determination.

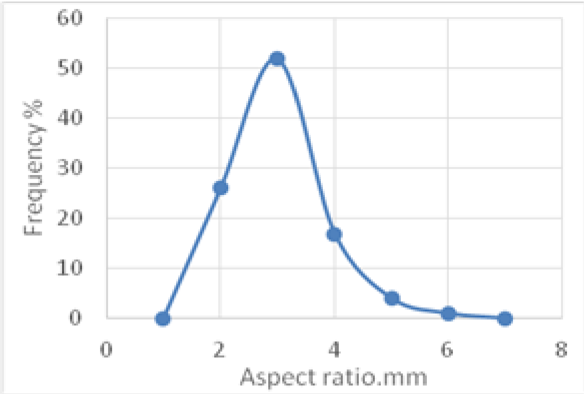

Fig. (E.11). Frequency distribution curves for the Aspect ratio of cotton seeds
Source: Authors' determination.

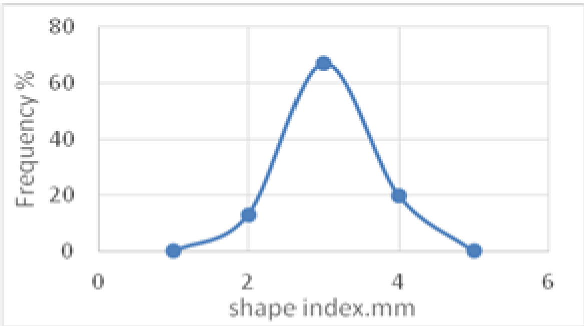

Fig. (E.12). Frequency distribution curves for the shape index of cotton seed
Source: Authors' determination.

-SUNFLOWER

The results showed, the average dimensions of sunflowers seeds length ranged from 19 to 26.12 mm., width ranged from 6.88 to 11.18 mm. Thickness ranged from 2.4 to 6.22 mm. Volume ranged from170.06 to 937.47 mm^3. geometric mean diameter ranged from 6.86 to 12.11 mm. The arithmetic mean ranged from 9.65 to 14.38 mm. and Sphericity, ranged from 51.49 to 33.75 %. Also, the surface area ranged from 147.84 to 460.84 mm^2. The area of flat surface ranged from 102.62 to 226.08

mm, the area of transverese ranged from 12.96 to 54.58 mm ,and aspect ratio ranged from29.72 to 52.73 mm, and the shape index ranged from 189.62 to 336.44 mm.

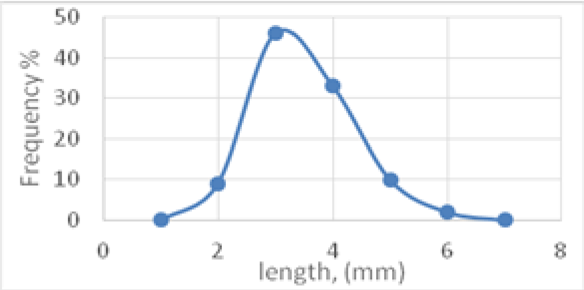

Fig. (F.1). Frequency distribution curves for the length of Sunflower seeds
Source: Authors' determination.

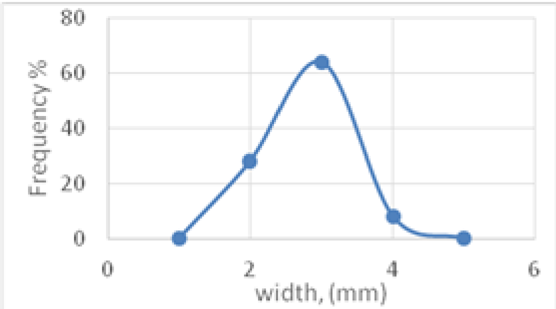

Fig. (F.2). Frequency distribution curves for the width of Sunflower seeds
Source: Authors' determination.

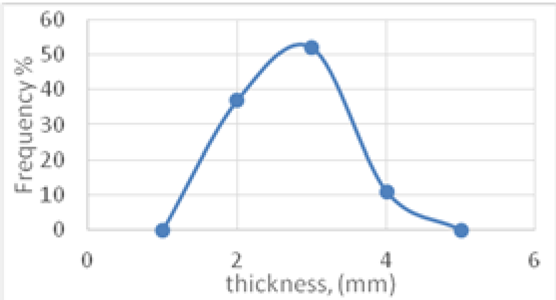

Fig. (F.3). Frequency distribution curves for the thickness of Sunflower seeds
Source: Authors' determination.

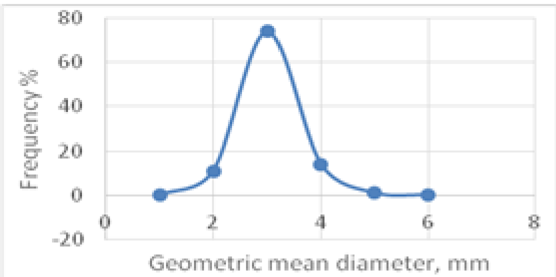

Fig. (F.4). Frequency distribution curves for the Geometric mean diameter of Sunflower seeds. Source: Authors' determination.

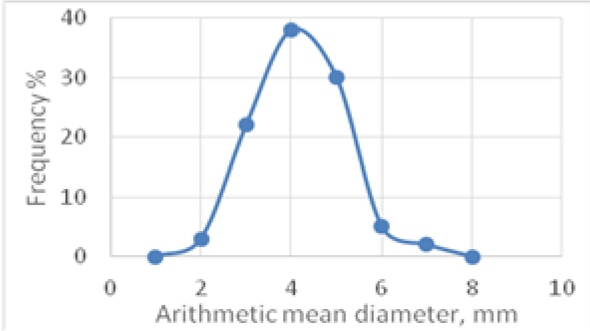

Fig. (F5). Frequency distribution curves for the Arithmetic mean diameter of Sunflower seeds
Source: Authors' determination.

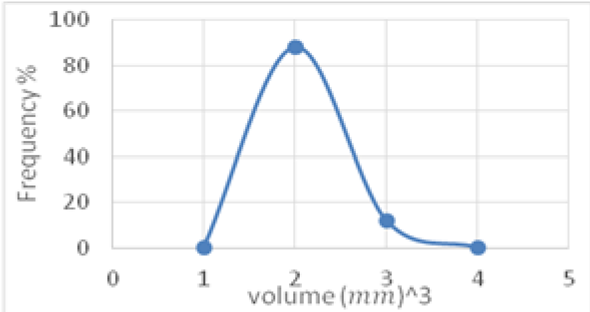

Fig. (F.6). Frequency distribution curves for the Volume of Sunflower seeds
Source: Authors' determination.

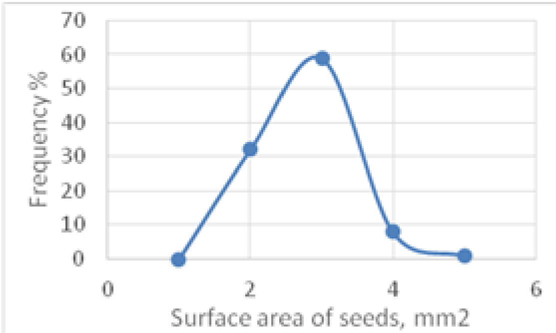

Fig. (F.7). Frequency distribution curves for the Surface area of Sunflower seeds
Source: Authors' determination.

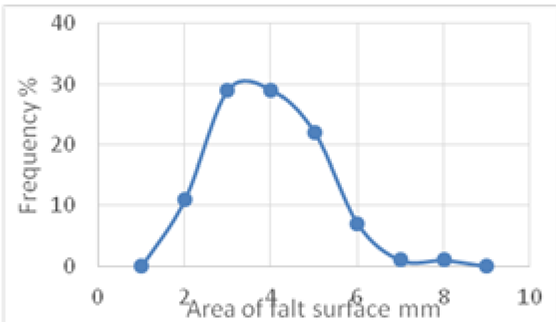

Fig. (F.8). Frequency distribution curves for the Area of flat surface of Sunflower seeds
Source: Authors' determination.

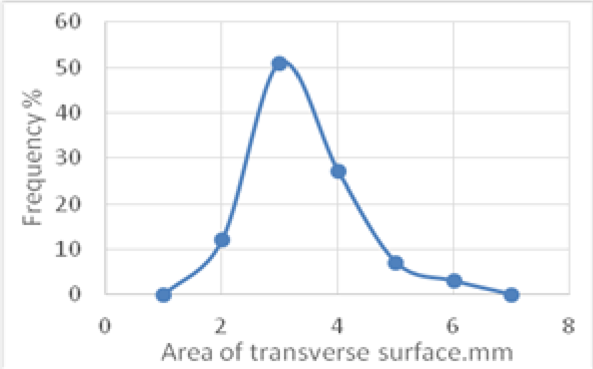

Fig. (F.9). Frequency distribution curves for the Area of transverse surface of Sunflower seeds
Source: Authors' determination.

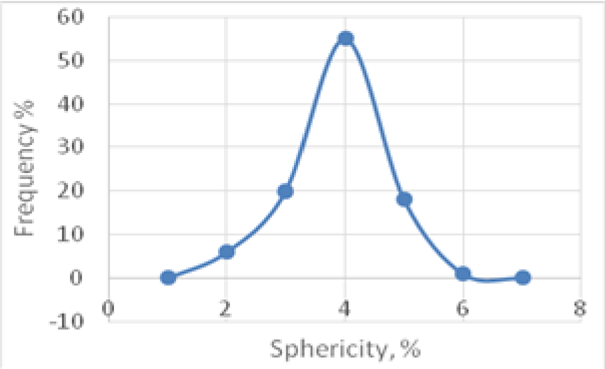

Fig. (F.10). Frequency distribution curves for the Sphericity of Sunflower seeds
Source: Authors' determination.

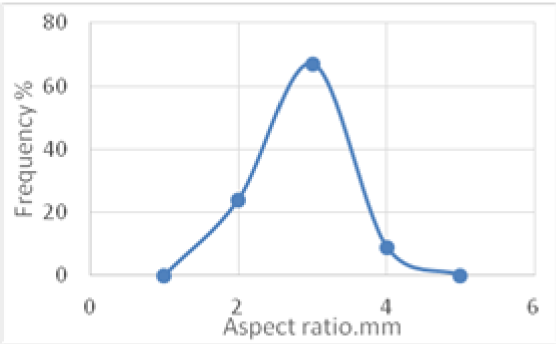

Fig. (F.11). Frequency distribution curves for the Aspect ratio of Sunflower seeds
Source: Authors' determination.

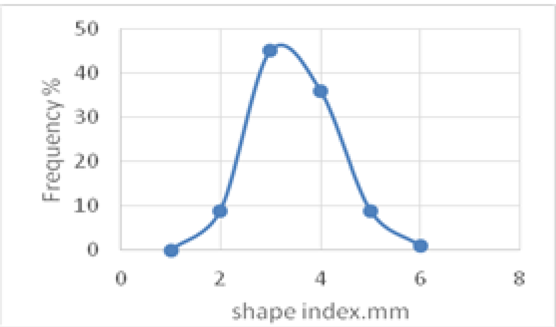

Fig. (F.12). Frequency distribution curves for the shape index of sunflower seed
Source: Authors' determination.

CONCLUSIONS

The small difference in length, width and thickness must be determined in the same variety of grain, as well as the grain that is similar in physical specifications and different in the variety, and this helps in the design of multi-purpose equipment
In this context, we need a database of physical specifications for cultivar-grained grains to help determine shape and size specifications for designing a metring device that fits many grains.

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DRYING KINETICS OF SWEET POTATO SLICES WITH INFRARED AND AIR CONVECTION HEATING

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Abstract

In this study, the combined infrared-hot air dryer develops and optimize in Agricultural Engineering laboratory, faculty of agriculture, Tanta University, Egypt. Thin-layer modelling of sweet potato slices drying under infrared (IR) and hot-air drying (HAD) were used to estimate the drying coefficients. The initial moisture content of the freshly harvested sweet potato was 79 – 81 % (w. b.). Three different levels of sweet potato slices thickness (1, 3, 5 mm), were pre-treated by dipping into a solution of 0.5 % sodium meta-bisulphite and 1% citric acid for 30 min. Four different levels of infrared radiation (0.861, 0.973, 1.039 and 1.161 kW.m-²) and three different levels of air-drying temperature (45,55 and 65°C) with a constant air velocity of 1.2 m. s^{-1} were using. The experimental measurements included sweet potatoes slices moisture content, air temperature, radiation intensity, and quality changes of the dried sweet potato. Three different thin layer drying models (Lewis's model and Henderson & Pabis's and Logarithmic model) were examined for describing the changes of moisture content during the drying process. The results show that, the Coefficient of determination R^2 and Standard error, SE. for The Logarithmic model recorded R^2= 0. 99 and SE= 0.122 were considered more proper for describing the drying kinetics and predicting the changes in moisture content of sweet potatoes more than the Henderson and Pabis's were model recorded R^2= 0.94 and SE= 0.51 and Lewis's model were recorded R^2= 0.96and SE = 0.241. The results show that, the moisture ratio of sample slices decreased when the radiation intensity and the drying air temperature increased. Meanwhile, the drying constant of Logarithmic model (k_{Log}) increased with the increasing of radiation intensity and air-drying temperature and the decreasing of slice thickness. The diameter and thickness shrinkage percentage occurred with all treatments, while slightly increasing with infrared radiation. The rehydration ratio ranged from 3.95 to 5.53.

Key words: *sweet potatoes, moisture ratio, rehydration, thin layer, infrared, hot-air drying.*

INTRODUCTION

Fresh fruits and vegetables are perishable and difficult to preserve because of their high moisture content. For example, fresh sweet potatoes have a short shelf life because of their high moisture content, and they are susceptible to rotting and microbial spoilage by microorganisms and external adverse conditions even at refrigerated conditions [32].
Therefore, drying treatment is one of the important processing methods for sweet potatoes for solving these problems and increasing their shelf life. Dehydrated sweet potatoes can be used as noodles, soups, beverages, bakery and confectionery products snacks. In addition, the transportation cost can be reduced dramatically due to the obvious reduction in sweet potatoes weight [31].
Sweet potatoes (*Ipomoea batatas L. (Lam.)*) are important tuber crops rich in β-carotene (precursor of vitamin A), vitamin B, C, and E as well as, polysaccharides, potassium, copper, manganese, iron, and low in fat and cholesterol with anti-carcinogenic and cardiovascular disease prevention functions [25].
In 2019 sweet potato world production exceeded 100 million tonnes, and the major producers include China, Malawi, Nigeria, Tanzania, Uganda, Indonesia, Ethiopia and Angola. The total area harvest and production of sweet potato in Egypt is 35,002.39 faddan and 454,041 tonnes, respectively [11].

Several pre-treatments and blanching are applied prior to drying of sweet potato to improve nutritional and sensory qualities of the final product. It also prevents undesirable changes during drying and increases shelf life of the final product during storage [5].

In these studies, sodium and potassium hydroxide, potassium carbonate, potassium meta bisulfite, ethyl and methyl ester emulsions, citric and ascorbic and were mostly used as pre-treatment solutions [2].

Pretreatments prior to drying are desired to increase the drying rate by removing the surface resistance as well as relaxing tissue structure of fruits and vegetables. It can also incapacitate enzymes, thus preventing color changes and produce a desirable dried product. For example [22] for sweet potatoes, [17] for potato and [21] for Mango.

The most popular and efficient way to preserve food by reducing its moisture content is convective drying. However, there are many problems such as low energy efficiency, long drying times and the problem of case hardening etc. during the falling rate period. The use of high drying temperatures results in degradation of the quality parameters of the product such as color, nutritional value and taste etc. [3].

Infrared drying, which is the part of the electromagnetic spectrum in the wavelength range 0.78-1,000 μm, is employed for thermal processes involving food such as drying and pasteurization and for determining the quality and safety of agricultural products [4].

IR drying technology has a number of advantages over traditional drying technology, including high energy efficiency, short drying time, uniform heating of materials, easy control of material temperature, good quality of the final products and low energy costs [16].

The combination of infrared with hot air provides an efficient drying process. When infrared radiation strikes a material's surface, it penetrates it. The increased molecular vibration due to absorption of radiation generates heat in the material both at surface and inner layers simultaneously [29].

[30] Compared the hot air drying and infrared drying characteristics of garlic slices. With decreasing air flow velocity and increasing IR radiation intensity, the drying rate increased and decreased at the time of drying.

In a vacuum infrared drying system, the effect of drying behaviour on the drying rate and qualitative attributes of potato slices was investigated. [14]. The drying time decreased, while drying rates increased with infrared radiation power increase. The rehydration process at 100ºC yielded the highest rehydration capacity at the power level of 200 W, vacuum 80 mmHg and thickness of 1 mm.

The effect of infra-red radiation and ultraviolet radiation on protein, trypsin inhibitor and total microbial count in cowpea seeds as pre- conditioning approaches before storage. Five exposure times of (3-6-9-12-15 min) and five irradiation intensity (804.255, 882.67, 964.74, 1,050.45, 1,139.8 W/m^2) were used for infra-red treatments. For ultraviolet treatment four exposure times (10-20-30-40min) and three irradiation intensity (7.077 – 3.538 – 2.359 mW/cm^2) were used.

The IR conditioning approach recommend to an irradiation intensity of 882.67 W/m^2 and a 15-minute exposure time. This level of radiation intensity and exposure time, showed total microbial count of 2.3 Log CFU/g., protein content 28.88 %, trypsin inhibitor 1.148 TIU/mg and moisture content 8.13 % of cowpea seeds Meanwhile, for UVC irradiation pre-treatment, a 3.538 mW/cm^2 irradiation intensity at a 40-minute exposure time is indicated to achieve a total microbial count of 2 Log CFU/g., protein content 28.15%, trypsin inhibitor 0.57 TIU/mg and moisture content 10.95% [12].

Specific energy consumption was lower and thermal efficiency was higher for the Infrared-Hot air setting when compared to both Infrared-Cold air and Hot air settings. The rehydration ratio, shrinkage and color properties of apples dried under Infrared-Hot air conditions were better than for either Infrared-Cold air or Hot air [10].

The application of infrared heating of legumes (Cowpea seeds) is gaining importance due to its inherent advantages over conventional heating. Pre-treatment with infra-red of cowpea seeds or ultra-violet radiation and storage of cowpea seeds in hermetic bags (three or seven layers) showed a safe storage result in terms of seeds quality and prevention of microorganisms and insect growth at the FIR and UVC optimum conditions. When using infra-red pre-treatment for cowpea seeds, the irradiation intensity of 882.67 w/m^2 at exposure time of 15 min get total microbial count 2.3 log cfu/g., and moisture content 8.13 % of cowpea seeds [13].

Mathematical modelling of thin layer drying is important for optimum management of optimising operational and predicting the drying system's performance.

Thin layer drying equations are used to predict drying kinetics and to generalise drying curves for a variety of items. Modelling the drying process and kinetics is a process control technique that is required to select the optimum drying method for specific product [23].

The main aims of the research were:

-To evaluate and examine the drying behavior of sweet potato slices by drying rate using a combination of the infrared radiation heating method.

-Studying the effect of air temperature, thickness of slices and initial chemical treatment with 0.5% sodium meta bisulfate solution and 1% citric acid for 30 minutes on the drying properties of sweet potato slices.

MATERIALS AND METHODS

Sweet potatoes, (*Ipomoea batatas* L.) available in a local market was selected for experimental work during December 2020. The raw sweet potatoes had an initial moisture content of 380- 420% (d. b.).

Sweet potatoes preparation included washed with tap water to remove any dirt or dust particles attached to the surface, and peeling followed by slicing of the sweet potatoes with thickness of 1, 3 and 5mm using digital Vernier caliper.

After that, sweet potato slices were pre-treated by dipping into a solution of 0.5: 1 % sodium metabisulphite and citric acid for 30 min [27], the concentration of sodium metabisulphite in solution was reduced from 1 to 0.5% because of the risk of allergy [24].

The sweet potato was distributed uniformly as a single layer of 800: 300g for each sample on a perforated tray which was then placed directly inside the drying chamber at a distance of 20 cm from the two ceramic Infrared heaters. The output from the weighing balance, indicated as weight changes of the samples which were recorded every 15 min along the first two hours and every 30 min along the next two hours, and every 60 min up to the end of the run for the slices. Each run was reproduced three times in order to reduce experimental errors, and the average was used. Initial moisture content was measured before the drying process by taking (5 g) of sample in three replicates and using drying in an air oven for 24 hours at 105°C as recommended by [1].

The samples were initially weighed using an electronic balance having a sensitivity of 0.01 g. The average initial moisture content was found to be 79-81% (wet basis).

To weight the periodical changes of samples masses, throughout the experimental runs using 5kg Load Cell with HX711 Amplifier.

A Load cell is made from an aluminium-alloy and is capable of reading a capacity of 5kg. (Rated Output: 1.0±0.15mV/V, Operation temp. range -20~+60°C, Combined error (%RO) : < ±0.03)

Thermocouple K Type Temperature Sensor was used to measure the temperature of the air passing over the samples.

General LCD digital Anemometer (model DCFM 700) was used for measuring the air velocity. The unit is a self – contained direct reading portable instrument.

The dryer was used for conducting the experimental work for drying sweet potatoes at the Agricultural Engineering Department, Faculty of Agric. Tanta University.

The combined infrared-hot air dryer used for the experimental set up. The dryer, it consists of a box-type drying chamber, an electric heater, a centrifugal fan, two ceramic Infra-red heaters, a drying tray, a load cell, two control panels and a personal computer. The exterior of the box-type dryer is made of stainless steel. The drying air velocity was measured using a Thermo-Anemometer. The

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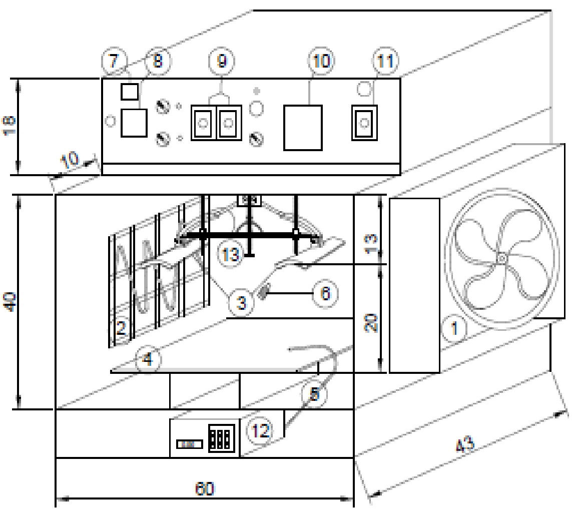
air velocity was kept constant at1.2 m. s-1 as recommended by [6].

The drying bed consists of three drying shelves. Each shelf was (60* 43 *40) cm (L * W* H). The drying trays which were made of stainless-steel wire net were situated at 20 cm from each IR lamp [9] For infrared heating process, two Elstein Germany Ceramic Infrared Emitter (wavelength of 2-10 µm; length of 24.5 cm/width of 6 cm/max power of 1,000W/ up to 750°C each ceramic Infra-red heaters were fixed over two iron blades and assembled into the ceiling of each drying chamber facing the drying shelves at constant distance of 20 cm, using two screw rods welded to the iron blades. To control the radiation intensity of the infra-red heaters, a set of dimmers were used as shown in Figure1

No. **Part name**



No.	Part name
1	Axial flow fan
2	Electric heater
3	Infrared heaters
4	Sample tray
5	Temperature sensor
6	Temperature & Humidity sensor
7	Led ampir
8	Thermostat
9	Dimmer
10	Electric meter
11	Fan speed control
12	Load cell
13	Lifter

Fig. 1. Schematic diagram of the experiment
Source: Author's own illustration.

An electric heater was also used for air heating of the drying chambers. The heating circuit of each chamber consists of two (1 kW-Turki) were connected to a thermocouple type (T) to control and measure air temperature. Electric heaters fixed over the surface of an iron net in order to increase the area of air contact with the heating source.

An analogue thermostat was used for temperature control of air passed over the drying trays at drying chamber. Each Details about digital thermostat (AUTONICS – Korean), connected to the electric circuit for stopping and connecting the heater and keeping the pre-adjusted temperature relatively constant throughout each experimental run.

Moisture ratio (MR) was calculated using the following formula [1]:

MR=(Mt-Mf)/(Mo-Mf) ……....................(1)

where:

MR, The moisture ratio, Mt, Moisture content at a specific time, (d. b.). Mf, The Final moisture content, (d. b.). Mo, The initial moisture content, (d. b.).

The drying rate (DR) of sweet potatoes slices was calculated using the following equation:

$$DR = (M_t - M_{t+\Delta t}) / \Delta t, \quad \ldots\ldots (2)$$

where:

$M_{t+\Delta t}$ is moisture content at $t + \Delta t$ (kg water/kg dry matter) and t is time (min), according to [2].

Drying Models for Simulating the Drying Data

The obtained data of the laboratory experiments was employed to examine the applicability of three thin layer drying models (Lewis's, Henderson and Pabis's and Logarithmic equations) on describing and simulating behavior of sweet potato slices satisfactory as indicated from the higher coefficient of determination for the three models.

The drying models that were investigated may be summarized as follows:

1. Lewis's model

Lewis's model [19] was applied to fit the drying data of the sweet potato slices. It based on Newton's law of cooling in heat transfer and is often used to explain the mass transfer in thin layer drying as follows:

$MR=\exp^{(-k_L t)}$ …..(3)

where:
M: Instantaneous moisture content during the drying process, % (d. b). Mf: Final moisture content of sweet potato slices representing the equilibrium moisture content, % (d. b).
Mo: Initial moisture content of sweet potato slices, % (d. b). t: Time, min K_L: Drying constants, min-1

2. Henderson and Pabis's model

Henderson and Pabis's model [15] were applied to fit the drying data of the sweet potato slices. The form of the model could be presented as follows:

$MR = A \exp^{(-k\,t)}$ ….....................................(4)

where:
A: Drying constant, dimensionless. K_L: Drying constant, min -1
The equation was modified to the exponentially form and the constants (k and A) were calculated.

Calculation of drying constants (k_H, A) for Henderson and Pabis's equation

The values of Henderson and Pabis's drying constants (k_H) and (A) can be calculated using the linear relationship between Ln (MR) and drying time (t) as follows:

$\mathrm{Ln}_{MR}= \mathrm{Ln}\,A^{-K_H t}$ …. ....(5)

where:
the slope of the drying curve represents the drying constant (k_H) while the constant (A) could be calculated from the intercept.

Logarithmic model

To simulate and characterize the observed drying curves and analyze the relationship between the drying constants and the investigated drying parameters, a mathematical analysis of the experimental data and a calculation of the drying constants (K_{log}), (A_o), and (c) were performed.

The values of drying constants (K_{log}), (A_o) and (c) for the Logarithmic equation, could be obtained using a developed computer program based on MATLAB.

$MR=A_o \exp^{(-kt)+c}$ ..……….................(6)

where:
A_0 and c: Drying constant, dimensionless.
K: Drying constant, min -1, according to [28]
General comparison was also conducted between the three models based on the statistical analysis between the observed and the calculated values of moisture ratio to assess the most proper model for describing the drying behaviour of sweet potatoes slices. In addition to high value of correlation coefficient (r), various statistical parameters such as; reduced chi-square (x^2), mean bias error (MBE) and root mean square error ($RMSE$) were computed.
The correlation coefficient (R^2), the reduced chi-square (x^2), and the root mean square error were used to assess the quality of fit of the tested mathematical models to the experimental data (RMSE), according to [26]. The better the fit, the higher the R^2 values and the lower the x^2 and RMSE values. The following formulas can be used to determine the reduced chi-square and RMSE:

$$\chi^2 = \frac{\sum_{i=1}^{N}(MR_{obs.,i} - MR_{calc.,i})^2}{N-n} \quad \text{……..... (7)}$$

$$MBE=\frac{1}{N}\sum_{i=1}^{N}(MR_{calc.,i} - MR_{obs.,i}) \quad \text{………… (8)}$$

$$RMSE=\left[\frac{1}{N}\sum_{i=1}^{N}(MR_{calc.,i} - MR_{obs.,i})^2\right]^{1/2} \quad \text{. (9)}$$

where:
MR_{obs}: The observed moisture ratio, dimensionless.
MR_{calc}: The calculated moisture ratio, dimensionless.
N: number of observations.
n: The model's total number of constants.

Determination of shrinkage

This diameter shrinkage and thickness shrinkage can be measured by the Archimedes principle or by a number of displacement techniques; it was calculated by the following equation:

Diameter shrinkage of dried sweet potato slices = $(D_0-D)/D_0$ % …….. ....(10)

Thickness shrinkage of dried sweet potato slices = $(Th_0-Th\ d)/Th_0$ % ……………...(11)

Where Th_d and D are the thickness and diameter of the dried sample, respectively. While $Th_0$and D_0 represent the initial values of the thickness and diameter of the sample before drying, respectively.

Determination of rehydration rate

Generally, it found that the greater the drying, the slower and less complete is the degree of rehydration [20].

[18] showed that dried sweet potato slices were rehydrated in water at 25°C (±1°C). About 5 g of the dried products were added to 200 ml distilled water. Weight of the sample was measured after 180 min. Subsequently, the samples were drained, with absorbent paper to eliminate excess water on its surface, and weighed. The following formula was calculated the rehydration ratio (RR):

RR = Weight after rehydration/Weight before rehydration.

Variables under study were:

- Four radiation intensity (0.861, 0.973, 1.093 and 1. 161kW.m^{-2}).
- Three hot air temperature (45, 55 and 65 ºC), at constant air velocity (1.2 m. s^{-1})

RESULTS AND DISCUSSIONS

Influence of drying parameters on the change of sweet potatoes moisture ratio

Four different levels of infrared radiation intensity including 0.861, 0.973, 1.093 and 1.161 kW. m^{-2} were applied to determine the effect of infrared radiation intensity on the drying kinetics of sweet potatoes. The variation of the moisture ratio versus drying time for the experimental data are shown in Figure 2, 3 and 4.

Changing the radiation intensity from 0.861 to 1. 161kW.m^{-2} and a minimum air temperature of 45°C, the drying time decreased from 165 to 90 min for 1mm slice thickness. While, at 5 mm thickness, the drying time decreased from 630 to 330 min.

However, changing the radiation intensity from 0.861 to 1.161 kW.m^{-2} at the maximum air temperature of 65°C, the drying time decreased from 105 to 60 min for 1mm slice thickness. While, at 5 mm thickness, the drying time decreased from 450 to 240 min.

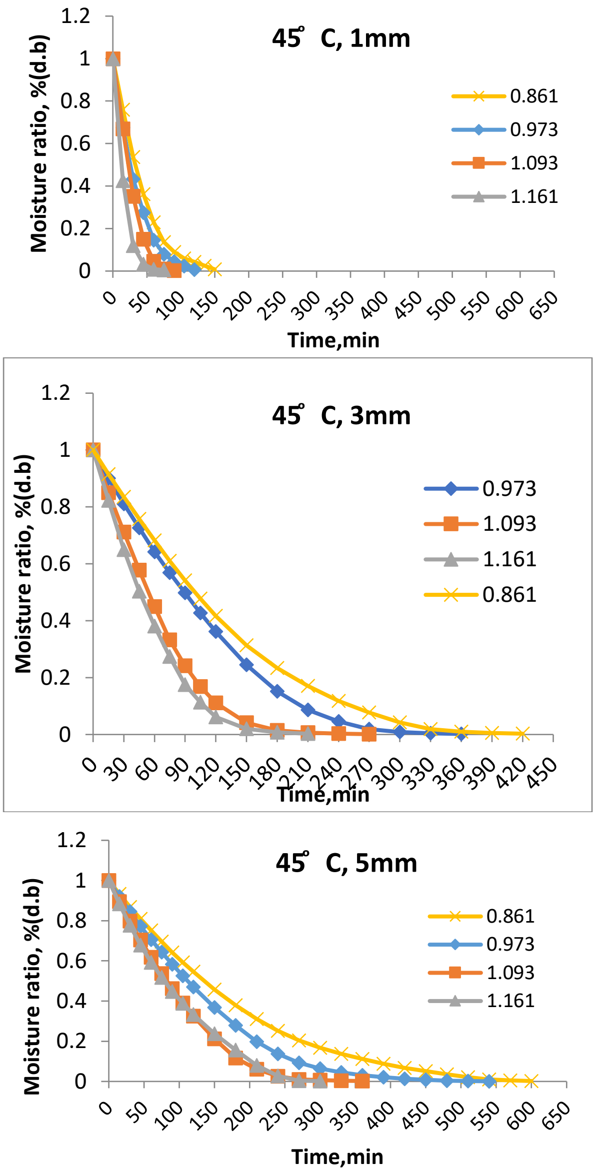


Fig. 2. Sweet potatoes moisture ratio as related to drying time for different levels of radiation intensity and slices thickness (1mm, 3mm, 5mm) at drying air temperature of 45°C.

Source: Authors' determination.

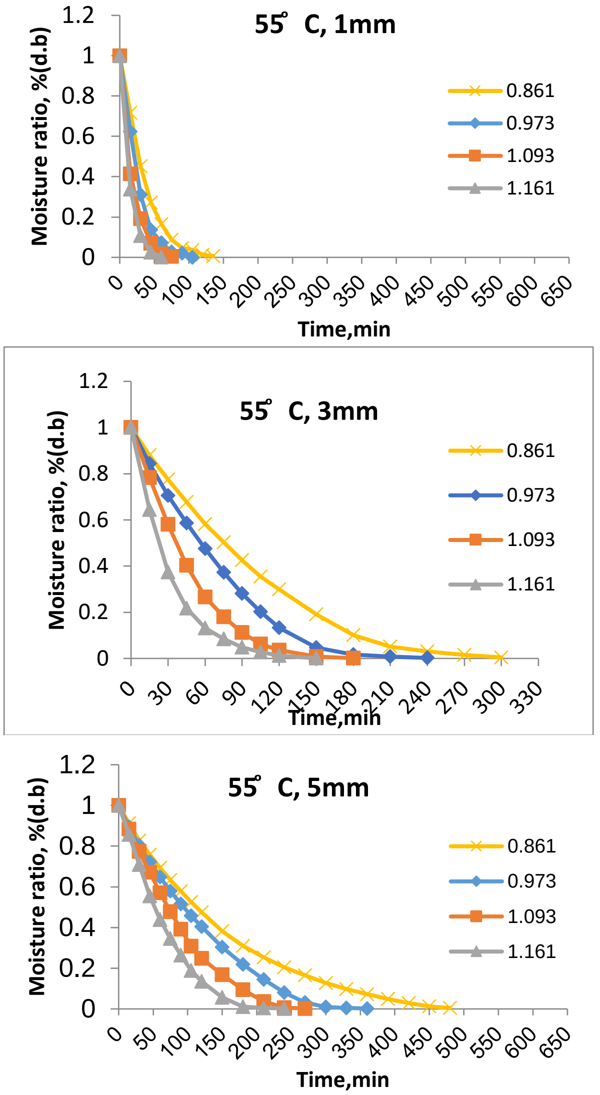
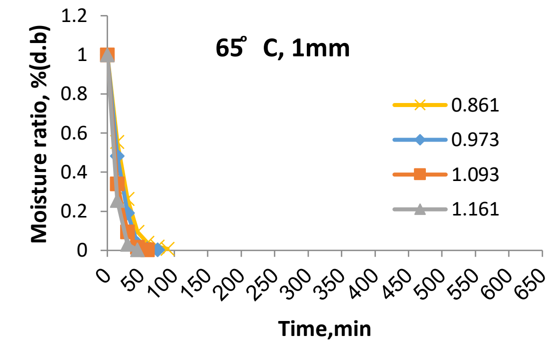
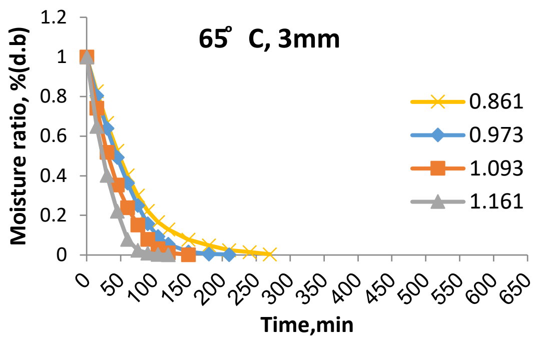


Fig. 3. Sweet potatoes moisture ratio as related to drying time for different levels of radiation intensity and slices thickness (1mm, 3 mm, 5mm)at drying air temperature of 55°C.
Source: Authors' determination.





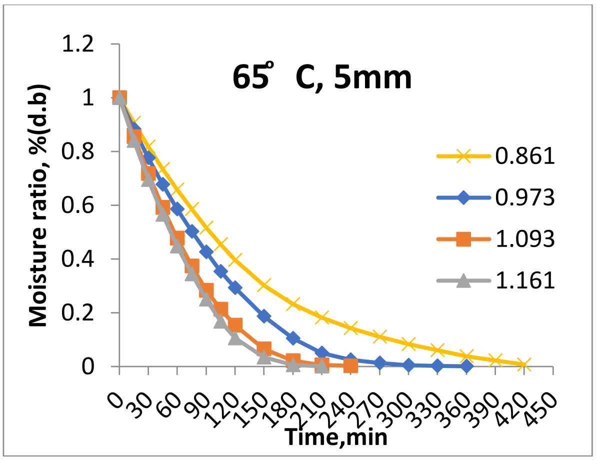


Fig. 4. Sweet potatoes moisture ratio as related to drying time for different levels of radiation intensity and slices thickness (1mm, 3mm, 5mm) at drying air temperature of 65°C
Source: Authors' determination.

Influence of drying parameters on the change in sweet potatoes drying rate

Figures 5, 6 and 7 show the changes in drying rate as a function of moisture content at the same temperatures.

It is clear that the moisture content and drying rate decrease endlessly with drying time.

During the beginning phases of the drying process, the rate of drying was fast, but it became quite slow throughout the drying method.

Comparison between drying data at various conditions revealed that the drying time of slices at higher IR power or less thickness permissible limits must be determined.

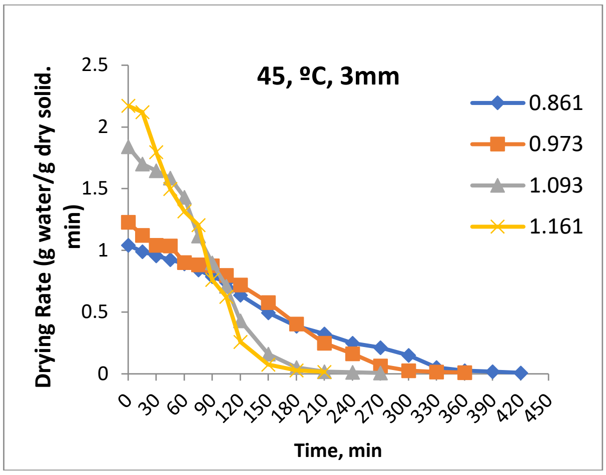


Fig. 5. Drying rate of sweet potato slices as related to drying time for different levels of radiation intensity and slices thickness (3mm) at drying air temperature of 45°C
Source: Authors' determination.

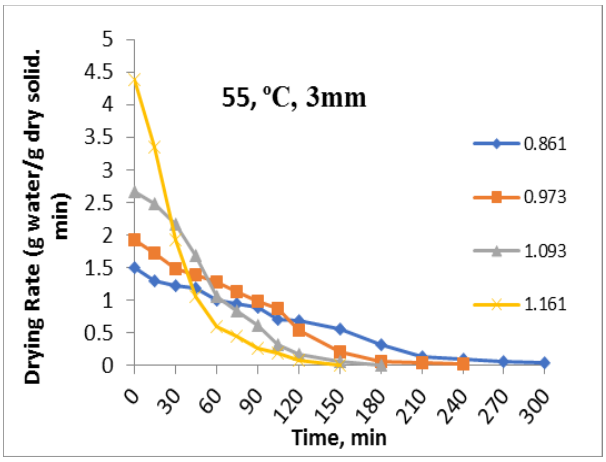


Fig. 6. Drying rate of sweet potato slices as related to drying time for different levels of radiation intensity and slices thickness (3mm) at drying air temperature of 55°C.
Source: Authors' determination.

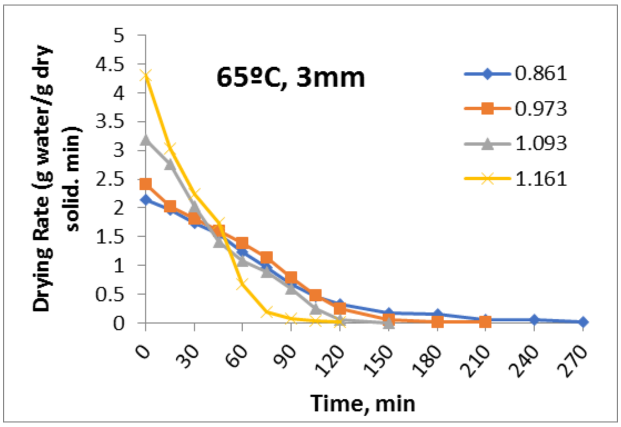


Fig. 7. Drying rate of sweet potato slices as related to drying time for different levels of radiation intensity and slices thickness (3mm) at drying air temperature of 65°C.
Source: Authors' determination.

Analysis Of Thin Layer Drying Of Sweet Potato

Analysis of thin layer drying of sweet potato using Lewis's model

The values of drying constant (k_L) for the Lewis's model could be obtained from the exponential relationship between the moisture ratio (MR) of the tested sample versus drying time (t).

As shown in Table 1, the drying constant (K_L) increased with the increase of drying air temperature and the increase of radiation intensity. However, it was decreased with the increase of slice thickness.

A multiple regression analysis was also performed to correlate the investigated parameters (I, T, and Th) with the drying constant (k_L). The following equation could be used to express the nature of dependence:

$$K_L = 0.100663I + 0.000958\,T - 0.01233\,T_h - 0.08353 \quad (12)$$

and r = 0.898636, R^2 = 0.807547 and S. E= 0.012687.

Table 1. Drying constant (k_L) of Lewis's model at different levels of radiation intensity (I), air temperature (T) and slice thickness (T_h).

Air temp. ºC	Thickness of slices, mm	Radiation intensity, kW.m^{-2}			
		0.861	0.973	1.093	1.161
45	1	0.028	0.036	0.057	0.073
	3	0.011	0.014	0.023	0.025
	5	0.007	0.011	0.015	0.016
55	1	0.033	0.046	0.066	0.088
	3	0.015	0.022	0.031	0.039
	5	0.008	0.013	0.017	0.022
65	1	0.053	0.076	0.091	0.125
	3	0.018	0.026	0.035	0.051
	5	0.009	0.016	0.021	0.025

Source: Authors' determination.

Analysis of sweet potatoes drying using Henderson and Pabis's model:

To simulate and describe the obtained drying curves and to assess the relationship between the drying constants and the studied drying parameters, a mathematical analysis of the experimental data and a calculation of the drying constants (K_H and A) were performed.

The drying constants (K_H) and (A) for Henderson and Pabis's model could be calculated from using the exponential relationship between the moisture ratio (MR) of the tested samples and the drying time (t).

The drying constant (K_H) was found to be dependent on the drying air temperature (T), radiation intensity (I), and the thickness of the slices (T_h). The drying constant (K_H) increased with increasing of drying air temperature and radiation intensity, but it was decreased with increasing slice thickness, as shown in Table 2.

Table 2. Drying constant (K_H) of Henderson and Pabis' model at different levels of radiation intensity (I), air temperature (T) and slice thickness (T_h).

Air temp. °C	Thickness of slices, mm	Radiation intensity, kW.m^{-2}			
		0.861	0.973	1.083	1.161
45	1	0.03	0.04	0.065	0.074
	3	0.013	0.017	0.026	0.029
	5	0.008	0.012	0.018	0.019
55	1	0.036	0.049	0.069	0.094
	3	0.017	0.025	0.036	0.044
	5	0.009	0.016	0.021	0.026
65	1	0.055	0.082	0.096	0.134
	3	0.019	0.03	0.042	0.058
	5	0.01	0.018	0.025	0.032

Source: Authors' determination.

A multiple regression analysis was also proceeded to relate the studied parameters (I, T and T_h) with the drying constant (K_H). The following equation might be used to explain the nature of dependence:

K_H = 0.112347I + 0.001042 T – 0.0127 Th –0.09526 …………... (13)
and r= 0.90576, R^2= 0.820406 and S.E = 0.012838.

Calculation of drying constant (A)

The drying constant (A) was determined for various combinations of drying air temperature, radiation intensity, and slice thickness as indicated in Table 3.

Table 3. Drying constant (A) of Henderson and Pabis' model at different levels of radiation intensity (I), air temperature (T) and slice thickness (T_h).

Air temp. °C	Thickness of slices, mm	Radiation intensity, kW.m^{-2}			
		0.861	0.973	1.083	1.161
45	1	1.273	1.3442	1.739	1.0689
	3	1.6826	1.8897	1.75	1.6946
	5	1.5084	1.6803	1.8199	1.9924
55	1	1.1904	1.22	1.2247	1.3142
	3	1.5851	1.8296	1.8569	1.565
	5	1.3854	1.9108	1.9477	1.8678
65	1	1.1654	1.4139	1.266	1.3496
	3	1.2275	1.6561	1.9397	1.7711
	5	1.253	1.6131	1.8358	2.3164

Source: Authors' determination.

The drying constant (A) was varied from 1.0689 to 2.3029 with an average value of constant (A).

Analysis of thin layer drying of sweet potatoes using Logarithmic model

The values of drying constants (K_{Log}), (A_o) and (c) for the Logarithmic equation could be obtained using the computer program (MATLAB).

The drying constant (K_{Log}) was discovered to be dependent on the drying air temperature

The drying constant (k_{log}) was discovered to be dependent on the drying air temperature (T), radiation intensity (I), and the thickness of the slices (Th). The drying constant (k_{Log}) increased with increasing drying air temperature and radiation intensity, but it was decreased with increasing slice thickness, as shown in Table 4.

A multiple regression analysis was also proceeded to relate the studied parameters (I, T and Th) with the drying constant (kLog). The following equation might be used to explain the nature of dependence:

K_{Log} = 0.06489 I+ 0.000684 T – 0.00995 Th – 0.04969 ……... (14)
and r= 0.8856, R_2= 0.7844 and S. E = 0.010411.

Table 4. Drying constant (k_{Log}) of Logarithmic model at different levels of radiation intensity (I), air temperature (T) and slice thickness (Th)

Air temp. °C	Thickness of slices, mm	Radiation intensity, kW.m^{-2}			
		0.861	0.973	1.093	1.161
45	1	0.0215	0.0265	0.0383	0.0595
	3	0.0073	0.0095	0.0118	0.0153
	5	0.0031	0.0064	0.0069	0.0091
55	1	0.0261	0.0360	0.0560	0.0704
	3	0.0089	0.0124	0.0169	0.0216
	5	0.0059	0.0089	0.0092	0.0121
65	1	0.0417	0.0487	0.0705	0.0875
	3	0.0155	0.0160	0.0267	0.0291
	5	0.0092	0.0111	0.0117	0.0128

Source: Authors' determination.

A comparison study for the three drying models (Lewis's-Henderson and Pabis's and Logarithmic models). Figures (8 to 16) also show the measured and predicted moisture content values at a 45-degree chart for the minimum and maximum levels of drying air temperature, radiation intensity, and slices thickness.

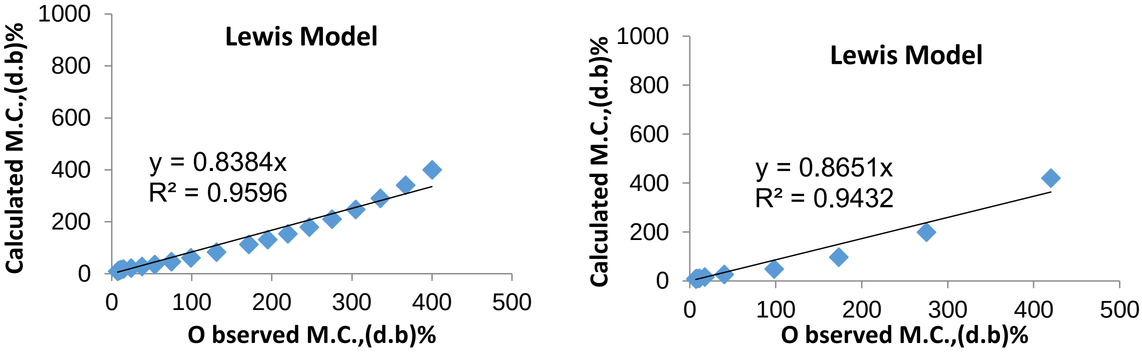


Fig. 9. Observed and calculated values of sweet potatoes slices moisture content using Lewis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 3 mm slices thickness
Source: Authors' determination.

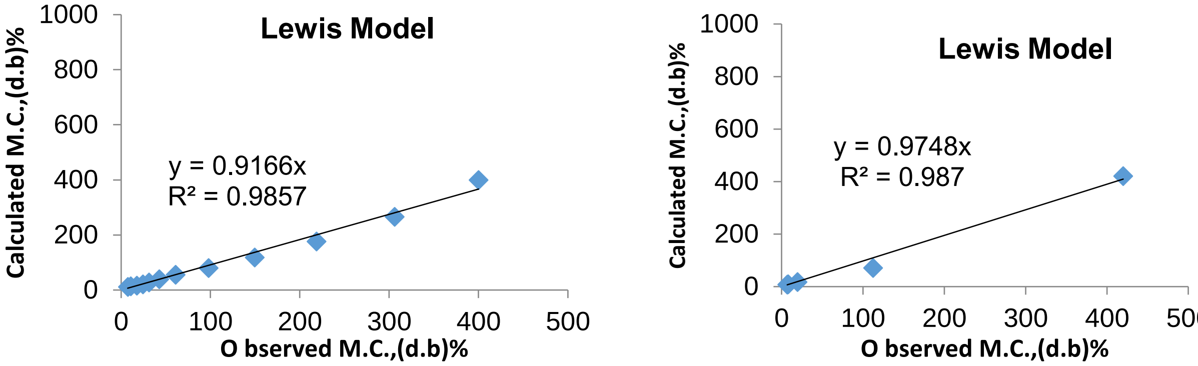


Fig. 9. Observed and calculated values of sweet potatoes slices moisture content using Lewis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 3 mm slices thickness
Source: Authors' determination.

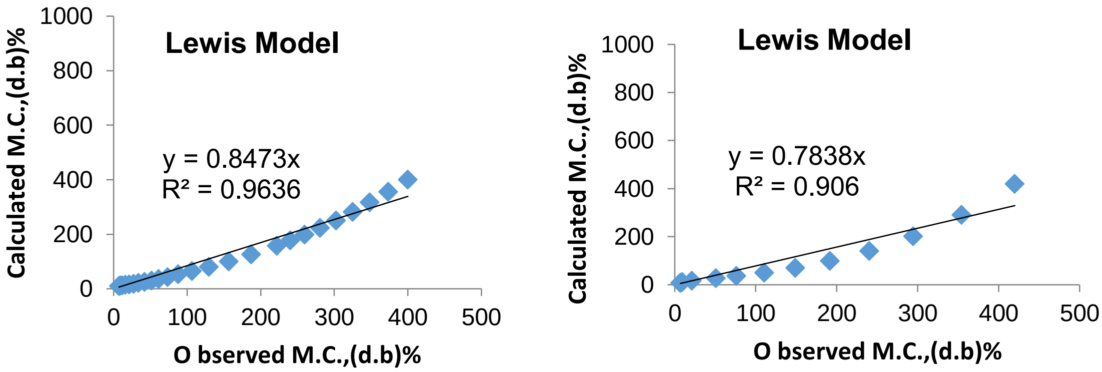


Fig. 10. Observed and calculated values of sweet potatoes slices moisture content using Lewis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 5 mm slices thickness
Source: Authors' determination.

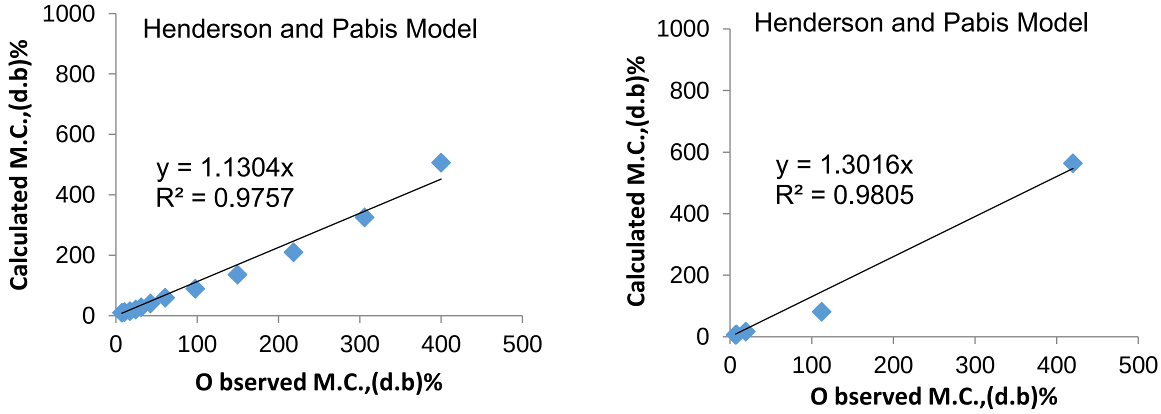


Fig. 11. Observed and calculated values of sweet potatoes slices moisture content using Henderson and Pabis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 1 mm slices thickness
Source: Authors' determination.

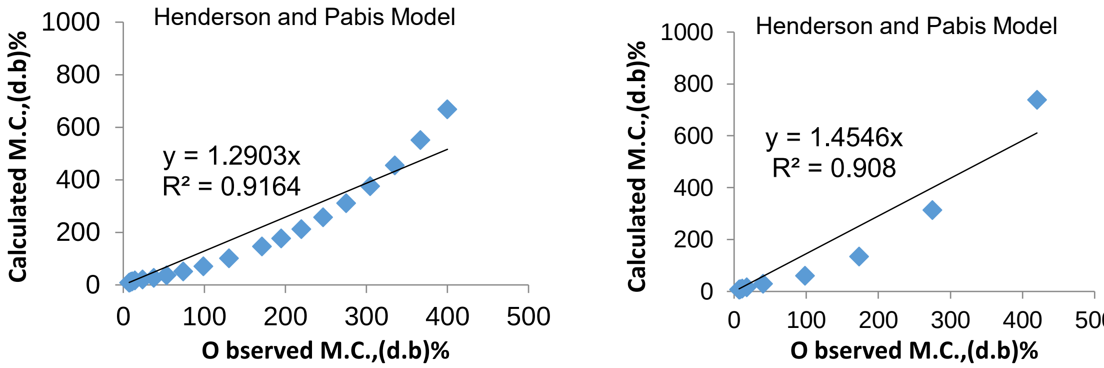


Fig. 12. Observed and calculated values of sweet potatoes slices moisture content using Henderson and Pabis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 3 mm slices thickness
Source: Authors' determination.

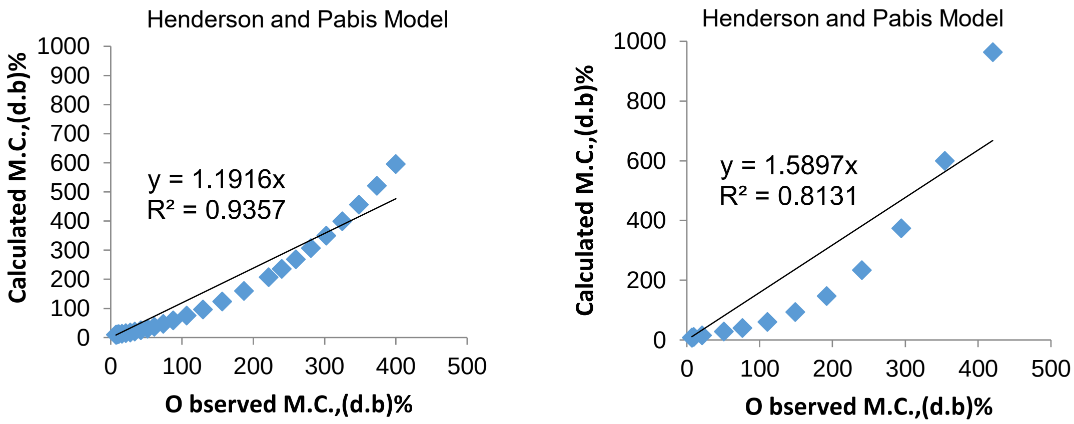


Fig. 13. Observed and calculated values of sweet potatoes slices moisture content using Henderson and Pabis's model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 ºC and 1.161 kW/m^{-2} at 5 mm slices thickness
Source: Authors' determination.

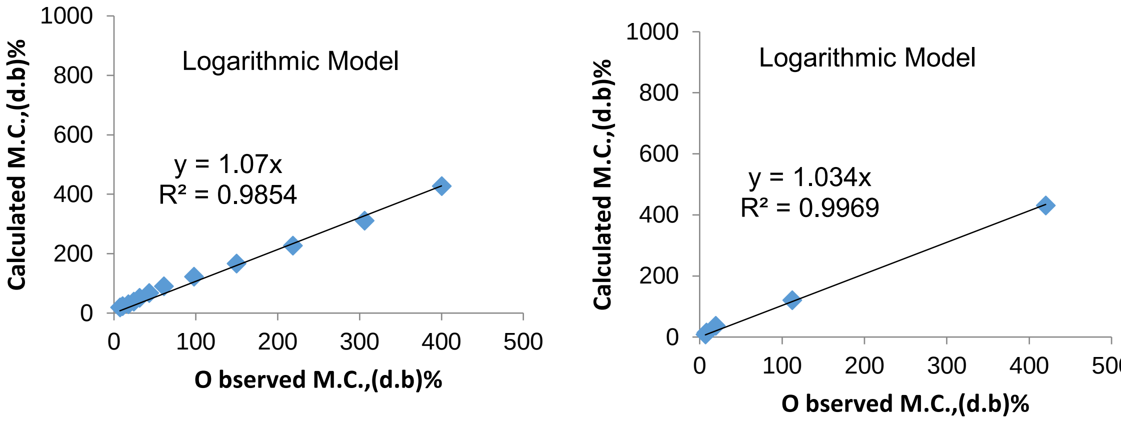


Fig. 14. Observed and calculated values of sweet potatoes slices moisture content using Logarithmic model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 oC and 1.161 kW/m^{-2} at1 mm slices thickness
Source: Authors' determination.

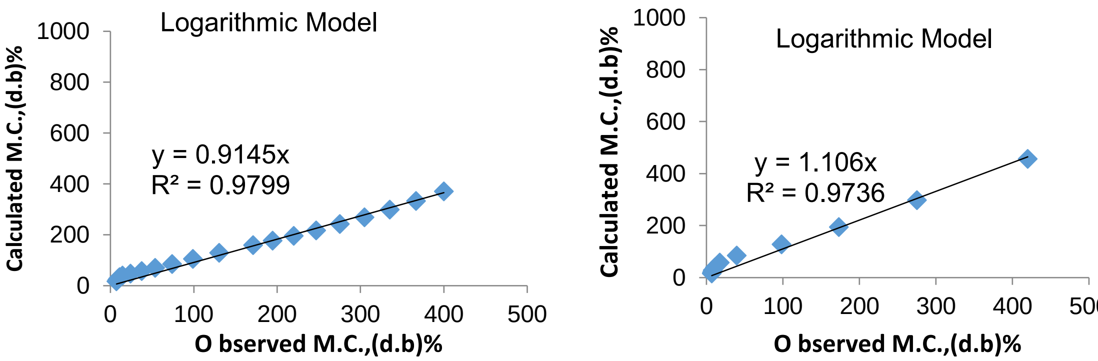


Fig. 15. Observed and calculated values of sweet potatoes slices moisture content using Logarithmic model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 oC and 1.161 kW/m^{-2} at 3 mm slices thickness
Source: Authors' determination.

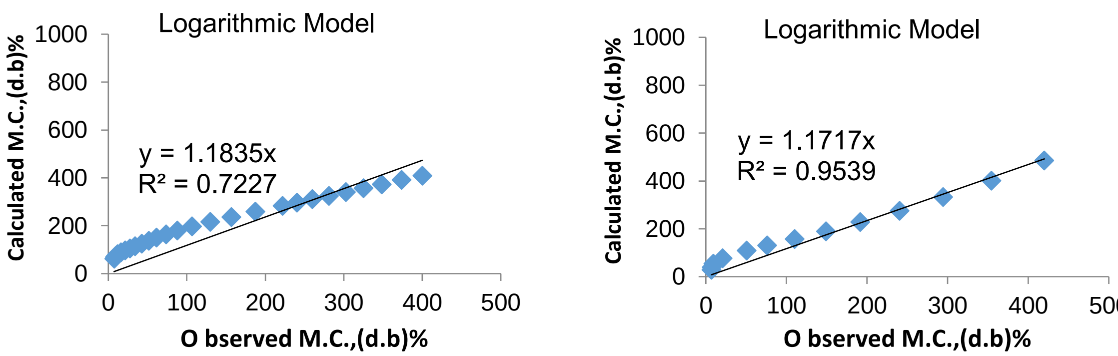


Fig. 16. Observed and calculated values of sweet potatoes slices moisture content using Logarithmic model at (T) 45°C, (I) 0.861 kW.m^{-2} and 65 oC and 1.161 kW/m^{-2} at 5 mm slices thickness
Source: Authors' determination.

Comparative Evaluation Of The Studied Drying Models For Predicting The Changes Of Moisture Content Of Sweet Potatoes Slices

A comparison study for the three drying models (Lewis's, Henderson and Pabis's and Logarithmic models) was conducted to assess the most appropriate drying model for simulating and describing the drying behavior of sweet potatoes under the studied range of experimental parameters.

Table 5 presents the overall average of the obtained coefficient of determination (R^2) and the standard error (SE) for the observed and the calculated moisture ratio of the studied model.

Table 5. The overall average of the obtained ($\boldsymbol{R^2}$) and (SE) for three studied drying models

The model	Coefficient of determination (R^2)	Standard error, (SE)
Lewis	0.96383	0.24079
Henderson and Pabis	0.94090	0.50930
Logarithmic	0.99448	0.12193

Source: Authors' determination.

The computed values of chi-square ($x2$), mean bias error (MBE), root mean square error ($RMSE$) and correlation coefficient (r) are listed in Table 6 for the three models. The best model describing the thin-layer drying characteristics of sweet potatoes slices was chosen as the one with the highest $R2$ values and the lowest $\chi2$ and RMSE values. Statistical results from models are summarised in Table 6. The results from Table 6, the statistical parameter estimations showed that $\chi2$, and RMSE values were ranged from 0.00004 to 0.06767, and 0.00607 to 0.25131, respectively.

Table 6. Values of coefficient of correlation (r), chi-square ($\boldsymbol{x2}$), mean bias error ($\boldsymbol{MBE}$) and root mean square error ($\boldsymbol{RMSE}$) at three models

IR	Ta °C	Th, mm	Lewis model				Henderson and Pabis model				Logarithmic model			
			r	X^2	MBE	RMSE	r	X^2	MBE	RMSE	r	X2	MBE	RMSE
0.861	45	1	0.99315	0.00323	-0.03729	0.05438	0.98976	0.00494	-0.04773	0.06729	0.99821	0.00323	-0.03729	0.05438
		3	0.98165	0.00950	-0.05851	0.09501	0.96600	0.01228	-0.07877	0.13919	0.99813	0.00055	-0.01195	0.02354
		5	0.98545	0.01006	-0.07857	0.09833	0.97652	0.01578	-0.09853	0.12318	0.99211	0.00701	0.07081	0.08209
	55	1	0.99574	0.00180	-0.02574	0.04040	0.99362	0.00280	-0.03397	0.05047	0.99859	0.00049	0.00996	0.02111
		3	0.97652	0.01365	-0.08653	0.11312	0.96370	0.02119	-0.10924	0.14094	0.99830	0.00077	0.00864	0.02695
		5	0.99370	0.00440	-0.05360	0.06481	0.98787	0.00846	-0.07452	0.08989	0.99987	0.00004	-0.00138	0.00607
	65	1	0.99430	0.00210	-0.02239	0.04283	0.99277	0.00275	-0.02716	0.04905	0.99842	0.00062	0.01092	0.02326
		3	0.99643	0.01964	0.11308	0.13538	0.99449	0.01393	0.09446	0.11402	0.99874	0.06767	0.21519	0.25131
		5	0.99662	0.00083	-0.02312	0.02807	0.99267	0.00286	-0.04407	0.05213	0.99599	0.01682	0.10847	0.12642
0.973	45	1	0.99296	0.00313	-0.03599	0.05307	0.98701	0.00593	-0.05107	0.07304	0.99923	0.00886	-0.03724	0.08932
		3	0.96818	0.01668	-0.08169	0.12550	0.94356	0.00976	-0.04849	0.09602	0.99376	0.00292	-0.00071	0.05250
		5	0.97464	0.01432	-0.08344	0.11715	0.96569	0.01910	-0.09742	0.13528	0.99748	0.00120	0.01018	0.03388
	55	1	0.99408	0.00146	0.02424	0.03608	0.99127	0.00089	0.01584	0.02811	0.99804	0.00662	0.05930	0.07671
		3	0.96812	0.01633	-0.08945	0.12313	0.95261	0.02433	-0.11100	0.15032	0.99667	0.00149	0.01505	0.03718
		5	0.96879	0.01693	-0.09384	0.12665	0.94285	0.03103	-0.12943	0.17145	0.99421	0.00239	-0.02464	0.04762
	65	1	0.98483	0.00473	-0.01589	0.06366	0.97963	0.00800	-0.04439	0.08282	0.99803	0.00110	0.01894	0.03067
		3	0.97722	0.01045	-0.06660	0.09823	0.96224	0.01759	-0.08954	0.12742	0.99617	0.00179	0.02090	0.04061
		5	0.97169	0.00281	0.03879	0.05156	0.95792	0.00134	0.01829	0.03558	0.99720	0.03660	0.16033	0.18592
1.093	45	1	0.96709	0.01386	-0.06396	0.11012	0.95255	0.02019	-0.07950	0.13291	0.99479	0.00277	0.02730	0.04926
		3	0.97041	0.01434	-0.07910	0.11569	0.95570	0.02123	-0.09833	0.14076	0.99286	0.00401	0.04189	0.06114
		5	0.96924	0.01670	-0.09008	0.12561	0.94627	0.02876	-0.11996	0.16476	0.99632	0.00157	0.00061	0.03847
	55	1	0.99110	0.01174	0.07648	0.10033	0.98869	0.00959	0.06880	0.09068	0.99747	0.02255	0.10739	0.13902
		3	0.96996	0.00969	-0.06535	0.09423	0.96415	0.01673	-0.08781	0.12383	0.99529	0.00327	0.04169	0.05472
		5	0.96996	0.01535	-0.08503	0.11971	0.94359	0.03149	-0.13102	0.17145	0.99819	0.00606	0.05775	0.07521
	65	1	0.99609	0.00167	-0.01971	0.03736	0.99433	0.00250	-0.02484	0.04560	0.99975	0.00018	0.00851	0.01233
		3	0.97890	0.00958	-0.06485	0.09333	0.96005	0.01817	-0.09104	0.12851	0.99524	0.00177	-0.02004	0.04017
		5	0.97213	0.01011	0.08087	0.09690	0.95140	0.00650	0.06328	0.07767	0.99725	0.04479	0.17531	0.20393
1.161	45	1	0.99577	0.00143	-0.01416	0.03500	0.99536	0.00159	-0.01565	0.03696	0.99853	0.00058	0.01037	0.02233
		3	0.97747	0.01090	-0.06955	0.10031	0.96195	0.01860	-0.09386	0.13102	0.99644	0.00171	0.01933	0.03974
		5	0.96423	0.02093	-0.11120	0.14007	0.94233	0.03363	-0.14160	0.17755	0.99873	0.00164	0.03482	0.03921
	55	1	0.99705	0.00096	-0.00474	0.02821	0.99506	0.00177	-0.01482	0.03845	0.99995	0.01113	-0.03817	0.09633
		3	0.99609	0.00167	-0.02707	0.03895	0.99032	0.00410	-0.04341	0.06130	0.99948	0.00016	0.00516	0.01204
		5	0.97332	0.01420	-0.08378	0.11485	0.95377	0.02432	-0.11165	0.15028	0.99727	0.00138	0.01486	0.03578
	65	1	0.99454	0.00263	-0.02185	0.04586	0.99248	0.00373	-0.02695	0.05462	0.99948	0.00040	0.01177	0.01795
		3	0.97401	0.00943	-0.05320	0.09211	0.96052	0.01332	-0.05948	0.10948	0.99685	0.00424	0.05071	0.06178
		5	0.95961	0.01251	0.09024	0.10747	0.92390	0.00869	0.07388	0.08954	0.99673	0.04553	0.17634	0.20501
Average			**0.98142**	**0.00916**	**-0.03563**	**0.08510**	**0.96979**	**0.01300**	**-0.05252**	**0.10143**	**0.99722**	**0.00872**	**0.03670**	**0.06705**

Source: Authors' determination.

Quality of the dried sweet potatoes:

Effect of air-drying temperature and infrared radiation on the sweet potato slices shrinkage shows. In that, with increase of air-drying temperature the diameter and thickness shrinkage percentage were decreased and with increase of infrared radiation, the diameter shrinkage percentage was increased, as shown in Figures 17 and 18.

The rehydration ratio increased with increasing of drying air temperature and radiation intensity, while rehydration ratio decreased with increase of slice thickness as shown in Table 7.

Table 7. Effects of drying temperature, infrared and thickness on rehydration ratio of dried sweet potatoes

Radiation intensity, kW.m^{-2}	Slices thickness, mm	Air drying temperature, °C		
		45	55	65
0.861	1	2.86	3.35	3.43
	3	2.60	2.87	3.04
	5	2.46	2.64	2.90
0.973	1	3.75	3.81	3.84
	3	3.25	3.28	3.24
	5	2.72	2.73	2.64
1.093	1	3.74	4.00	4.05
	3	3.26	3.28	3.35
	5	2.55	2.95	3.00
1.161	1	3.95	4.15	4.16
	3	3.03	3.29	3.48
	5	2.60	2.73	3.13

Source: Own calculation.

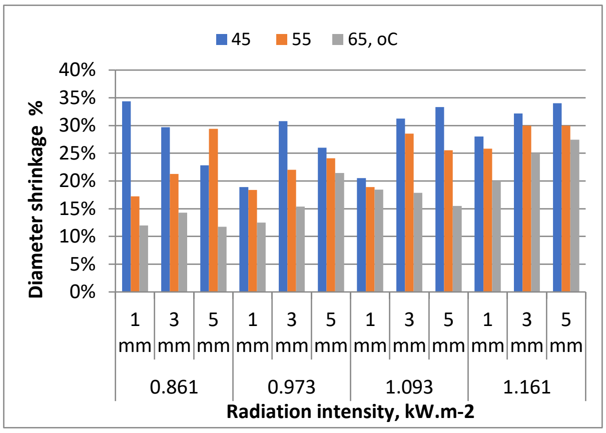


Fig. 17. Effect of air-drying temperature and infrared radiation on the diameter shrinkage percentage of sweet potato slices.
Source: Authors' determination.

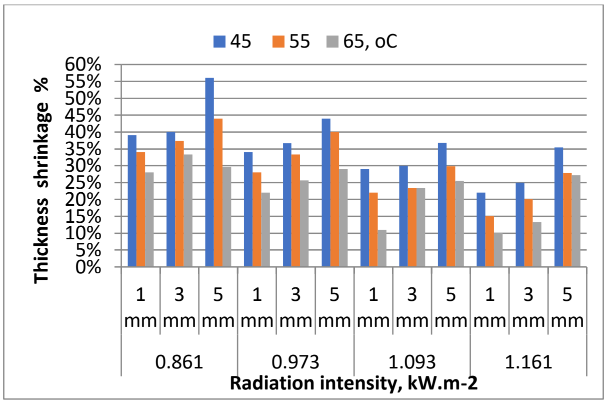


Fig. 18. Effect of air-drying temperature and infrared radiation on the thickness shrinkage percentage of sweet potato slices.
Source: Authors' determination.

The highest rehydration ratio of 4.16 were obtained at drying air temperature of 65°C, and the minimum rehydration ratio of 2.46 was obtained for 45°C.

CONCLUSIONS

The intensity of infrared radiation and drying air temperature had a significant effect on the moisture ratio of sweet potato slices. The moisture ratio of sample slices decreased when the radiation intensity and the drying air temperature increased. The drying constant (k_L), (k_H) and (k_{Log}) increased with the increase of the drying air temperature and radiation intensity. However, it was decreased with the increase of slices thickness An exponential relationship was found between the drying constant (k_L), (k_H) and (k_{Log}) and the radiation intensity at all levels of air temperature and slice thickness. The drying constant (A) showed no direct relation with the experimental variable, while all the drying process occurred during the falling rate-drying period. Models (Lewis's model, Henderson and Pabis's model and Logarithmic model) could describe the drying behavior of sweet potato slices satisfactory.

Logarithmic model could be considered more proper model for describing the drying behavior of sweet potato slices and predicting the change in moisture content during the laboratory drying process due to simplicity of calculations.

- The final moisture content of the dried sweet potato slices under the studied conditions almost reached the recommended range of the dried sweet potato 4-8% (d. b).
- The rehydration ratio ranged from 3.95 to 5.53 for the sweet potato slices.
- The diameter shrinkage percentage of sweet potato slices ranged from 12% to 34%, while the thickness shrinkage percentage of slices ranged from 10% to 56%.

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THE EVOLUTION OF MAIZE CULTIVATED AREA AND PRODUCTION IN ROMANIA (2011-2021)

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Abstract

Using empirical data provided by the National Institute of Statistics for the years 2011 through 2021, the paper's objective was to study the dynamics and distribution of maize cultivation area and production in Romania and its development regions. With 2.5 million ha of maize cultivation, Romania ranked first among the EU-27 in 2021. It is the second-largest producer of maize after France. Compared to 2011, the area planted with maize decreased by 1.6% in 2021. In the studied period, Romania's production climbed by 26.5%, and in 2021, the developing regions contributed as follows: 20.6% of South Muntenia, 17.7% of the South, 17.1% of the East, 14.5% of the North, 12.0% of the West, 11.9% of the North, 6.8% of the Central area, and 0.013% of Bucharest-Ilfov make up Romania. The yield of maize in 2021 was 5082 kg/ha, which was 22% more than in 2011.

Key words*: *cultivated area, maize, production, Romania

INTRODUCTION

Maize is a widely consumed and versatile crop. It is a rich source of carbohydrates and fibre, with moderate content of total protein and some micronutrients. Genetics, growing conditions, processing procedures, and preparation and storage environments influence nutrient amounts and bioavailability. It contains about 72% starch, 10% protein and 4% fat, providing an energy value of 365 Kcal/100 grams, comparable to rice and wheat, but has a lower protein content [6].

The maize grain is mainly composed of fibre, ranging from 61 to 86%, depending on the variety. Approximately 99% of the fibre is found in the endosperm and consists of starch (about 73% of the total weight). It also contains polysaccharides such as cellulose, hemicellulose and lignin to a lesser extent [1].

Maize is the most geographically widespread crop and the third largest crop in the world occupying 13% of the world's cultivated land [9] and reaches its highest cropping intensity in the U.S. maize belt, but it is also a major commodity in northeastern China (Manchuria), along the Rift Valley in Africa, and in eastern Europe [4].

Maize can be grown on very different soils and under very different climatic conditions, is not demanding on the pre-seedling plant and tolerates monoculture better than other cereals. Maize has a high multiplication rate, which is why it requires a small amount of seed per hectare, and its cultivation is highly mechanizable, from sowing to harvesting [12, 11].

Romania, along with France, is consistently among the two largest producers of corn in the European Union (EU) [8, 10].

However, with limited irrigation and frequently hot and dry summer, Romania's corn harvest fluctuates significantly.

Recently, the national production reached a record level of 14.3mn tonnes in 2019/20, in almost ideal weather conditions, but this was followed by a minimum of the last few years of 10.8 million tonnes in 2020/21 [3].

MATERIALS AND METHODS

The study consisted of the research, analysisand interpretation of the statistical data provided by the National Institute of Statistics
in Romania for the period 2011-2021.
The following indicators have been used and analyzed: total cultivated area, cereal cultivated area, maize cultivated area, distribution of maize cultivated area in the territory by macroregions (Macroregion 1, Macroregion 2, Macroregion 3, Macroregion 4) and microregions (North-West, Centre, NorthEast, South-east, South Muntenia, Bucharesti for, South-West Oltenia and West).
At the national level and in macro and microregions, production was examined using yield and total production.
The methodology consisted of descriptive analysis of data and comparative analysis, the results being presented in tabular and graphical form.

RESULTS AND DISCUSSIONS

The maize cultivated area: Romania ranked top among EU nations in terms of cultivated area in 2021, according to statistics from the National Institute of Statistics and Eurostat.

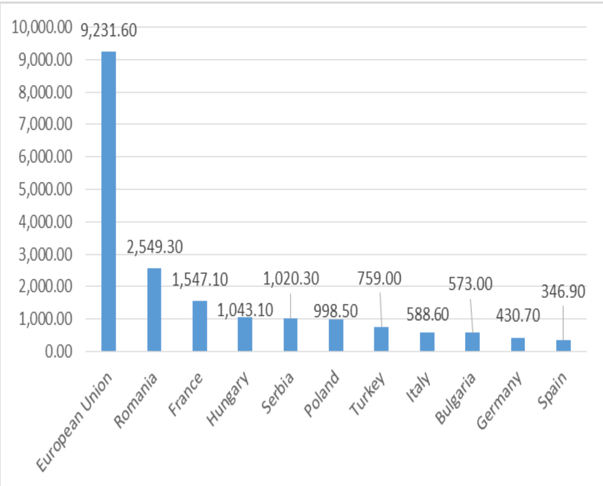

Fig. 1. The top 10 producers of maize in the EU, in 2021, after cultivated area (thousand hectares)
Source: statistical data processing EUROSTAT, Accessed on 19.07.2022 [2].

Cereals occupied 64.75 percent of Romania's total cultivated land in 2021, which was 8,263.8 thousand hectares. About 30.8% of the total cultivated land and 47.6% of the cereal-cultivated area is made up of maize. (Table 1).
The area used for maize cultivation changed between 2011 and 2021. A reduction in the area used for maize cultivation to 2,402.1 thousand hectares in 2017 was followed by a rise such that in 2021 the area used for maize cultivation rose to 2,549.3 thousand hectares from 2,730.2 thousand hectares (Figure 2).

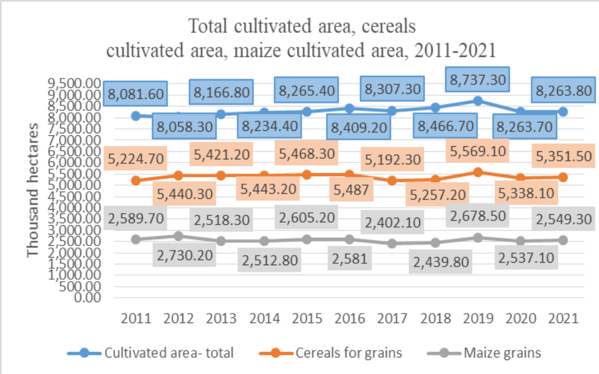

Fig. 2. Dynamics of Romania's total cultivated area, cereals cultivated area and maize cultivated area, 2011-2021 (ha)
Source: statistical data processing National Institute of Statistics, Accessed 24.07.2022 [7].

The most important macroregions producing maize grains:
In terms of development macroregions it is found that Macroregion 2 owns the first place for maize acreages.
On average, during the 10 years analysed, Macroregion 2 occupied 37.3% of the total area under maize cultivation.
The largest area cultivated with maize was recorded in 2021 (1,042.15 thousand hectares). At the opposite pole, the lowest maize acreage was Macroregion 1 (Table 2).
Regarding the total area under maize cultivation, in the period 2011-2021, the largest areas of 2,730.16 thousand hectares and 2,678.84 thousand hectares were recorded in 2012 and 2019 respectively.
At the level of Macroregion 1, the largest area under maize, 451.61 thousand hectares, was recorded in 2021 and the smallest area, 384.45 thousand hectares, was recorded in 2011.

Macroregion 2 recorded the highest area under maize cultivation of 1,042.15 thousand hectares in 2021 and the lowest area of 876.57 thousand hectares in 2017 (Table 2).

Table 2. Distribution of maize cultivated area by Romania's macroregion, thousand hectare

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average 2011-2021
TOTAL MAIZE CULTIVATED AREA	2,589.67	2,730.16	2,518.27	2,512.81	2,605.17	2,580.98	2,402.08	2,439.84	2,678.50	2,537.10	2,549.28	2,558.53
M 1	384.45	397.56	406.35	418.70	437.61	438.27	416.76	426.64	427.72	431.75	451.61	421.58
% of the area that is cultivated for maize	14.8	14.6	16.1	16.7	16.8	17.0	17.3	17.5	16.0	17.0	17.7	16.5
M 2	979.72	994.70	934.71	924.96	947.48	954.99	876.57	907.03	966.73	956.95	1042.15	953.27
% of the area that is cultivated for maize	37.8	36.4	37.1	36.8	36.4	37.0	36.5	37.2	36.1	37.7	40.9	37.3
M 3	488.54	551.45	495.02	472.35	510.98	482.00	465.18	474.60	546.44	559.88	528.99	506.86
% of the area that is cultivated for maize	18.9	20.2	19.7	18.8	19.6	18.7	19.4	19.5	20.4	22.1	20.8	19.8
M 4	736.97	786.45	682.19	696.81	709.10	705.72	643.57	631.58	737.62	588.51	526.53	676.82
% of the area that is cultivated for maize	28.5	28.8	27.1	27.7	27.2	27.3	26.8	25.9	27.5	23.2	20.7	26.4

Source: statistical data processing National Institute of Statistics, Accessed on 24.07.2022 [7].

Macroregion 3 recorded the highest area under maize cultivation of 559.88 thousand hectares in 2020 and the lowest area of 465.18 thousand hectares in 2017. Macroregion 4 recorded the highest area under maize cultivation of 737.62 thousand hectares in 2019 and the lowest area of 526.53 thousand hectares in 2021 (Table 2).

All microregions of development offer ideal circumstances for maize growth. The South-Muntenia Region grows maize on an average of 19.4% of the country's land from 2011 to 2021, followed by the South East Region at 19%, the North East Region at 18.3%, the South West Oltenia Region at 13.5%, the West Region at 12.9%, the North West Region at 10.3%, the Center Region at 6.2%, and Bucharest-Ilfov Region at 0.4%. (Figure 3).

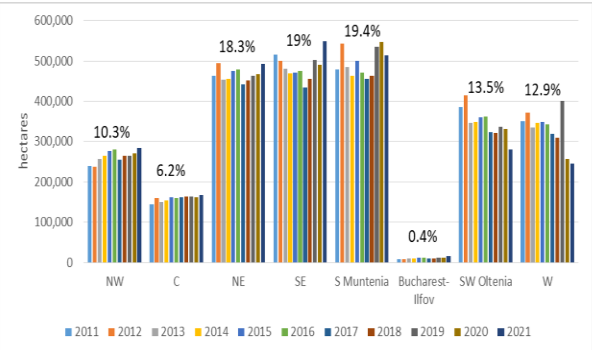

Fig. 3. Average share of maize cultivated area by development region of Romania, 2011-2021.
Source: statistical data processing National Institute of Statistics, Accessed on 24.07.2022 [7].

Compared to 2011, the area planted with maize decreased by 1.6% in 2021. The area farmed with maize increased in each of the macro-regions of development, compared to 2011, by the following percentages: 17.5% in Macro-region 1, 6.4% in Macro-region 2, and 8.3% in Macro-region 3. In Macro-region 4, the area planted with maize decreased significantly by 28.6%.

The Bucharest-Ilfov region, where maize cultivation increased by 78.9%, and the South West Oltenia region, where it decreased by 27.5% and the West region, where it decreased by 29.7%, showed the most obvious variations in the level of development of micro-regions compared to 2011 (Table 3).

Table 3. Evolution of the area under maize in 2021 compared to 2011

Macro/micro-region	Maize cultivated area (thousands ha)	Maize cultivated area (thousands ha)	Maize cultivated area (thousands ha)
	2011	2021	2021/2011 %
TOTAL	2,589.7	2,549.3	98.4
Macroregion 1	384.4	451.6	117.5
NW	239.7	284.7	118.8
C	144.8	166.9	115.3
Macroregion 2	979.7	1042.2	106.4
NE	463.9	492.4	106.1
SE	515.8	549.8	106.6
Macroregion 3	488.5	529	108.3
S Muntenia	479.9	513.5	107.0
Bucharest-Ilfov	8.7	15.5	178.9
Macroregion 4	737	526.5	71.4
SW Oltenia	386.5	280.2	72.5
W	350.5	246.3	70.3

Source: statistical data processing National Institute of Statistics, Accessed on 24.07.2022 [7].

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The area cultivated with maize is expected to decrease in the next five years, by almost 5%, a forecast because during the analyzed period 2014-2019 it showed a downward trend [11].

The maize production increased in the analyzed period (2011-2021) by 26.5 % from 11,717.16 thousand tons in 2011 to 14,820.7 thousand tons in 2021. Analyzing Table 4, the year 2012 recorded the lowest maize production (5,953.4 thousand tons), while in the year 2018 Romania registered the highest maize production (18,663.9 thousand tons). The variations were determined by the changes in cultivated surface and average production per surface unit, which in turn depended on the soil type, technologies applied, and weather conditions.

Table 4. The proportion of maize output in the production of cereals, Romania, 2011-2021 (%)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2021/2011 %
Cereals production (Thousand tons)	20,842.2	12,824.1	20,897.1	22,070.7	19,332.8	21,764.8	27,138.9	31,553.3	30,412.4	18,153.7	27,791.3	133.3
Maize production	11,717.6	5,953.4	11,305.1	11,988.6	9,021.4	10,746.4	14,326.1	18,663.9	17,432.2	10,096.7	14,820.7	126.5
Share of maize prod (%)	56.2	46.4	54.1	54.3	46.7	49.4	52.8	59.2	57.3	55.6	53.3	Average 2011-2021 53.8%

Source: statistical data processing National Institute of Statistics, Accessed on 30.07.2022 [7].

The share of maize production in cereal production decreased by 2.9 % from 56.2% in 2011 to 53.3 % in 2021. In this case, too there were variations, from 46.4% in 2012 to 59.2% in 2018, but on average, the share of maize in cereal production between 2011 and 2021 was 53.8%. At the EU-27 level, in terms of maize production, France together with Romania ranked first among the top ten maize producers, with similar productions of 15,285.7 thousand tonnes and 15,186.1 thousand tonnes respectively (Figure 4).

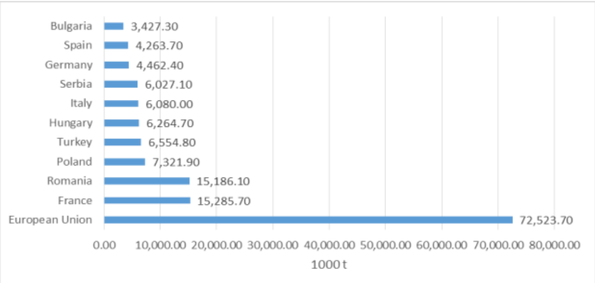

Fig. 4. Position of Romania in the EU-27 in terms of tons of maize produced in 2021

Source: statistical data processing EUROSTAT, Accessed 19.07.2022 [2].

With a total production of 4,372.6 thousand tonnes from the years 2011 to 2021, macroregion 2 produced the most maize. The production minimum was attained in 2012 (1,814 thousand tonnes), and the production peak was reached in 2018 (6,856.5 thousand tonnes). Also, Macroregion 4 recorded a significant average production of 3,520.2 thousand tonnes from 2011-2021. Macroregion 1, had a smaller contribution to the total maize production, averaging 2,159.7 thousand tonnes.

In 2021, an increase in maize production compared to 2011 of 59% is observed for Macroregion 1, 45% for Macroregion 2 and 30.9% for Macroregion 3. At the opposite pole, Macroregion 4 registers a decrease in production compared to 2011 by 21.9%.

Regarding the production realized by micro-regions, it is found that South Muntenia obtained the highest production of maize during 2011-2021, 2,532.8 thousand tons. It got a maximum of production in 2018 (3,674.4 thousand tons).

Table 5. Share in maize production by development region, 2011 vs 2021 (%)

TOTAL	2011	2021	Average 2011-2021	2021/2011 %
M1	14.8	18.6	17.7	125.7
NW	9.1	11.7	10.9	129.1
C	5.8	6.9	6.8	120.4
M2	37.7	43.4	34.8	115.1
NE	16.8	19.1	17.1	113.8
SE	20.9	24.3	17.7	116.2
M3	20.7	21.4	21.1	103.5
S Muntenia	20.3	20.8	20.6	102.3
Bucharest Ilfov	0.012	0.013	0.013	106.9
M4	26.8	16.5	26.5	61.8
SW Oltenia	13.4	7.5	12.0	56.2
W	13.4	9.0	14.5	67.3

Source: statistical data processing National Institute of Statistics, Accessed on 30.07.2022 [7].

In this region, in 2018, it was achieved 19.6 % of the total production of maize in Romania. The lowest production was achieved in 2012 (1,388.7 thousand tons).

Another micro-region that contributes significantly to the total maize production is the South East micro-region. Here, 2,254.1 thousand tons were obtained on average in the period 2011-2021, and the year with the highest production recorded was 2018, with 3,648.5 thousand tons. Low production in this micro-region was recorded in 2012 and 2020, years are known to be very dry (Table 6).

Macroregions 1, 2, and 3 saw increases in their proportions of the overall output of maize when compared to 2011 in the following ways: Macroregion 1 (+25.7%), Macroregion 2 (+15.1%), and Macroregion 3 (+3.5%). There was a decline in Macroregion 4's contribution to global maize output (-38.2%). At the level of microregions, the North West region recorded an increase compared to 2011 by 29.1% and the Centre region by 20.4%. The South West Oltenia region, which experienced a reduction of 43.8%, was at the other pole. In 2021 Macroregion 2 held 43.4% of the total maize production and at the micro-region level the South Muntenia region stood out with 20.8% (Table 5).

Table 6. Romania's maize production by development region, thousand tons, 2011-2021

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average 2011-2021	2021/2011 %
Total	11,717.6	5,953.4	11,305.1	11,988.6	9,021.4	10,746.4	14,326	18,663.9	17,432.2	10,096.7	14,820.7	12,370.2	126.5
M1	1,736.7	1,055.2	1,739.1	2,015.5	1,520.8	1,945.4	2,440.4	3,100.8	2,793.3	2,647.8	2,761.7	2,159.7	159.0
NW	1,060.8	648.2	1,095.0	1,226.3	873.4	1,191.6	1,504.0	1,953.6	1,769.6	1,643.7	1,732.2	1,336.2	163.3
C	675.8	407.0	644.1	789.3	647.4	753.8	936.4	1,147.2	1,023.7	1,004.1	1,029.5	823.5	152.3
M2	4,421.0	1,817.0	4,112.3	4,389.1	3,062.9	3,595.5	5,029.8	6,856.5	5,722.0	2,654.1	6,438.7	4,372.6	145.6
NE	1,966.5	977.2	2,057.1	2,261.3	1,497.4	1,712.0	2,473.5	3,208.0	2,683.2	1,637.3	2,830.3	2,118.5	143.9
SE	2,454.5	839.8	2,055.2	2,127.8	1,565.6	1,883.4	2,556.3	3,648.5	3,038.8	1,016.8	3,608.4	2,254.1	147.0
M3	2,420.3	1,401.2	2,568.4	2,501.7	2,080.3	2,007.8	3,085.1	3,756.3	3,655.0	1,820.3	3,167.8	2,587.7	130.9
S Munt.	2,381.5	1,388.7	2,519.4	2,449.3	2,032.9	1,959.4	3,020.0	3,674.4	3,579.5	1,775.3	3,080.2	2,532.8	129.3
Buch. - Ilfov	38.7	12.6	49.0	52.5	47.3	48.5	65.2	81.9	75.5	45.0	87.6	54.9	226.1
M4	3,139.6	1,679.9	2,885.3	3,082.2	2,357.4	3,197.7	3,770.8	4,950.3	5,262.0	2,974.5	2,452.5	3,250.2	78.1
SW Oltenia	1,569.3	604.2	1,475.7	1,445.0	1,066.3	1,243.4	2,076.8	2,362.3	1,924.1	1,456.1	1,116.0	1,485.4	71.1
W	1,570.3	1,075.7	1,409.6	1,637.3	1,291.1	1,954.3	1,694.0	2,588.0	3,337.8	1,518.5	1,336.5	1,764.8	85.1

Source: statistical data processing National Institute of Statistics, Accessed on 30.07.2022 [7].

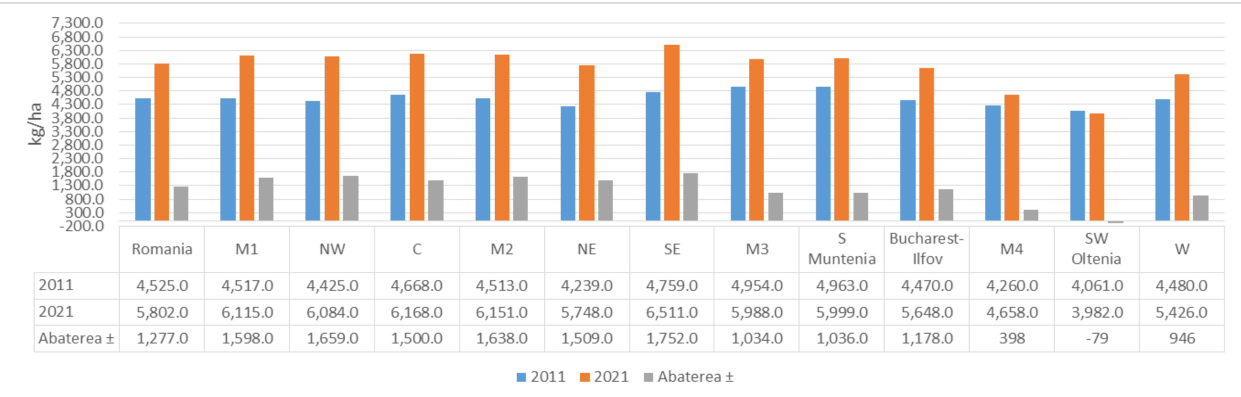

Fig. 5. National and development-related regions' average maize production per hectare, 2011 and 2021 (kg/hectare)
Source: statistical data processing National Institute of Statistics, Accessed on 30.07.2022 [7].

Figure 5 depicts the evolution of national average maize production per hectare and by region of regions.

The average amount of maize produced nationally in 2021 was 5,802 kg/ha, an increase of 1,277 kg/ha over the amount produced on average in 2011.

Except for the South West Oltenia region, which reported a negative deviation of -79 kg/ha, there were positive deviations in the emerging regions compared to 2011.

With a positive deviation of 1,752 kg/ha and a 6,511 kg/ha yield, the South East region had the highest yield.

CONCLUSIONS

Following are the findings of an examination of the growth of maize production and area in Romania:

- About 2.5 million ha of the surface were cultivated in Romania for maize, which continued to be the most significant crop with a share of 47.6% in the area cultivated for cereals and 30.8% in the total area cultivated.
- The following regions made up the majority of the area used to cultivate maize, in decreasing order: 19.4% South Muntenia, 19% South East, 18.3% North East, 13.5% South West Oltenia, 12.9% West, 10.3% North West, 6.2% Central, and 0.4% Bucharest-Ilfov.
- In 2021 there was a decrease of 1.6% in the area cultivated with maize compared to 2011
- At the level of macro-regions of development, compared to 2011 there was an increase in the area cultivated with maize as follows: 17.5% in Macro-region 1, 6.4% in Macro-region 2 and 8.3% in Macro-region 3. There was a significant decrease in the area cultivated with maize in Macro-region 4, by 28.6%.
- Between 2011 and 2021, the production of maize increased by 26.5%, from 11,717,9 thousand tons to 14,820.7 thousand tons.
- Maize production was 5,802 kg/ha with a positive deviation from the average production recorded in 2011 of +1,277 kg/ha.
- Changes in the cultivated surface and average production per surface unit, which in turn are dependent on the soil type, technologies used, and meteorological conditions, have an impact on maize productivity.

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RESEARCH ON ANIMAL PRODUCTION TRENDS IN 2014-2020 IN ROMANIA

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Abstract

The paper aims to analyze the actual trends in animal production in Romania. The statistical data were provided by the National Institute of Statistics for the period 2014-2020, and in order to highlight the evolution trends, the following statistical indicators were calculated: arithmetic mean, standard deviation, coefficient of variation and annual growth rate. The species with the most livestock in 2020, in Romania is represented by poultry (71,183,431 heads), of which adult laying birds (36,648,478 heads); cattle (1,875,169 heads), of which cows, buffaloes and heifers (1,230,717 heads,) and sheep (10,281,473 animals). Regarding animal production, we have the following statistical data: the live weight of cattle for slaughter was 172,586 tons, by approx. 6% lower than in 2014, pigs live weight decreased by 7%, reaching 498,098 tons in 2020. Finally, the live weight of sheep and goats increased by 12% during the period under review, reaching 120,571 tonnes in 2020. The largest increase of 36% was noticed in poultry live weight.

Key words: *Romania, livestock, animal production, prices*

INTRODUCTION

The livestock industry offers high quality foods, they have a higher energy value per unit weight and contain a high volume of protein. In Romania, the number of animal farms is significant. Farms are of various sizes, the most predominant being the family farms. Romanian farmers are also struggling to survive to meet market needs, but the shortage between supply and demand has led to an increase in imports of animal products, mainly from EU countries. The livestock sector has significantly diminished its importance in the value of total production, due to the decrease in the number of herds for cattle, pigs and poultry. According to the data presented by the National Institute of Statistics, in 2020, the animal sector contributed with approx. 30% of total agricultural production [8].

Animal production provides consumers with the following product categories: meat, milk, eggs and other products of animal origin and also meets the requirements industry for raw materials. Animal production is currently facing significant changes in the number of farms, diversification of production, technologies applied, structure of animal species and categories, product quality, production costs, agricultural inputs, productivity and economic efficiency. Moreover, animal production is a source of agri-food products for export, contributing to international trade [3].

Cattle breeding is the branch with the greatest importance in animal husbandry, due to the volume, diversity and value of productions and products obtained from this activity. Cattle contribute 90-96% of the total milk production consumed worldwide, 30-35% of the meat produced and about 90% of the total animal skins processed in the world tannery industry. In optimal operating conditions, a cow can cover the optimal consumption required for 6 to 8 inhabitants. At present, beef production is declining significantly, in this context it is necessary to make imports to cover the gap between production and consumption. The main cause of the decline in

production is the reduction in livestock, due to the high level of prices at agricultural inputs and the low price per kg of meat [4,10].
In Romania, the meat sector has been and continues to be affected by African swine fever, recording a significant loss. Pork is the most preferred assortment of meat by the Romanian consumer, in this context, an increase in trade imbalance is expected in the coming years which will generate an increase in prices [9,10].
Romania has a self-sufficiency for sheep meat of 150%, being among the first Community countries in terms of the number of registered cattle. The main reason why sheep meat production has remained constant, with increasing trends, is the Orthodox tradition during the Easter holidays, when demand increases significantly for this category of products [10, 2].
Romania has a long tradition in terms of milk production, due to its geographical position, with a wide variety of relief and a large area of agricultural land, as well as pastures and meadows for raising cattle, sheep and goats. In Romanian agriculture, milk production ranks second in importance, after meat production. The milk and dairy products sector is one of the most important fields of Romanian agriculture. Approximately 95% of the total milk production in Romania is obtained in the sector and provides the largest amount of milk for processing. The areas with the largest contribution to domestic milk production in Romania are represented by the central region and the North-East region, dairy products are processed mainly in the central part of the country, in the South-Muntenia region and the Bucharest-Ilfov region. In terms of cheese production, the North-West, Central and North-East regions have the highest cheese production in the country [7, 1].

MATERIALS AND METHODS

The data used in this study were provided by the National Institute of Statistics in Romania, based on which the following indicators were calculated: mean, standard deviation, coefficient of variation and growth rate.

- standard deviation:

$$= \sqrt{\frac{\sum(xi-\bar{x})^2}{n-1}}$$

∂ = standard deviation;
xi = data series values over a number of years;
n = the number of years considered.

- coefficient of variation:

$$C = \frac{\partial}{\bar{X}} * 100$$

s = standard deviation;
x= average level of a variable;

- growth rate:

$$r = \sqrt[n-1]{\prod\left(\frac{p\,n}{p\,n-1}\right)} - 1$$

r = average annual growth rate;
∏pn/pn-1 = chained growth indicators.

The research method used consisted in the quantitative and qualitative analysis of the data to highlight the evolution of the analyzed indicators.
The data used showed the number of animals, animal production and basic prices of products of animal origin in Romania in the period 2014-2020.

RESULTS AND DISCUSSIONS

In the period 2014-2020, the herds of animals registered a decreasing trend for the following species: cattle (-9.36%), cows and heifers (-5.86%), pigs (-24.94%), poultry (-5.65%) and adult laying birds (-14.25%) (Figure 1).
At the opposite pole, the species represented by sheep (8.02%) and goats (13.73%) registered an increasing trend during the analyzed period (Figure 1).
From the analysis of statistical indicators calculated for the total number of animals in Romania in the period 2014-2020, there were identified the trends and variations mentioned below.
Cattle herds varied between 1,875,169 heads and 2,092,414 heads, obtaining an average of the period equal to 1,999,690 heads and a standard deviation of 79,443 heads.
Regarding the coefficient of variation, a good homogeneity of the data series is observed,

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this having a value below 10%, respectively 3.97%. The annual growth rate showed a negative value (-1.63%) indicating a reduction in cattle during this period.

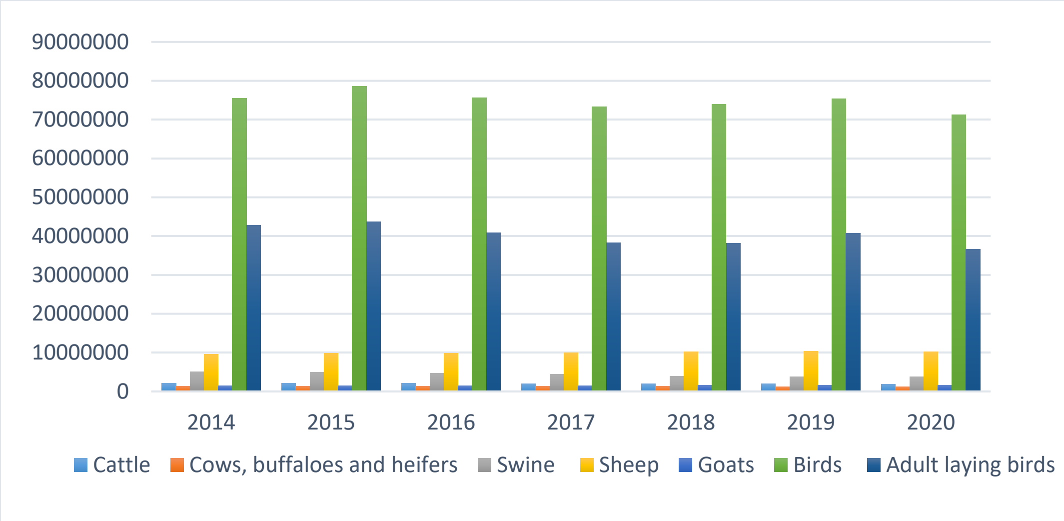

Fig. 1. Evolution of livestock in Romania at the level of the period 2014-2020 (number)
Source: National Institute of Statistics, NIS, data processing, Accessed on 20.06.2022 [6].

The herds of cows, buffaloes and heifers showed oscillations between 1,230,717 heads and 1,314,900 heads, with an average of the period equal to 1,282,913 heads and a standard deviation of 34,286 heads. The coefficient of variation is equal to 2.67% and indicates a homogeneity of the data series, and the annual growth rate is -1%, its negative value indicates a downward trend in the period analyzed.

-The herds of pigs were between 3,784,507 heads and 5,041,788 heads, highlighting an average of 4,375,196 heads and a standard deviation of 532,972 heads. An average value of the coefficient of variation of 12.18% was noticed, which suggests an average variation of the data series. Regarding the annual growth rate, there was a downward trend by -4.67%.

-The flocks of sheep registered variations between 9,518,225 heads and 10,358,699 heads, obtaining an average of the period equal to 10,000,236 heads and a standard deviation of 295,306 heads. The coefficient of variation of 2.95% marks a homogeneous series of data, and the annual positive growth rate (1.29%) underlines the trend of positive/increasing evolution of the data series (Table 1).

Table 1. Statistical indicators calculated for livestock in Romania at the level of the period 2014-2020

Nr. crt.	Categories of animals	MIN	MAX	AVERAGE	STANDARD DEVIATION	* COEFFICIENT OF VARIATION (%)	ANNUAL GROWTH RATE (%)
1.	Cattle	1,875,169	2,092,414	1,999,690	79,443	3.97	-1.63
2.	Cows, buffaloes and heifers	1,230,717	1,314,900	1,282,913	34,286	2.67	-1.00
3.	Swine	3,784,507	5,041,788	4,375,196	532,972	12.18	-4.67
4.	Sheep	9,518,225	10,358,699	10,000,236	295,306	2.95	1.29
5.	Goats	1,417,176	1,611,785	1,512,815	73,742	4.87	2.17
6.	Birds	71,183,431	78,648,098	74,802,061	2,322,050	3.10	-0.96
7.	Adult laying birds	36,648,478	43,662,606	40,151,041	2,567,192	6.39	-2.53

* Coefficient of variation: <10 - small; 10-20 - medium; > 20 - large.
Source: NIS, data processing, Accessed on 20.06.2022 [6].

The goat herds oscillated in the analyzed period between 1,417,176 heads and 1,611,785 heads, obtaining an average of the period equal to 1,512,815 heads. Following the analysis of the calculated statistical indicators, a coefficient of variation of 4.87% and an annual growth rate of 2.17% resulted, its positive value highlighting the growth trend.

-The flocks of birds and adult laying birds registered values between 71,183,431 and 78,648,098, respectively 36,648,478 and 43,662,606. The low value of the coefficient of variation (3.10%, respectively 6.39%) characterizes the data series as a homogeneous one, and the negative annual growth rate (-0.96%, respectively -2.53%), puts in highlights the decreasing trend (Table 1).

In Romania, at the level of the period 2014-2020, the meat production, respectively the live weight of the animals destined for slaughter for consumption registered an increase of 12% for the sheep and goat species.

The most significant increase in the analyzed period, of 36% was registered in birds. With regard to beef and pig meat production, decreases of 6% for cattle and 7% for pigs were recorded during the period considered. In the case of pigs, the decrease in production can be attributed to the spread of swine fever, which has generated economic losses for the pork sector (Figure 2).

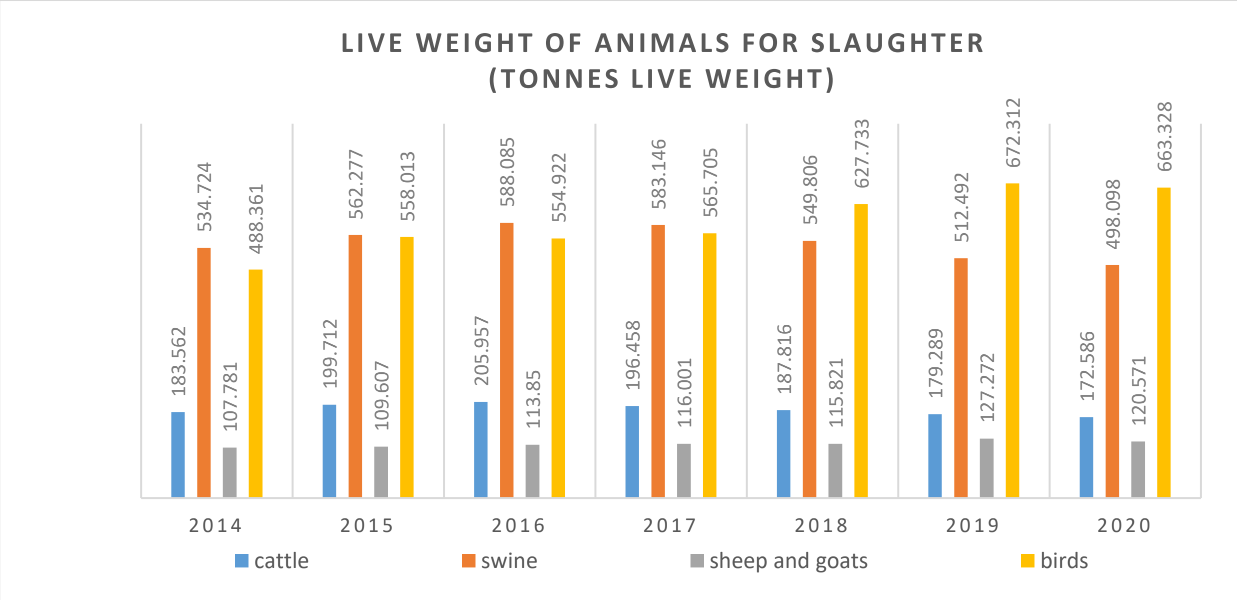

Fig. 2. Evolution of the live weight of animals destined for slaughter for consumption in Romania at the level of the period 2014-2020 (tons live weight)
Source: NIS data processing, Accessed on 20.06.2022 [6].

Analyzing the production of the main categories of animal products in Romania in the period 2014-2020, it showed a decrease. By product categories there was a decrease by 7.59% for milk production which includes the consumption of calves, and for that which excludes the consumption of calves the decrease was by 8.59%. The most significant decrease was recorded in egg production, which was 18.20% in the analyzed period.

Regarding the wool production, the trend was one of evolution, being highlighted an increase by approx. 5.68% during this period (Table 2).

From the analysis of statistical indicators calculated for animal production by product categories in Romania in the period 2014-2020, the following data were recorded: the milk production that includes the consumption of calves varied between 46,161 and 50,535 thousand hectoliters, registering an average of the period equal to 47,720 thousand hectoliters and a standard deviation of 1,623 thousand hectoliters. Regarding the milk production that excludes the consumption of calves, a variation between 42,113 and 46,615 thousand hectoliters was observed with an average period of 43,918 thousand hectoliters and a standard deviation equal to 1,637 thousand hectoliters. During this period, wool production averaged 22,740 tonnes, with variations ranging from 21,817 to 23,824 tonnes and a standard deviation of 722 tonnes. For egg production, the average for the period was 6,011 million pieces, with oscillations between 5,428 and 6,636 million pieces, and the standard deviation was equal to 473 million pieces (Table 3).

Table 2. The evolution of the production of the main categories of animal products in Romania in the period 2014-2020

Crt. No.	Product categories	Years							2020/2014 %
		2014	2015	2016	2017	2018	2019	2020	
1.	Milk production (including consumption of calves) -total (physical) -thousands of hectoliters	50,535	49,156	48,133	46,615	46,741	46,161	46,697	-7.59
2.	Milk production (excluding calves) - total (physical) -thousands of hectoliters	46,615	45,385	44,504	43,082	43,121	42,113	42,609	-8.59
3.	Wool production -tons	21,817	22,343	22,277	22,401	23,459	23,824	23,057	5.68
4.	Egg production -millions of pieces	6,636	6,555	6,182	5,996	5,713	5,564	5,428	-18.20

Source: NIS, Accessed on 20.06.2022 [6].

The coefficient of variation showed values between 3.40% for milk production which includes the consumption of calves and 7.88% for the production of eggs for consumption. Its low value, below 10%, indicates a homogeneous series of data. Regarding the coefficient of variation, it recorded negative values for milk production which includes calf consumption (-1.31%), which excludes calf consumption (-1.49%) and egg production (-3.29 %), indicating a downward trend of the data series in the analyzed period. Regarding the wool production, the evolution trend was an increasing one, the annual growth rate being a positive one of 0.93% (Table 3).

Table 3. Statistical indicators calculated for production of the main categories of animal products in Romania at the level of the period 2014-2020

Nr. crt.	Product categories	MIN	MAX	AVERAGE	STANDARD DEVIATION	* COEFFICIENT OF VARIATION (%)	ANNUAL GROWTH RATE (%)
1.	Milk production (including consumption of calves) -total (physical) -thousands of hectoliters	46,161	50,535	47,720	1,623	3.40	-1.31
2.	Milk production (excluding calves) - total (physical) -thousands of hectoliters	42,113	46,615	43,918	1,637	3.73	-1.49
3.	Wool production -tons	21,817	23,824	22,740	722	3.18	0.93
4.	Egg production -millions of pieces	5,428	6,636	6,011	473	7.88	-3.29

* Coefficient of variation: <10 - small; 10-20 - medium; > 20 - large.
Source: NIS data processing, Accessed on 20.06.2022 [6].

At the level of 2020, the milk production, including the consumption of calves in Romania reached the value of 46,697 thousand hectoliters, by approximately 7.59% lower than the one registered in 2014. From the calculation of the linear regression it results that the milk production, including the consumption of calves in Romania decreased on average by approx. 2,111 thousand hectoliters per year (Figure 3).

According to the equation of trend y = $129.96x^2$-1,752x + 48,327, milk production, excluding the consumption of calves decreased on average annually, during the analyzed period, by about 1,752 thousand hectoliters. At the level of 2020 (42,609 thousand hectoliters) there was a decrease in production by about 9% compared to the production recorded in 2014 (46,615 thousand hectoliters) (Figure 4).

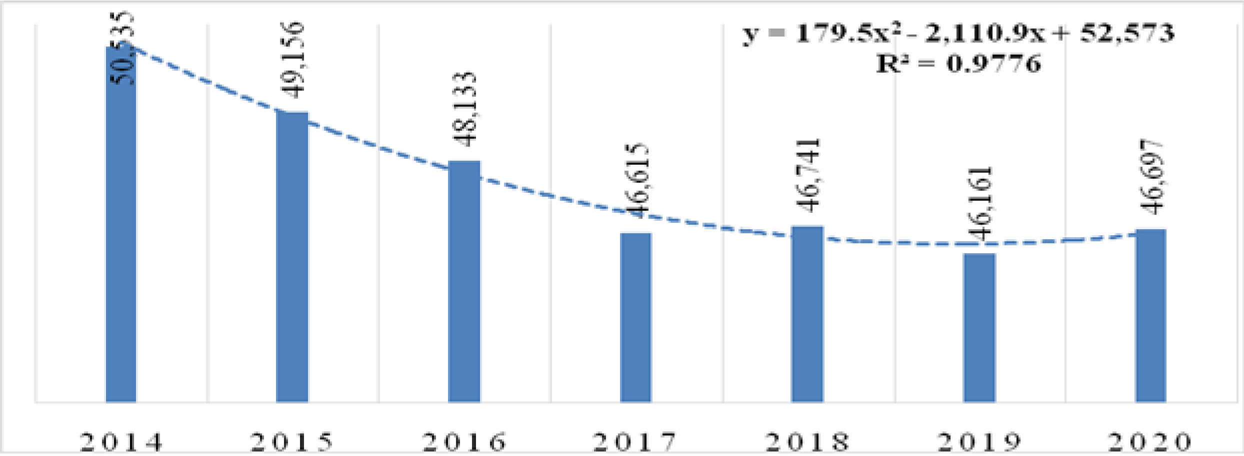

Fig. 3. Evolution of milk production (including calf consumption) - total (physical) - thousand hectoliters
Source: NIS data processing, Accessed on 20.06.2022 [6].

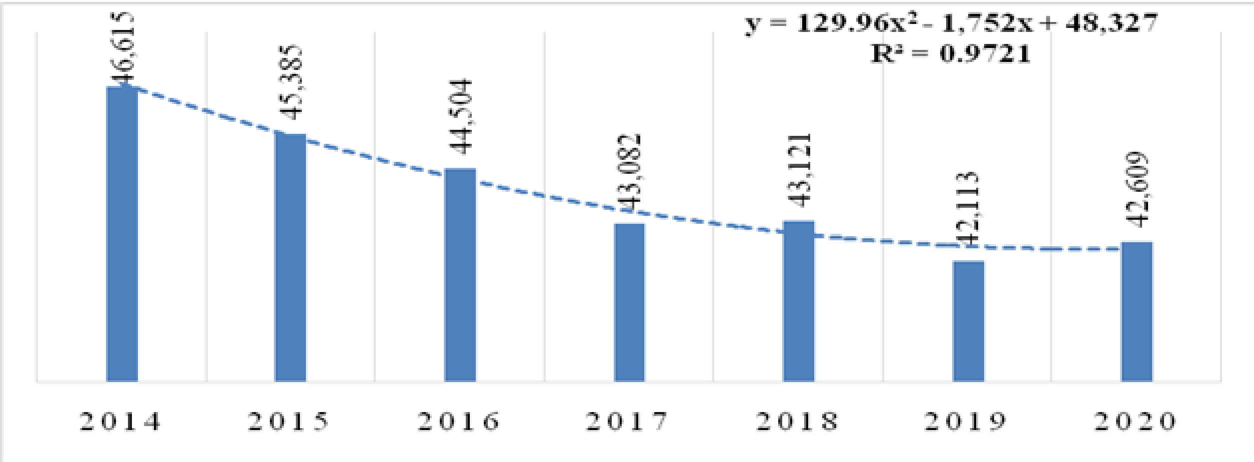

Fig. 4. Evolution of milk production (excluding calf consumption) - total (physical) - thousand hectoliters
Source: NIS data processing, Accessed on 20.06.2022 [6].

Calculating the trend equation y = $-29.071x^2$ + 513.43x + 21,267, it is found that on average annually, wool production increased by 513 tons. Also, there is a very strong link between the two variables, the variation of wool production being explained in proportion of 72.8% by the time factor, the rest being the influence of other factors not included in the model (Figure 5).

In the period 2010-2020, it was observed that egg production in Romania had a downward trend, registering values between 5,428 million pieces in 2020 and 6,636 million pieces in 2014, obtaining an average of the same period of 6,011 million pieces. During the analyzed period, an annual growth rate of -3.29% was registered, so that at the end of 2020 egg production was 22.25% lower than in the reference year 2014. By calculating the trend equation it is found that that egg production decreased on average during the analyzed period by 98.4 million pieces per year (Figure 6).

The basic prices of animal products registered an increase in the period 2014-2020, less poultry meat which registered a decrease of

5%, from 4,000 lei/ ton to 3,810 lei/ton. The largest increase in the basic price was noticed for eggs, their price registering an increase of approx. 30%, from 9,600 lei/ton to 12,400 lei/ton, followed by raw wool and beef that recorded an increase of about 23% during this period (Figure 7).

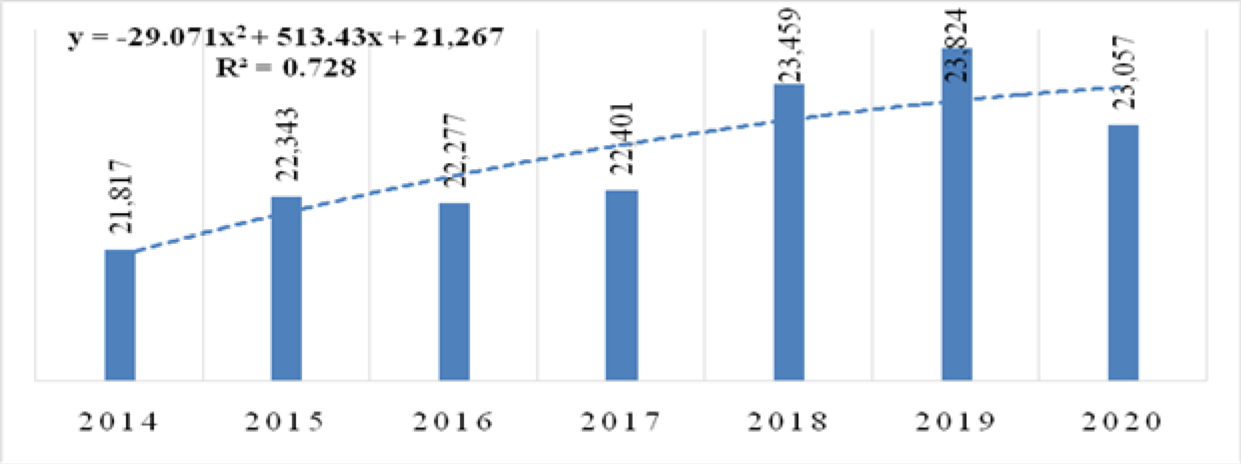

Fig. 5. Evolution of wool production - tons
Source: NIS data processing, Accessed on 20.06.2022 [6].

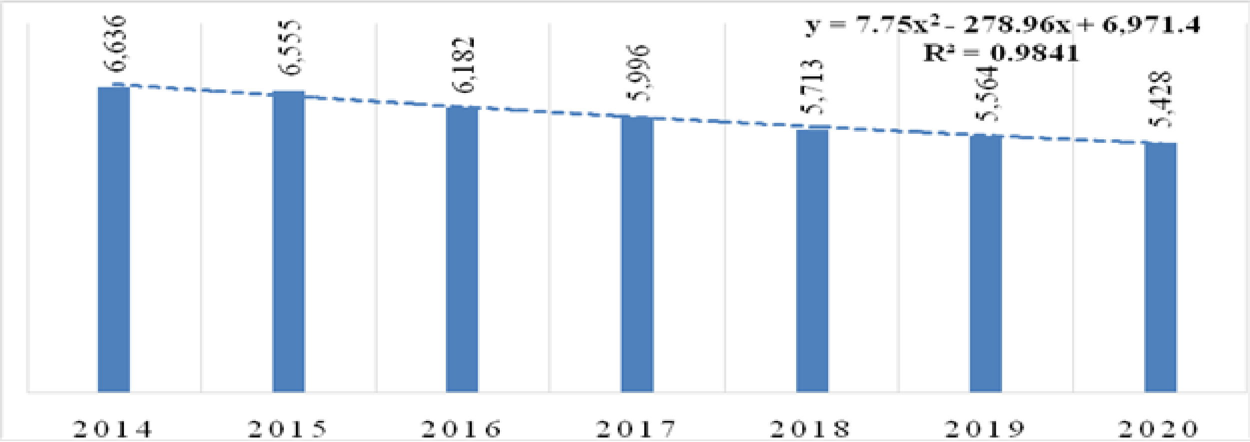

Fig. 6. Evolution of egg production - million pieces
Source: NIS data processing, Accessed on 20.06.2022 [6].

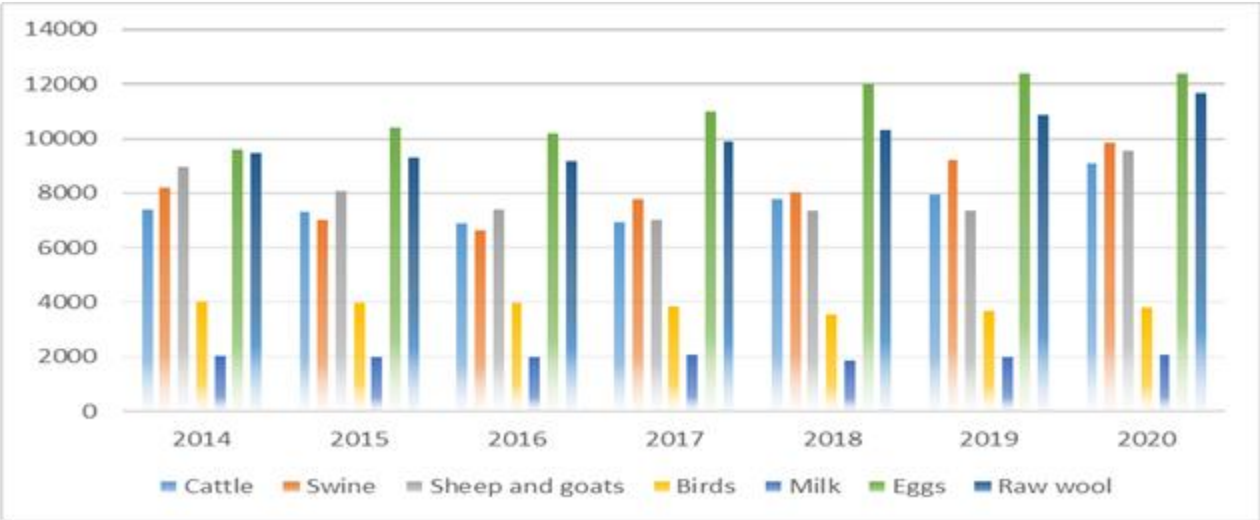

Fig. 7. Evolution of basic prices for the main categories of animal products (lei/ton)
Source: NIS data processing, Accessed on 20.06.2022 [6].

CONCLUSIONS

The livestock sector provides staple foods: meat, milk and eggs for consumption. These products are very attractive to Romanian consumers, being among the most consumed products in the food industry. Following the research, the following were found:

In the period 2014-2020, the herds of animals had a downward trend, except for sheep and goat species, which recorded increases by 8.02% and 13.73%, respectively. With regard to animal production, there was a decrease in production for all product categories, with the exception of wool production, which increased by 5.68% during the period considered. The most significant decrease was observed in egg production, of 18.20%.

Taking into account the fact that animal products are staple foods, they must be promoted among Romanian consumers and also to be sold on international markets.

Also, the national aids and the coupled support received from the Romanian government and the EU are especially important for livestock farmers, help them to better develop production in this sector.

ACKNOWLEDGEMENTS

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RECOGNITION OF NATURAL CAPITAL IN FINANCIAL REPORTING IN THE CONTEXT OF THE SOCIO-ECONOMIC PARADIGM: PRACTICE OF THE REPUBLIC OF MOLDOVA AND INTERNATIONAL EXPERIENCE

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Abstract

In the context of ensuring sustainable development, the activity of a business unit has come to be seen as a three-component system designed to provide reliable information about the contribution of business to the social and environmental segments of the economy. This trend led to the transition to the socio-economic paradigm of financial reporting, which predetermines its revolutionary transformations, one of which is finding ways to recognize natural capital (NC) and disclose information about its impact on the value of the business as a whole. This article puts forward and proves the hypotheses, which leads to the following conclusion: the recognition of NC as an element of financial reporting is an imperative of the socio-economic reporting paradigm. This study was conducted on the basis of general scientific and special methods: systematic approach, collection and comparison, analysis, synthesis, modeling, study of special literature. The justification of the hypotheses is carried out according to the following scheme: the current state of natural capital of the Republic of Moldova is assessed; the national accounting and financial reporting system is characterized in the context of the requirements of the socio-economic paradigm; methodological aspects of the recognition of natural capital as an element of financial reporting are analyzed; an algorithm and arguments of the NC recognition model based on the provisions of IFRS are proposed.

Key words: *socio-economic paradigm, natural capital, methodology of IFRS, recognition algorithm, accounting model*

INTRODUCTION

The transition to a more advanced technological mode predetermines changes in economic relations and productive forces, implemented already in the new paradigm of society development.

Because of the focus on a homocentric vision of economic development through ensuring the quality of life of people, their rights and opportunities, while creating the necessary conditions to maintain a healthy environment, the paradigm of the XXI century is interpreted as socio-economic. The socio-economic paradigm or the Concept of Sustainable development provides for a balance of economic, environmental and social aspects of activity not only at the macro level, but also at the micro level [1]. In this context, business began to be interpreted as a three-component system, each of the components of which is characterized by its own ”driver” of business value growth - financial capital, natural capital and social capital.

There is no doubt that demonstrating the contribution of each form of capital to the sustainability of the business model requires adequate disclosure in business reporting. The *first stage* of this requirement was the preparation of GRI-reporting (Global Reporting Initiative), which focuses on material issues for business and other stakeholders. Thus, within the environmental aspect, such issues include: compliance with environmental legislation, environmental performance of products, energy efficiency, energy conservation and innovation, protection of land resources and vegetation. This information is mainly quantitative in nature, does not create a complete accounting of the business activities of a business unit, and does not reflect all the factors contributing to the growth of wealth and well-

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being [3], [5]. Certainly, on the one side, indicators of the environmental aspect of business activity should provide a quantitative description of its contribution to the achievement of sustainable development goals. On the other side, since the environmental behavior of business has an impact on natural capital, it is also necessary to value the contribution to the maintenance of natural capital [19].

The GRI-reporting framework uses a cost-based methodology to determine the environmental indicators for which cost estimation is possible. In doing so:

1) no consideration of the market value of resources;
2) the role of natural capital as a factor of production is ignored, although it has been proven that short-term economic growth results in a loss of natural capital;
3) non-market negative and/or positive externalities that affect the value of natural capital are not taken into attention [11].

And in this context, the key problem of natural capital disclosure is the development of an effective tool for measuring the contribution to the environmental sustainability of business. Its use will make it possible to draw conclusions about the sustainability of business models and trends in total business capital [19].

The Rio+20 Summit Declaration on Natural Capital (2012) recognized the interconnectedness of natural and financial capital and the need for accounting and financial reporting reform. The adoption of the System of Environmental-Economic Accounting – Central Framework (*second stage*) is part of this reform. System is a multi-purpose concept of business impact on the environment, which provides for the use of the principle of double entry and the opening of functional accounts for environmental activities.

This recognized the need to standardize information on new forms of capital that is presented on a consistent basis: helps to assess the past and look into the future [5]; influences management decision-making by stakeholders at both the state and corporate levels [8].

The idea of presenting information about new forms of capital was implemented in the concept of integrated reporting (*third stage*). The key assumption of this concept is the interpretation of capital as value, which includes two elements: 1) the value that ensures the return on investment to the depositors of financial capital; 2) the value from the participation of other stakeholders and society as a whole [9]. Moreover, this is the value of human, social, natural capital and other forms of capital. In this regard, the following theses are true:

T1 – natural capital as part of the second element of capital is monetarily measurable;

T2 – the value of natural capital and its impact on the value of business capital, to be disclosed in the financial statements.

Under this concept, natural capital refers to the stock that is the source of a sustainable flow of environmental (natural) services and real natural resources.

However, despite the obvious need to recognize natural capital and consider the risks, uncertainties, and opportunities associated with the use of the benefits it contains, not all business units reflect them in their financial statements [4].

Moreover, there is still no information about natural capital as a contribution to the total capital of the business in the financial statements. In this regard, a number of questions arise:

-What is the current situation of natural capital recognition in the Republic of Moldova?

-Is there a unified conceptual space for the presentation of information on natural capital in the accounting and financial reporting system of the Republic of Moldova?

-Does modern accounting methodology have the tools to recognize natural capital as an element of financial reporting of a business unit?

The answer to the questions posed will be the argumentation of the authors' hypotheses as presented in Fig. 1.

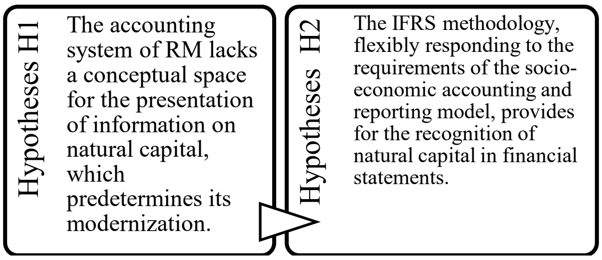

Fig. 1. Authors' hypotheses.
Source: Own concept.

Justification of the hypotheses is aimed at achieving the goal of the study: the recognition of natural capital as an element of financial reporting is an imperative of the socio-economic reporting paradigm. In the context of justification of the hypotheses, the following research algorithm was developed:
-assessment of the current state of recognition of natural capital of the Republic of Moldova (hereinafter, RM);
-characterization of the accounting and financial reporting system of the RM in the context of transition to the socio-economic paradigm of financial reporting;
-analysis of methodological aspects of recognition of natural capital as an element of financial reporting;
-improved model of natural capital recognition based on the provisions of International Financial Reporting Standards (hereinafter, IFRS or IAS) is proposed.

MATERIALS AND METHODS

This research is conducted on the basis of general scientific and special methods: system approach, collection and comparison, analysis, synthesis, modeling, study of special literature. The systematic approach of this research consists in a rational combination of certain scientific directed to the construction of research methodology: formulation of the problem, proposing a hypothesis and its justification.
The authors studied the works of famous scientists, published in scientific journals and as monographs in order to achieve the stated goal of the research. When forming the evidence base of the hypothesis, official materials were also used: legislative and normative acts, data published by the Bureau of Statistics of the RM. Depending on the tasks set, some of which are of empirical nature, others of theoretical nature, appropriate methods were applied. Such task of the research as presentation of information about the current state of natural capital in RM was solved by the authors with the help of methods of observation and comparison (Tables 1, 2, 3).
In the study of this problem, the authors were guided by the following methods:
abstraction to identify from the position of accounting methodology the properties of natural capital, which allow us to qualify it as a form of capital;
axiomatic - to formulate theses T1 and T2;
induction, the application of which made it possible to put forward hypotheses H1 and H2 to be argued;
analysis, which highlighted the stages of the natural capital identification algorithm;
synthesis, which made it possible to formulate conclusions and argue the hypotheses put forward and substantiate the methodology of natural capital accounting;
finally, *modeling*, on the basis of which the algorithm of identification of natural capital and functional accounts for the presentation of information on its state in financial statements were proposed.

RESULTS AND DISCUSSIONS

Conceptual analysis of the current state of natural capital in the Republic of Moldova and its recognition as part of business capital

In order to substantiate the hypothesis H1, let us disclose the current state of the most demanded types of natural resources in Moldova. For this purpose, we will use the official information, prepared by the National Bureau of Statistics (Tables 1, 2). The tables present generalized data on separate ecosystems of the RM.
The analysis of the information presented in Tables 1 and 2 shows the fact that at present in RM:
(1)There is a quantitative assessment of the criteria characterizing the state of natural resources (Table 1) and the factors

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determining the quality of natural resources (Table 2).

Table 1. Quantitative assessment of some ecosystems of the Republic of Moldova

n/n	Ecosystems	2018	2019	2020
1	**Land fund**, thousand hectares	3,384.7	3,384.7	3, 384.7
2	**Extractable minerals, including:** ▪ oil, (thousand tons) ▪ raw materials for cement (thousand tonnes). ▪ molding and other materials (thousand tonnes); ▪ rocks (million m³).	5.1 1,016.7 481.3 4,910.4	5.0 1,084.4 382.4 5,460.4	5.0 988.9 410.7 5,579.9
3	**Used water resources** (million m³) including: ▪ for production and agricultural needs ▪ for domestic needs.	777 666 111	777 667 110	778 666 112
4	**Fuel and energy resources consumed** (thousand tons), including: ▪ industry; ▪ transport; ▪ residential sector.	2,862 251 758 1,385	2,739 234 769 1,274	2,670 226 681 1,296
5	**Forest fund**, total (thousand hectares), including forest covered	422.8 379.5	423.9 380.7	425.4 381.8

Source: Own development based on data from the national bureau of statistics [15].

Table 2. Quantitative assessment of polluting emissions into ecosystems of the Republic of Moldova

n/n	Types of dirt	2018	2019	2020
1	Emissions of pollutants into the atmosphere (thousand tons) from: ▪ industrial production ▪ various types of transport, including motor vehicles	143.6 227.9 198.1	124.3 189.5 163.8	113.8 155.6 148.7
2	Emissions of pollutants into natural water bodies, including from energy production facilities (thousand tons)	139.1 125.3	186.7 166.3	181.4 168.9
3	Discharge of polluted water into the water space (million m³)	9	8	8
4	Industrial waste (thousand tons), including: toxic	1,597.3 4.26	1,222.0 4.14	1,191.0 2.10

Source: Own development based on data from the national bureau of statistics [15].

(2)There is a degradation of ecosystems, due to the constant growth of the level of their pollution with the preserved amount of relevant natural resources and environmental services (Fig. 2). It should be noted that the author deliberately focuses on the pollution of natural water resources. This is due to the fact that atmospheric pollution by production and transport, and the volume of waste from these segments of the RM economy decreased in the context of minimization of transport services provided and reduction of production capacity during the pandemic COVID 19 2020 and 2021.

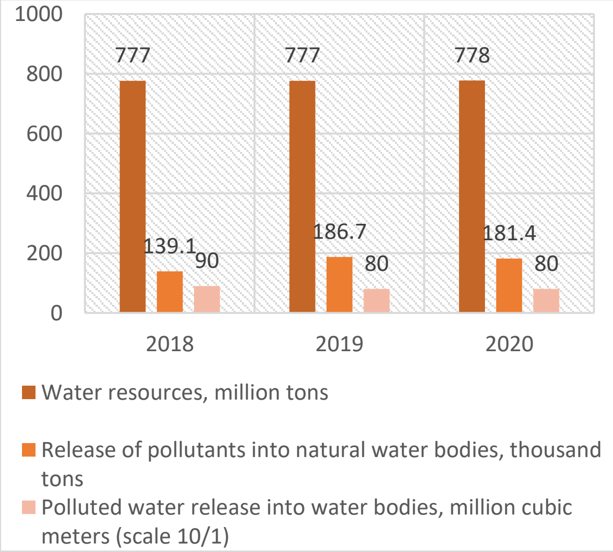

Fig. 2. Diagram of changes in the volume of natural water resources and discharges of their pollution in the period 2018-2020.
Source: Own design.

(3)The Business Unit incurs environmental costs due to production activities, which practically do not change over time (Table 3), and, therefore, the cost of the products/provided services does not change.

Table 3. Costs of economic agents of the Republic of Moldova for the environment and its restoration (thousand Mld.lei)

n/n	Types of expenses	2018	2019	2020
1	penalties for violating environmental laws	5,315.2	6,975.8	6,530.4
2	penalties for non-compliance with environmental legislation	7,809.1	18,428.4	22,000.2
3	current costs of economic entities due to interaction with the environ-ment, including: included in the cost of products/ servi-ces,recognized as expenses of the period	269,238.3 227,752.2 41,486.1	258,478.7 217,243.3 41,235.4	264,982.5 182,530.3 66,258.6

Source: Own development based on data from the National Bureau of Statistics [15].

(4)The size of ecosystems as a whole has not changed quantitatively (Table 1). However, businesses continue to carry out their activities and use ecosystem services. At the same time, as noted above, the level of environmental costs of business is quite stable (Fig. 2), the value of consumed ecosystem goods due to their limitation is steadily increasing over time, and, consequently, ecosystems are damaged;

(5) **Simultaneously with the above mentioned, there is a significant increase in the external costs of business** as a taxpayer due to penalties for violations of environmental legislation and environmental protection (Fig. 3).

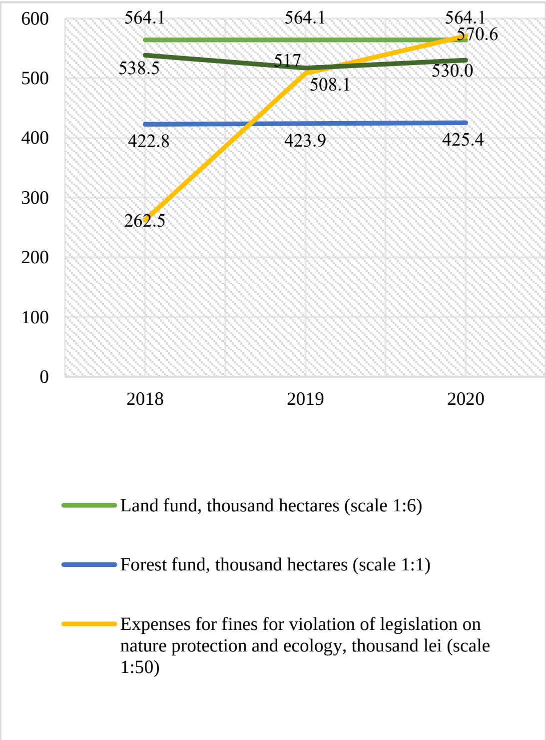

Fig. 3. Diagram of the relationship between the volume of natural resources and expenditures of organizations on their use in the period 2018-2020
Source: Own design.

It becomes clear that the tendency of state support of business as a taxpayer, contributing to the increase of its capital by excluding production costs for natural resources from the cost of production (services), is preserved in the RM. The consequence of this approach is the establishment at the legislative level of principles, procedure of charging and mechanism of payment of fees for the use of natural resources. The issue of compliance of the provisions of the legislative framework of the Republic of Moldova regarding the recognition of natural capital with the requirements of the concept of sustainable development is thoroughly disclosed in the work [7]. In this regard:

-at the micro level - the business unit lacks the motivation to recognize natural capital and assess its contribution to the sustainability of the adopted business model;

-at the macro level - there is no basis for integrating information about the changes in the value of natural capital in the context of maintaining the sustainable development of society.

In addition, the use of this kind of state support for business leads to contradictions with the provisions of the National Strategy ”Moldova-2030” on the transition to the paradigm of socio-economic development.

To identify this problem, let us use the question formulated by Mises: is the exemption of owners from liability for environmental damage arising in the course of their activities not the result of a deliberate policy of government and legislators? Or is it an unintended consequence of the traditional wording of laws...? [14, p. 615].

Summing up this part of the study, we emphasize that in the context of EU-Moldova association, the Government of Moldova undertook a number of commitments, including support of natural capital, for the implementation of which the National Development Strategy ”Moldova – 2030” for 2021-2030 was adopted. Nevertheless, the accounting system of RM is oriented to the continental (European) model, according to which the financial statements are prepared on the basis of a legal approach according to the principle of "directivity and clarity", which gives an accurate picture of the financial situation of the reporting organization. This principle is enshrined in the Law № 287 of 15.12.2017. ”On Accounting and Financial Reporting” [12]. As a consequence, the application of the concept of valuation at fair value - a trend of the Anglo-Saxon model of accounting and reporting in the national accounting system of the Republic of Moldova is not yet provided, as well as the transition to the socio-economic paradigm of financial reporting. To be fair, we should note that the General Chart of Accounts of the RM has a separate account 342 ”Subsidies to entities with public property”, which reflects the recognition of subventions received by the entity with their subsequent allocation to increase the charter capital. However, the application of this account for the recognition of natural capital as a contribution to the business of other stakeholders to ensure sustainable development is difficult in the context of the outlined features of the accounting system of RM.

The above is the justification of hypothesis *H1* - the Moldovan accounting and financial reporting system currently lacks a conceptual space for presenting information about natural capital as a result of the business environment's participation in ensuring sustainable development of society.

Methodological assessment of the recognition of natural capital as an element of financial statements

One cannot but agree with Ageev and other authors of ”Integrated Reporting: A Challenge for Management” that the central point in the evolution of financial and non-financial reporting is the interpretation of the content of the concept of ”capital” [1].

Today it has been proven that natural capital, while differing in form, has a number of economic characteristics typical of financial capital: it is transformed into other forms of capital, brings profits in the future, depreciates in time, requires investment support, affects the total value of a business unit [7]. And, therefore, along with financial capital, information about the state of natural capital and its impact on the amount of total business capital should be reflected in the financial statements.

One of the controversial issues is the development of a mechanism for the recognition of natural capital, the implementation of which is complicated by a number of reasons. These include:

-the problem of identifying a natural phenomenon as an economic event [18];

-the dependence of the validity of accounting records on the formalization of natural capital accounts and individual ecosystem goods and services accounts, which are still incomplete in some countries today and non-existent in others [5];

-limited ability to unify the valuation of each type of capital, due to the fact that capital indicators and methods of measurement are constantly evolving [1].

Let us first try to solve the problem of the identification of natural capital. It is known that when recognizing a particular object of observation as an element of financial reporting, the reporting preparer faces a task of a professional nature - to identify the economic event. The identification of an economic event is one of the compositional elements of modern accounting and reporting methodology, the application of which is considered the first step in generating useful information for users of financial statements.

Recognizing natural capital as an element of financial reporting is a rather complex process. This is due to the fact that it embodies the contribution to business capital of natural phenomena (natural resources and ecosystem services), which should be given economic content. According to the authors, the identification of natural capital consists of going through a three-step algorithm, presented in Figure 4.

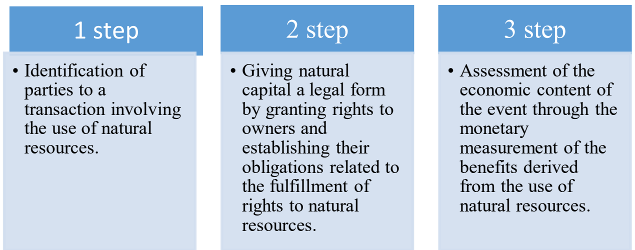

Fig. 4. Algorithm of natural capital identification
Source: Own result.

Let's disclose the essence of each of the stages of the identification algorithm. In this context, one cannot but agree with Ofurum and Ngoke that the function of management, the tool of implementation of which is accounting, includes the identification of stakeholders in the increase in the cost of business capital and the shares of their interests in this increase [16]. Moreover, they emphasized that in the absence of the value of natural capital in the financial statements, the information provided would not meet the needs of stakeholders. And, as a consequence, the actual purpose of the financial statements will not meet the purpose of presentation.

So, according to the legislation of the Republic of Moldova, ownership of natural resources can be public and private. Natural resources that are in private ownership belong to individuals or legal entities by the right of possession, use and disposal, and national resources belong to the state. Private ownership is limited, and the right to own them traditionally belongs to the state [13].

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On the basis of various public-private partnership agreements (subsidies, concessions, leases and others) natural resources and their services are transferred by the state to businesses in order to use them effectively and produce quality public services (the first stage of identification, see Fig. 3). By the form of execution, such contracts are a financing mechanism operating on the basis of the pooled capital, consisting of two parts: private (equity) capital and non-private (public) capital. In this case, the state becomes one of the contributors to the aggregate capital of the business.

According to the authors, ownership is of particular importance for the recognition of natural capital as an element of financial reporting, since it is the basis for imposing liability on an economic entity for environmental damage as a result of its activities. We emphasize that this work does not aim at an in-depth study of the concept of "ownership" and refers to it only in the context of forming the evidence base for the recognition of natural capital in the financial statements.

The legal person, having contractual rights in relation to the property, recognizes and obligations associated with its use (*the second step*, Fig. 3). The accounting system then interprets the economic content of the transaction, and, on the one hand, the assets embodying the rights in respect of the property are recognized, and, on the other hand, the liabilities of the legal entity to be fulfilled.

Otherwise, the legal entity neglects the costs associated with the maintenance of this property and does not reflect them in the financial statements. This approach is legitimate because it is a consequence of the implementation in the accounting and reporting system of the concept of property rights. According to generally accepted definition, property right is a set of legally enshrined rights in relation to the property owned by the owner that does not violate rights and legitimate interests of other persons [6]. This practice exists in RM (Fig. 2), and the national accounting and financial reporting system responds accordingly (see justification of hypothesis *H1*).

It is a well-known fact that accounting converts economic events into accounting entries, which in generalized form are accumulated in the financial statements of the economic entity (*the third step* of identification, Fig. 3). One cannot but agree with Pérez-Benedito, who believes that since financial reporting is the synthesis of human activity, it must reflect the value measurement of all the results of this activity, which will contribute to a qualitative assessment of the decisions made [17]. In this context, the valuation of the contribution of natural capital and its changes is one of the problems of modern accounting methodology.

Let us now focus on the problem of the validity of accounting records for natural capital recognition. In this regard, we support Boyd et al.'s view that individual business units' approaches to natural capital summarization can be varied, but they must meet accounting standards [5]. The author's argumentation of the methodological approach to the recognition and accounting of natural capital will be carried out on the basis of the IFRS system, flexibly responding to the requirement of the new development paradigm of transition to the socio-economic model of accounting and reporting.

So, the modern interpretation of capital underlying the Concept of IFRS determines the purpose of financial reporting in presenting useful information to a wide range of users for making effective decisions, and first of all, to investors for their assessment of the use of all economic resources. This does not exclude their interest in reliable information about the interaction between the business and the environment, the influence of this interaction on the increase in the cost of equity or on the change in the value of the business as a whole. As a consequence, the provisions of IFRS provide alternative approaches to the recognition of new forms of capital, which contributes to the development of appropriate accounting methodologies.

According to the accounting methodology, the reconstruction of the economic event associated with the transfer of the right to control, use or receive income from natural resources, it must find its reflection in the financial statements. On the one side, controlled resources (land and natural reserves) are presented in the section ”Assets” as controlled resources, on the other side - the source of their occurrence in the section ”Liabilities”. But as what element of it, capital or liability?

It is appropriate to emphasize that the IFRS methodology on the basis of special standards makes it possible to legitimately solve the problem of recognition of natural capital in reporting in the performance of a number of public-private partnership agreements. However, this study intentionally focuses on the provisions of IAS 20 ”Accounting of Government Grant and Disclosure of Government Assistance” (hereinafter, IAS 20), because the interpretation of its provisions is adequate [10]:

▪ to recognize in the section "Equity" a non-monetary form of government subsidy as a source of obtaining land for the use of the business;

▪ will provide a key to resolving the problem of recognizing natural capital as a source of origin and types of resources such as mineral resources and environmental services.

Because IAS 20 does not prescribe a specific approach to recognizing a government grant, accountants will need to exercise good judgment and common sense to take into account and evaluate all the circumstances that would allow them to clearly identify the grant as either a capital item or a specific revenue item [2, p. 261].

This standard provides for two alternative approaches to the recognition of government subsidies (Article 13): the equity approach, under which the subsidy is recognized outside profit or loss, and the income approach, under which the subsidy is recognized in profit or loss over time, and provides arguments (Articles 14, 15) for each of them [10]. Let's justify the appropriateness of applying the equity method for recognizing natural capital in the equity section of the Balance Sheet in circumstances where a nonmonetary governmental subsidy in the form of a land plot has been provided:

(a)the government subsidy in the form of a non-monetary asset is a financing mechanism through capital pooling and should be recorded in the Balance Sheet;

(b)on the basis of ownership, no repayment of the subsidy is expected, although the granting of the subsidy provides for the performance of certain obligations;

(c)ownership of the transferred asset is vested in the government, which makes a contribution to the aggregate capital of the business similar to that of the shareholders;

(d)finally, the government subsidy in the form of a non-monetary asset represents an incentive for the business unit to carry out operational activities whose vector is social in nature, with which no income or expense is associated.

In accordance with the above:

(1) consider it incorrect to recognize the non-monetary form of the state subsidy (land plot) as deferred income, the main purpose of which is to reflect information on changes in the state of monetary assets;

(2) we propose to open formal accounts: "Funding under public-private partnership agreements," used for initial recognition of a non-monetary form of subsidy and with its subsequent closure to Equity accounts; "Other forms of capital," subaccount "Natural capital under public-private partnership agreements," used for recognition of natural capital;

(3) and finally, we propose to modernize the structure of the Statement of Changes in Equity to present information on recognized natural capital and the reasons for changes in its condition.

As a consequence, we can state that the proposals put forward on the application of three-stage identification and formalized accounts are part of the methodology of natural capital recognition. Its second part, the assessment of natural capital, is a debatable issue and is subject to further study.

The results of this part of the study substantiate hypothesis *H2* - the adequacy of IFRS methodology for the recognition of natural capital as an element of financial statements. Moreover, the authors propose improved methodological techniques for the recognition of natural capital: an algorithm for its identification and the opening of special accounts.

CONCLUSIONS

In this study, hypotheses were put forward and argued, resulting in a general conclusion: the recognition of natural capital as an element of financial reporting is an imperative of the socioeconomic reporting paradigm. Particular conclusions of the study include:

(1) the tendency of state support of business as a taxpayer, which contributes to the increase of its capital at the expense of the depreciation of natural capital, remains in the RM;

(2)the national accounting and reporting system lacks the conceptual space for the recognition of natural capital as a result of business environment participation in the sustainable development of society, which predetermines its modernization;

(3) the IFRS methodology of applying the equity method to recognize the non-monetary form of the grant is effective for recognizing natural capital as an element of the financial statements.

The result of the applied part of the work are proposals to improve the methodological techniques for the recognition of natural capital: a three-step algorithm for identification and reasoned opening of a special account.

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TECHNICAL EFFICIENCY DETERMINANTS OF OECD COUNTRIES' AGRICULTURAL PRODUCTION - A STOCHASTIC FRONTIER ANALYSIS APPROACH

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Abstract

The purpose of this study is to analyze the efficiency in OECD countries' agricultural sector and also to examine some selected factors that affecting the efficiency of production in this sector. For this aim, using Stochastic Frontier Analysis (SFA) during the period 2015-2019, the agricultural producers' technical efficiency in all 38 OECD member countries was evaluated. However, some factors affecting efficacy in these countries were also examined. According to the study's results, the average technical efficiency value in the agricultural sector of OECD countries in the 2015-2019 period was 78.6%. The countries with the lowest and highest average technical efficiency were Luxembourg and Colombia, respectively. On the other hand, as a result of the examination of the factors affecting the efficiency in these countries, it was revealed that the Global Innovation Index variable did not affect the efficiency of agricultural producers, but the reel exchange rate and agricultural pesticide use variables positively affected the efficiency.

Key words: *efficiency, Stochastic Frontier Analysis (SFA), OECD Countries, Global Innovation Index, agricultural economics*

INTRODUCTION

The agricultural sector is of special importance in terms of having significant capabilities and capacities and is noteworthy in terms of its role in providing food to the people and raw materials of some industries. Also, most of the income from non-oil exports comes from this sector and has a comparative advantage over other economic sectors due to high employment and less foreign exchange [11]. The agricultural sector, as the oldest production activity with a rural origin, has been of special importance in the process of growth and development of different countries in different periods. The researches in different countries development process shows that it is vital the development of agricultural sector as one of the most important economic sectors for sustainable development realization of each country; Therefore achieving prosperity and development in other sectors, including industry is not possible without removing the development obstacles in this sector. From the point of view of the European Union, achieving economic development requires achieving agricultural development [20]. Agricultural development is the most important priority in national development programs in most countries and it plays a very important role in the process of growth and development of these countries. Since this economic sector is important in terms of meeting the nutritional needs of the people and the raw materials of industries as well as creating employment and income, its stability and continued growth can be considered as major factors contributing to social stability and economic growth of society [10]. But without management and empowerment of production resources in agricultural sector, development in this sector is not possible. Therefore, in order to maintain production resources and the optimal use of these resources, as well as making a positive change in the agricultural sector situation, paying attention to the development of this sector is necessary. However, today, being interested to the agricultural sector has become a obligation and political independence that it is tied to food security and the basic needs of the people. Therefore, to address this need, efforts should be made to improve the use of production resources in the agricultural sector [5].

Due to the low level savings of most farmers, the most important way for farmers to raise the required capital is to use bank credits. The development of the agricultural sector and its future is a concern of many policymakers in the most country and apparently in all the plans of the country more attention is paid to other sectors. Among the variables, bank credits used in the agricultural sector can lead to increase the economic growth of country by increasing this sector's value added. Therefore, using correctly and optimally of bank credits, can remove lack of financial resources problem that it is one of the important barriers in the growth and development of the agricultural sector. Solving this, lead to improved performance of agricultural inputs and therefore increase the value added of this sector [18]. In addition, like every production sector, innovations and inventions in this sector may affect the technical performance of the producers. On the other hand, many economists believe that the existence of a strong agricultural sector is a necessity in the process of economic development, and until the development barriers of this sector are removed, other sectors will not achieve growth and development. The experience of successful countries in the field of agricultural production shows that the use of capital equipment in various agricultural activities has led to increased productivity of factors of production, including management, labor and land. This, in addition to covering the cost of production factors and creating a good return on investment, has led to a surplus of domestic supply and the development of agricultural products exports [15].

Therefore, considering the importance of the agricultural sector in the country's economy, this study seeks to examine the optimal use of production factors in the agricultural sector of OECD countries and also to examine the impact of some economic factors such as agricultural pesticides used, reel exchange rates and innovation on the efficiency of this sector using the Stochastic Frontier Analysis (SFA) method in the period between 2015-2019.

MATERIALS AND METHODS

The literature on Stochastic Frontier Analysis began in the 1950s with the [12], [6] and [19] and continued by [17]. According to [7]'s definition, technical efficiency is the firm's ability to obtain the maximum output from a certain amount of input. In addition, Farrell was the first to be able to estimate technical efficiency in practice. This evolutionary path in efficiency measurement was initially associated with non-parametric methods and then parametric approaches were used by focusing on production functions. In parametric frontier models, the production inefficiency component is expressed by a specific probability distribution function, while in nonparametric models, this component is considered without considering a statistical distribution function.

Nonparametric models include Data Envelopment Analysis (DEA) models, which is in fact a mathematical programming method. These models estimate frontier functions by determining the best performance among all observations and relate all firm deviations from the frontier to inefficiencies. On the other hand, parametric frontier models include Deterministic Frontier Approach (DFA) models and Stochastic Frontier Analysis (SFA) models. Following a theoretical framework for measuring performance presented by Farrell, [2] introduced the model of a deterministic frontier function. In this model, it is assumed that the only source of error in the frontier production function is inefficiency, and the impact of other error terms and statistical disturbances is not considered [14]. Later, practical measurements of efficiency using a stochastic frontier production function method performed by [1].

The derivative form of the original model for measuring efficiency using the production function estimation proposed in 1987 by the model of Aigner, Lovell, Schmidt, Meeusen and Den Broeck for cross-sectional data was as follows:

$$Y_i = f(X_i, \beta) TE_i e^{V_i} \quad (1)$$

where: Y is the output and X is input. In the model, the efficiency is between zero and one ($0 \leq TE(y_i, x_i) \leq 1$) and β is the vector of the production function parameters that must be estimated. v is a random component that converts a certain frontier to a stochastic frontier and explains factors that are beyond the control of the producer; Factors such as favorable or unfavorable external events (such as luck, weather, machine malfunctions) as well as measurement errors and other unimportant variables that have been excluded from the model.

Since the production function is specified linearly with respect to the variables, the experimental function is presented as follows:

$$\ln Y_i = \ln f(X_i, \beta) + \ln TE_i + V_i = \ln f(X_i, \beta) - U_i + V_i \quad (2)$$

U_i is a measure of technical inefficiency so that $U_i = -\ln TE_i$ and it is representative of the factors that cause inefficiency in production and includes such things as differences in skills and effort or lack of effort of management and employees, unique information of an enterprise and information constraints and so on. The economic interpretation of U_i , which defines inefficiency, is consistent with Farrell's definition. Since the efficiency (TE_i) cannot be greater than one, U_i must include one-sided values. Therefore, in the models that will be used in the research, the basic model for panel data is expressed in the following general form:

$$Y_{it} = f(X_{it}; \beta) + \varepsilon_{it} \quad (3)$$

or

$$Y_{it} = \beta_\circ + X'_{it}\beta + \varepsilon_{it} \quad (4)$$

Where Y_{it} represents the amount of output or product of firm i (i = 1,2,…., N) at time t. X_{it} represents the homogeneous matrix of K and β is the unknown $K \times 1$ vector of the coefficients to be estimated. The residual term ε is also introduced as follows:

$$\varepsilon_{it} = V_{it} - U_{it} \quad (5)$$

where, U_{it} represents inefficiency and V_{it} represents the random error terms. It should be noted that the deviation from the observed points of the frontier production function depends on the two parts U_{it} and V_{it}, and the econometric logic of the separation of U_{it} and V_{it} is that these two random variables are different in terms of behavioral characteristics. As a result, the value of U_{it} can be separated from V_{it}, by specifying a model for U_{it}. It is also assumed in all models that the random term has a normal distribution with a mean of zero and an sismilar variance δ_v^2:

$$V_{it} \sim iidN(0, \delta_v^2) \quad (6)$$

To identify the factors that change technical efficiency, [13] and [17] proposed the term U_i inefficiency as a function of some of the factors affecting firm's inefficiency and the component of random error. Later, [3] introduced an equivalent model to this model, except that the use of panel data was allowed. The specifications of the Battese and Coelli model are as follows:

$$Y_{it} = X^*_{it}\beta + (v_{it} - u_{it}) \quad (7)$$

$$u_{it} = Z_{it}\delta + w_{it} \quad (8)$$

u_{it} are non-negative variables indicating technical inefficiencies and are assumed to be distributed independently of v_{it} and has a normal distribution N (M_{it} , δ_u^2) thet interrupted at zero with mean of $M_{it} = Z_{it}\delta$ and variance of δ_u^2. z is the vector $(1 \times m)$ of the variables affecting the inefficiency value during the period under study. δ is also a vector (m × 1) of unknown coefficients that must be estimated.

Explanatory variables Z_{it} can also include inputs of random frontier production function. The random variable w_{it} has a interrupted normal distribution with mean zero and variance σ_w^2 and at the point of intersection is equal to $-Z_{it}\delta$ and must always be $w_{it} \geq -Z_{it}\delta$. Under these assumptions, the term u_{it} becomes non-negative with a interrupted distribution of $N(M_{it}, \delta_u^2)$.

To estimate the Battese and Coelli inefficiency effects model, the maximum likelihood method can be used to simultaneously estimate the parameters of the random frontier function and the technical inefficiency effects model.

In this study, the data of the agricultural sector producers of 38 countries that are members of the Organization for Economic Co-operation and Development (OECD) during 2015-2019 will be used. Although data for 2020 year are available for some of the variables discussed, since this year's data are missing in some countries, and also in order to include all of the OECD group countries in the analysis, 2019 year was considered as the last updated year. While 20 countries joined to OECD until 14 December 1960, 18 countries have joined this group since then, increasing the total number of member countries to 38.

The data required in the study were obtained from the [8], [16] and [9]databases and annual reports between the period of 2015-2019. Stochastic Frontier Analysis (SFA), which is an econometric approach, was taken into account to make the estimations and estimations were made using FRONTIER 4.1c and EXCEL 2003 programs.

According to the method discussed, it is necessary to determine the input and output variables. In addition, there is a need to define the variables used in the inefficiency model. In the literature, different input and output variables are used to analyze the efficiency in the agricultural sector. however, in this sector, labor force and capital stock data are frequently used as input variables, while the value added or production value of agricultural products is used as output variable. A total of four input variables will be used, with the use of agricultural land and the amount of energy used in the agricultural sector along with labor force and capital stock variables. The agricultural sector value added of the countries is considered as the only output variable. The agricultural pesticides used in this sector, the real exchange rates of the countries and the Global Innovation Index variables were used as the variables affecting the inefficiency of the agricultural sector producers in OECD countries.

Global Innovation Index includes two sub-categories of innovation input and innovation output. Innovation input represents innovative activities and has five sub-categories: inputs, human capital and research, infrastructure, market Sophistication, and business Sophistication. The innovation output represents the results of innovative activities and it includes two sub-categories: the knowledge and technology outputs and the creative outputs [4].

RESULTS AND DISCUSSIONS

The main purpose of this study is to examine the performance analysis in the agricultural sector of OECD countries between 2015-2019 and also to examine some variables that affect this performance. Stochastic Frontier Analysis (SFA) method, which is a parametric method, was used to estimate the efficiency values of the countries. For estimating the production function of the agricultural sector by this method, the type of function on which the data fit should be specified. In most studies, the Translog or Cobb-Douglas production function is usually used. However, in this research, a hypothesis test will be made to determine the appropriate function type and it will be decided which function to use by looking at the test results. However, there is a need to determine the distribution type in the study and also to test the hypothesis that the term inefficiency affects the agricultural production of these countries.

Due to the approximate standard deviation of t-test coefficients, this test is not satisfactory and therefore to test the significance of the frontier production function, the generalized maximum likelihood ratio test (LR) is used:

$$LR = -2[\text{Log likelihood}(H_\circ) - \text{Log likelihood}(H_1)] \quad (9)$$

where: $\text{Log likelihood}(H_\circ)$ and $\text{Log likelihood}(H_1)$ denote the Likelihood value of the constrained and unconstrained functions, respectively. The distribution of the test is the extended Chi-Square distribution with numbers of restrictions as degrees of freedom.

The hypothesis testing results of likelihood ratio for frontier production function parameters are shown in Table 1. The hypothesis test in the first row is done to determine the appropriate production function.

Table 1. Log likelihood Ratio Tests Results

Null Hypothesis	Log likelihood	LR Value	Critical Value		Decision
			%1 level	%5 level	
$\beta_{11} = \beta_{12} = \cdots = \beta_{ij} = 0$	-57.88 -57.34	1.08	22.525	17.670	$H_\circ$ accepted
$\mu = 0$	144.54 144.91	0.74	5.412	2.706	$H_\circ$ accepted
$\delta_1 = \delta_2 = \cdots = \delta_n = 0$	144.54 -57.88	404.84	10.501	7.045	$H_\circ$ rejected
$\gamma = 0$	-	448.07	12.483	17.670	$H_\circ$ rejected

Source: Research Findings.

Accordingly, the Cobb-Douglas production function was tested against the Translog production function. Since the LR value could not exceed the critical value at the 1% or 5% significance level, the test result was not significant and therefore the $H_\circ$ hypothesis was accepted. Therefore, the Cobb-Douglas production function, which is a constrained function, was determined as the appropriate function form for this study.

The hypothesis of $\mu = 0$ is related to whether the model is restricted with half normal distribution or unrestricted with truncated normal distribution for the inefficiency component. According to the LR test statistics, since the LR test statistics (0.74) could not exceed the critical value, the null hypothesis could not reject and thus the half normal model is sufficient. According to these hypothesis tests, a Cobb-Douglas production function with half-normal distribution is considered for the inefficiency term in present study. Using the LR test, it will be decided whether the inefficiency term is included in the model. Accordingly, the constrained model without factors affecting inefficiency can be tested against the unconstrained model with influencing factors. This hypothesis test is in the third row of Table 2. According to the LR test results, the $H_\circ$ hypothesis is rejected because the statistical value exceeds the critical value. Therefore, in the model, besides the random term, the inefficiency term should also be included. In other words, it is necessary to examine some factors affecting inefficiency in the OECD agriculture sector. For this reason, Maximum Likelihood Ratio method estimators will be used instead of OLS method in the estimation of the model.

Whether there is an inefficiency effect in the model can also be tested by looking at the LR test of the γ coefficient. Accordingly, it is seen that the LR test statistical value (448.07) given in Table 1 is higher than the critical value. Therefore, the $H_\circ$ hypothesis was rejected and the test was significant. Thus, in this model, it has been proven again that some factors affecting inefficiency should be examined.

Table 2. The maximum likelihood estimation (MLE) for parameters of Cobb-Douglas stochastic frontier for Agriculture Sectors of OECD Countries

Variable*	Parameters	Coefficients	Std. Error	t statistics
Constant	$\beta_\circ$	1.35	0.24	5.72
Ln(AE)	β_1	0.31	0.024	12.99
Ln(ACS)	β_2	0.42	0.032	13.02
Ln(ALU)	β_3	0.14	0.023	6.17
Ln(AEU)	β_4	0.11	0.017	6.25
Sigma-Squared	$\sigma^2 = \sigma_u^2 + \sigma_v^2$	0.64	0.14	4.54
Gamma	$\gamma = \sigma_u^2/\sigma^2$	0.99	0.0018	559.32
LR	-	-57.88	-	-

* AE, ACS, ALU and AEU represent Agricultural Employment, Agricultural Capital Stock, Agricultural Land Use and Agricultural Energy Use respectively. Ln is the natural logarithm.

Source: Research Findings.

The results of estimating the maximum likelihood of the parameters in the agricultural sector of OECD countries during the period 2015-2019 using the SFA method are shown in Table 2.

Considering the results in Table 2, the coefficients of all variables were significant at the 1% significance level. This shows that the effects of the variables discussed in the agricultural sector production of OECD countries are very important.

When the signs of the variables coefficients are taken into consideration, the signs of all the coefficients have emerged in accordance with the expectations. This means that the marginal production values of the variables used in the study are positive and therefore they affect agricultural production in OECD countries in the same direction.

Looking at the scale elasticities of the agricultural sector in OECD countries, it is understood that there is a decreasing return to scale in this sector ($\varepsilon = 0.98$). Accordingly, it is seen that the increase in the production scale in these countries does not have a positive effect on production, and instead, increasing the production factors is more effective.

The gamma variable value of the model was 0.99 and its t statistical value was significant at the 1% significance level. This means that socio-economic variables that affect inefficiency are introduced in the model, and therefore the error term should consist of not only random effects but also inefficiency effects. In addition, the closer the Gamma value is to 1, the more effective the inefficiency term in the model. Therefore, an analysis of the socio-economic aspect of the OECD agriculture sector may be more appropriate to explain the current efficiency gap. This result was also revealed by the LR test of the gamma coefficient before. Therefore, the LR test confirmed that the inefficiency effect of socio-economic background in the OECD agriculture sector strongly influences technical efficiency among OECD agricultural producers.

As a result of the Maximum Likelihood Estimation (MLE) of the inefficiency effect, a description of the socio-economic factors that affecting technical efficiency is provided in Table 3.

Table 3. The Maximum Likelihood Estimation (MLE) of Inefficiency Effect

Variable	Parameter	Coefficients	Std. Error	t istatistics
Constant	$\delta_\circ$	1.31	0.87	1.50
Agriculture Energy Use	δ_1	-0.15	0.025	-6.07
Annual Exchange Rate	δ_2	-0.27	0.038	-7.04
Global Innovation Index	δ_3	0.73	0.22	0.33

Source: Research Findings.

Considering the results, the coefficients of Agricultural Energy consumption and annual real exchange rate changes were significant at the 1% confidence level. The coefficients of these variables were negative. This means that the change of these variables positively affects the agricultural production efficiency of OECD countries. The effect of energy consumption can be explained by the agricultural machinery used in this sector. Increasing energy consumption means that agricultural machinery is used more in this sector and is therefore expected to positively affect efficiency. In other words, it can be said that producers using energy for agricultural production in OECD countries are more efficient.

It is understood that the negative annual real exchange rate coefficient affects the agricultural production efficiency of OECD countries positively. The effect of the real exchange rate can be explained by the change in exports. Accordingly, an increase in real exchange rates increases the export of goods produced in that country and thus enables producers to produce more by using resources efficiently.

The coefficient of the Global Innovation Index variable was positive and insignificant. Since the coefficient of this variable is positive, it is seen that OECD agriculture sector efficiency is negatively affected. However, this variable's coefficient is not significant. Therefore, this variable's effect on agricultural production efficiency is not taken into account. In other words, this variable do not affect the agricultural sector efficiency of OECD countries. One of the reasons for this may be that OECD countries are generally industrial countries and innovations are made in the industrial sector and there is not much innovation in the agricultural sector of these countries. So this sector's efficiency does not affect by innovations.

The agricultural sector efficiency values of OECD countries for the period 2015-2019 are shown in Table 4.

According to the results in this Table, the general average of agricultural producers' efficiency in OECD countries was 78.6% in the period under consideration.

This means is that producers in the countries studied do not use, on average, about 21% of their resources at an optimal level.

In the period under consideration, the lowest efficiency value belongs to Luxembourg with 0.33 in 2017 and 2018 years. By promoting the quantities and use of inputs in efficient producers, it is possible to increase production by up to 0.67 in this country. Otherwise, maximum production will not be achieved. In the country group examined, the highest efficiency value occurred in the Columbia country in 2019. In the period under consideration, no country in OECD countries has reached full efficiency in the agricultural sector. In other words, it is seen that agricultural producers of all countries produce under the frontier production function. In this sense, it is seen that the technical efficiency values in these countries are in the range of 0.33-0.97.

Looking at the annual averages in Table 4, the average technical efficiency of agricultural producers in these countries did not change much between 2015-2019. This means that in these countries, not much effort has been made to reach the optimal level of agricultural products and production has been made with the same resources and production technologies.

Figure 1 shows how the technical efficiency of agriculture producers is distributed during this period.

Table 4. Annual Technical Efficiency of Agriculture Sector of OECD Countries

Country	**Year**				
	2015	2016	2017	2018	2019
Australia	0.81	0.84	0.82	0.80	0.79
Austria	0.52	0.53	0.56	0.59	0.58
Belgium	0.80	0.78	0.79	0.77	0.77
Canada	0.88	0.89	0.89	0.90	0.90
Chile	0.95	0.95	0.95	0.95	0.95
Colombia	0.96	0.96	0.96	0.96	0.97
Costa Rica	0.94	0.94	0.94	0.94	0.94
Czech Republic	0.87	0.87	0.86	0.86	0.87
Denmark	0.78	0.75	0.77	0.74	0.80
Estonia	0.56	0.50	0.51	0.42	0.53
Finland	0.73	0.74	0.73	0.72	0.73
France	0.88	0.87	0.88	0.89	0.89
Germany	0.78	0.78	0.77	0.73	0.75
Greece	0.76	0.75	0.77	0.78	0.80
Hungary	0.94	0.94	0.94	0.94	0.94
Iceland	0.87	0.86	0.85	0.85	0.86
Ireland	0.62	0.63	0.66	0.61	0.69
Israel	0.91	0.91	0.91	0.91	0.91
Italy	0.88	0.89	0.89	0.89	0.89
Japan	0.94	0.94	0.94	0.94	0.94
Latvia	0.52	0.49	0.50	0.50	0.52
Lithuania	0.58	0.58	0.57	0.53	0.55
Luxembourg	0.37	0.36	0.33	0.33	0.35
Mexico	0.94	0.94	0.95	0.95	0.95
Netherlands	0.84	0.85	0.85	0.85	0.85
New Zealand	0.82	0.80	0.80	0.82	0.82
Norway	0.89	0.88	0.89	0.89	0.90
Poland	0.86	0.87	0.87	0.86	0.86
Portugal	0.72	0.72	0.72	0.71	0.73
Republic of Korea	0.96	0.96	0.96	0.96	0.96
Slovakia	0.62	0.65	0.62	0.66	0.66
Slovenia	0.53	0.57	0.53	0.57	0.59
Spain	0.86	0.87	0.86	0.86	0.86
Sweden	0.86	0.85	0.86	0.86	0.87
Switzerland	0.56	0.57	0.56	0.58	0.59
Turkey	0.89	0.90	0.91	0.92	0.93
United Kingdom of Great Britain	0.78	0.78	0.78	0.78	0.79
United States of America	0.87	0.87	0.87	0.87	0.87
Annual Mean	*0.769*	*0.766*	0.765	*0.761*	*0.776*
General Mean	0.786				

Source: Research Findings.

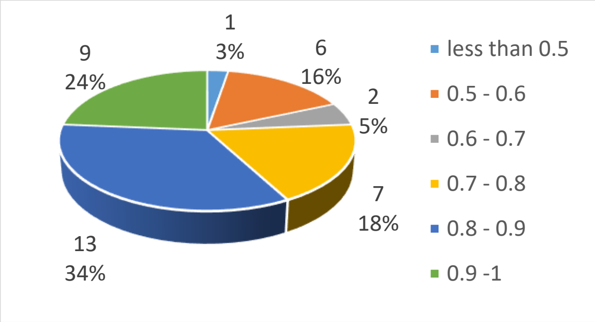

Fig. 1. Distribution of Technical Efficiency of Agriculture Sector in OECD Countries Between 2015-2019.
Source: Research Findings.

According to Figure 1, the average technical efficiency of 9 out of 38 OECD countries (24%) was above 0.9 in the period under consideration. Among countries, only one country (Luxembourg) has a technical efficiency value of less than 0.50. This corresponds to a low rate of 3% among 38 countries. It shows the potential for increasing agricultural production in this country by improving the technical efficiency of producers in the current technical conditions.
On the other hand, 13 country of OECD countries, have an average technical efficiency value between 0.80 and 0.90 in the agricultural sector. These countries have the highest rate (34%) among the total OECD countries as well. Consequently, there are is 29 countries with an average technical efficiency higher than 0.70 in the examined OECD countries, which corresponds to 76%. This shows that the agricultural producers in these countries are using the available resources close to the optimal level.
The comparative technical efficiency values of agricultural producers in OECD countries between 2015-2019 are shown in Table 5. Considering Table 5, the lowest and highest technical efficiency difference among OECD countries in the examined period belongs to Estonia with 0.142. The gap emerging in this country point to the potential of achieving the increase in agricultural production with the increase of technical efficiency in terms of production and management technology. On the other hand, the country with the lowest difference in maximum and minimum technical efficiency among these countries was the Republic of Korea with 0.001.

Table 5. Comparison of Technical Efficiency of Agricultural Sector of OECD Countries between 2015-2019

Country	Mean Efficiency	Minimum Efficiency	Maximum Efficiency	Difference
Australia	0.813	0.793	0.838	0.044
Austria	0.557	0.523	0.586	0.063
Belgium	0.783	0.766	0.804	0.038
Canada	0.892	0.883	0.900	0.017
Chile	0.952	0.951	0.953	0.002
Colombia	0.964	0.962	0.967	0.005
Costa Rica	0.940	0.939	0.941	0.003
Czech Republic	0.866	0.859	0.873	0.013
Denmark	0.768	0.744	0.797	0.053
Estonia	0.500	0.421	0.562	0.142
Finland	0.730	0.717	0.739	0.022
France	0.879	0.865	0.887	0.022
Germany	0.762	0.733	0.779	0.046
Greece	0.773	0.747	0.804	0.057
Hungary	0.938	0.937	0.940	0.003
Iceland	0.858	0.846	0.872	0.026
Ireland	0.642	0.613	0.689	0.076
Israel	0.913	0.911	0.914	0.002
Italy	0.885	0.877	0.888	0.011
Japan	0.942	0.941	0.943	0.002
Latvia	0.505	0.489	0.520	0.031
Lithuania	0.564	0.529	0.584	0.055
Luxembourg	0.346	0.328	0.367	0.039
Mexico	0.946	0.943	0.948	0.005
Netherlands	0.847	0.845	0.850	0.005
New Zealand	0.813	0.799	0.823	0.025
Norway	0.890	0.884	0.897	0.013
Poland	0.866	0.856	0.873	0.017
Portugal	0.719	0.713	0.727	0.014
Republic of Korea	0.962	0.962	0.963	0.001
Slovakia	0.641	0.619	0.664	0.045
Slovenia	0.556	0.527	0.585	0.058
Spain	0.864	0.860	0.869	0.009
Sweden	0.859	0.851	0.869	0.018
Switzerland	0.573	0.560	0.592	0.032
Turkey	0.910	0.895	0.926	0.031
United Kingdom of Great Britain	0.784	0.793	0.838	0.044
United States of America	0.869	0.523	0.586	0.063

Source: Research Findings.

However, the results of Table 5 show that, in general, OECD countries have a low difference in maximum and minimum technical efficiency of agricultural producers. Accordingly, OECD countries have the average technical efficiency values between 0.328 and 0.967. However, the lowest average technical efficiency belongs to Luxembourg (0.346) and highest belongs to Colombia (0.964) during the 2015-2019.

CONCLUSIONS

In this study, the technical efficiency of agricultural production in OECD countries during 2015-2019 was investigated. For this purpose, first, after estimating the shape of Cobb-Douglas production function and selecting it as the optimal form of the relationship between production and inputs use, the technical efficiency of these countries was measured by stochastic frontier analysis. The results showed that the average technical efficiency in the studied countries was 78.6%, which ranged from a minimum of 32.8% to a maximum of 96.7%. It was also found that Luxembourg with 34.6% had the lowest and Colombia with 96.4% had the highest average technical efficiency in this period.

The coefficients of all the inputs used in the study were positive and significant and consistent with the expectations. The input that has the most impact on agricultural production in OECD countries has been the capital stock variable. On the other hand, in the factors affecting inefficiency in these countries, the coefficient of the Global innovation index variable was positive and insignificant. However the effects of the real exchange rate and pesticides use variables on agriculture sector inefficiency were negative and significant.

In general, according to the obtained results, the following suggestions can be made:

-The results of estimating the frontier function indicated that by improving management there would be a high capacity to increase production in this sector. For this reason, considering this possibility for production increase in the agricultural sector, providing the necessary relevance measures is necessary and important.

-The results of efficiency calculation showed that there is a relatively large gap in some countries in terms of technical efficiency. The results of technical efficiency calculation showed that there is a relatively large gap in some countries in terms of technical efficiency.

-Since the GII variable does not have an effect on agricultural production inefficiency in OECD countries, instead of innovation other variables that have an effect on agricultural sector production increase should be included in these countries.

-Finally, according to the findings of this study, it can be said that instead of increasing inputs in the agricultural sector, it is necessary to emphasize the more efficient use of existing inputs and their more appropriate composition.

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MODELS FOR EVALUATING THE DYNAMICS OF MAIZE CROP AND ESTIMATING PRODUCTION BASED ON SATELLITE IMAGES

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Abstract

The study used remote sensing-based techniques to monitor a maize crop, the Pioneer 9911 hybrid, and thus predict the production for crop and farm management. The Sentinel 2 satellite system was used to obtain the satellite scenes. Satellite images were taken at 10 different times, between April 26 and October 3, 2021. Based on spectral information, the NDMI, NDVI, CIG and NBR indices were calculated, and they were used to describe the dynamics of maize crop during the study period and prediction of maize production. The dynamics of maize cultivation was quantified based on NDMI, NDVI and CIG indices in statistical accuracy conditions at the level of R^2= 0.943 to R^2= 0.976, p <0.001, and based on the NBR index at the level of R^2= 0.802, p = 0.0156. The prediction of maize production was possible based on the indices calculated in statistical accuracy conditions (p<0.001, R^2>0.990). The errors calculated between predicted production (YP) and real production (YR) varied according to the image capture time and the combination of indices used in the regression analysis.

Key words**:** *crops management, maize, models, remote sensing, Sentinel 2, yield prediction*

INTRODUCTION

The methods of evaluating agricultural crops have evolved a lot, from simple direct observation by the farmer, until the use of remote surveillance and monitoring techniques, based on imaging analysis [12, 15, 30, 40]. Techniques based on remote sensing and GIS have developed and became more and more accessible, due to the facilities offered by different satellite systems and the delivery of images at adequate and accessible resolutions [3, 8, 24, 26].

In addition to direct spectral information, satellite images offer the possibility to find new information, through different specific indices, in relation to the category of analyzed surface (natural areas, agricultural crops, urban ecosystems, etc.) for the purpose proposed in the study [2, 46].

Thus, the indices calculated on the basis of spectral information in different satellite systems, offer new and more precise information, with a higher refinement of analysis and evaluation of agricultural crops, in relation to natural or technological factors of influence [28, 35, 41, 46].

Various studies based on remote sensing have addressed aspects of crop monitoring [18, 22, 34], evaluation of water provision for the crops [1, 39], providing the nutrients and fertilizing crops [5, 6, 38], plant protection [13], estimation of productions [14, 23, 27] and other aspects of practical importance. Aspects related to the prediction of crop production based on remote sensing, are also of interest in relation to the agricultural products market, the sustainability of the rural environment and food security [20].

Farm and crop management based on remote sensing, benefits from real-time information with high precision and very detailed, regarding agricultural crops, in terms of physiological indices and processes, plant health, growth rate, biomass production, etc., so that timely intervention decisions can be taken for high-profitability productions [4, 29].

Crop evaluation based on remote sensing is very useful in relation to the nutritional status of plants, especially azoth (N), and nutrient supply by fertilization, in relation to the technical and economic efficiency of each agricultural crop [7, 25, 45, 47].

The monitoring of rice cultivation based on remote sensing (Sentinel-2) has facilitated the evaluation of plant phenology and production parameters, and early interventions (33 days after sowing - tillering stage) through appropriate treatments (biostimulators) led to production increases of up to 13.06% [37]. The authors communicated a culture monitoring strategy based on culture dynamics and correlations between spectral information (green, red, and NIR). Also, the authors San Bautista et al. [37] reported that a new approach (NCMI) was more effective than classical indices (NDVI, GNDVI, or EVI2), as a result of a higher sensitivity when capturing the condition of plants and culture, based on which the intervention decisions are useful / beneficial.

In the context of the interest on remote sensing in the management of agricultural crops and the facilities offered, the present study analyzed a corn crop based on satellite images in the Sentinel 2 system, evaluated the dynamics of the crop in relation to time (days) and found models for estimating the production through indices calculated on the basis of spectral information.

MATERIALS AND METHODS

The study used remote sensing techniques to monitor maize cultivation during the growing season based on calculated specific indices and to estimate maize production based on those indices. The land considered in the study, with an area of 20 ha, is located in the area of Lipova, Arad County, Romania, figure 1. The biological material was represented by the corn crop, the Pioneer 9911 hybrid, the crop being destined for grain production. The sowing was done on April 10, and the harvest on October 20, 2021. The production obtained was 9,170 kg ha^{-1}.

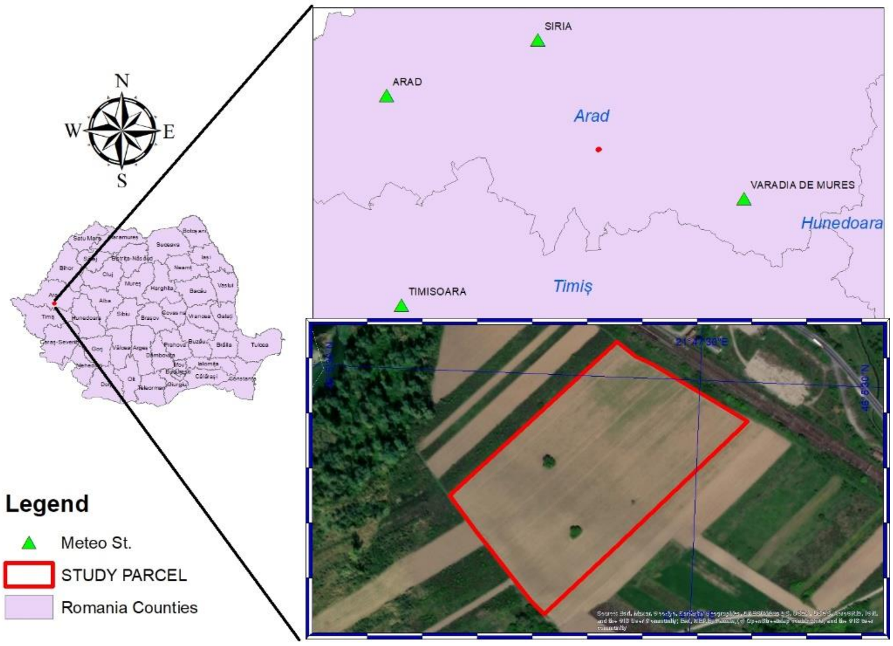


Fig. 1. Framing area and study plot, Lipova locality, Arad County, Romania
Source: Original image.

The Sentinel 2 system was used to take over the satellite scenes in order to characterize the corn crop. 10 satellite images were taken, between April 26 and October 3, 2021. Satellite images were taken at 10 moments during the vegetation period: April 26 (Id1), May 11 (Id2), May 26 (Id3), June 15 (Id4), July 5 (Id5), July 25 (Id6), August 9 (Id7), August 19 (Id8), September 13 (Id9) and October 3 (Id10). The time (T, days) was calculated for each image capture time in relation to the first image capture date.

Based on the satellite images, indices have been calculated: NDMI [42], relation (1), NDVI [36], relation (2), CIG [16, 17, 44], relation (3) and NBR [21], relation (4).

$$NDMI = (B8 - B11)/(B8 + B11) \quad (1)$$

$$NDVI = (B8 - B4)/(B8 + B4) \quad (2)$$

$$CIG = (B8/B3) - 1 \quad (3)$$

$$NBR = (B8 - B12)/(B8 + B12) \quad (4)$$

In order to evaluate the variability of the data (within each index), the coefficient of variation (CV) was calculated. The interdependent relationship between the calculated index values (correlation analysis, parameter r) was evaluated.

The variation of the index values was analyzed in relation to the time during the vegetation period (regression analysis, regression coefficient R^2, parameter p, 95%, for statistical safety). Regression analysis was used to estimate production based on the values of the indices calculated from the satellite images, taken at different moments in time (regression coefficient R^2, parameter p, 95%, and parameter RMSEP, for statistical safety). The data analysis was done in the EXCEL program (mathematical and statistical calculation module), with the PAST software [19], and the Wolfram Alpha software (2020) [43].

RESULTS AND DISCUSSIONS

Based on satellite images, spectral information was obtained (Sentinel 2 system) and NDMI, NDVI, CIG and NBR indices were calculated to characterize the maize crop, Pioneer 9911 hybrid, during the vegetation period, between April 26 and October 3, 2021, Table 1. The graphical distribution, as Matrix plot, shows the temporal variation of the index values, and highlights the minimum (blue colour) and the maximum (red colour), Figure 2.

Table 1. The values of the indices calculated for the temporal characterization of the maize crop

Image acquisition date	Trial	NDMI	NDVI	CIG	NBR	Production (Y) (kg ha^{-1})
26.04.2021	Id1	-0.1298056	0.1466207	0.2365325	-0.0279997	9,170
11.05.2021	Id2	-0.1294211	0.1498069	0.2412191	0.0235460	
26.05.2021	Id3	-0.0065019	0.2542073	0.2915165	-0.1355289	
15.06.2021	Id4	-0.0065019	0.3179364	0.5170612	0.6789103	
05.07.2021	Id5	0.1901094	0.5801357	0.5170612	0.5801357	
25.07.2021	Id6	0.3322841	0.6888322	0.5814463	0.6888322	
09.08.2021	Id7	0.3021260	0.6807519	0.5697305	0.6641069	
19.08.2021	Id8	0.3074087	0.6914967	0.5923583	0.6641069	
13.09.2021	Id9	0.1497599	0.5674268	0.4872892	0.4986275	
03.10.2021	Id10	-0.0805157	0.3557402	0.3118401	0.1913175	

Source: original data calculated based on satellite imagery.

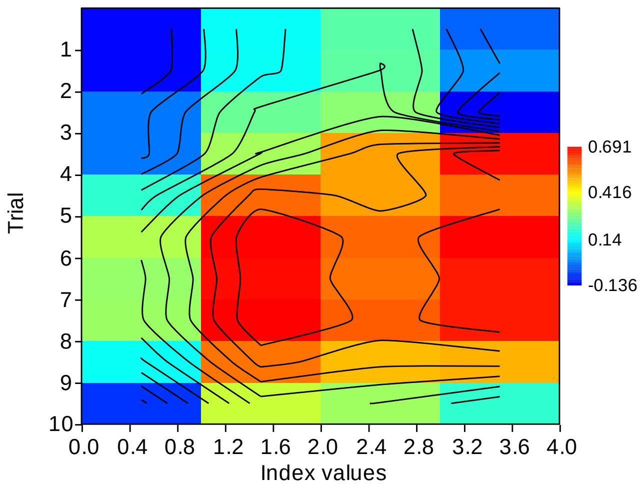


Fig. 2. Temporal variation of index values, arable land, maize crop, the Pioneer 9911 hybrid
Source: original figure.

The index values showed differentiated variability, in relation to the characteristics they express regarding the corn culture. Based on the coefficient of variation (CV), the NDMI index showed the highest variability (CV_{NDMI}=199.3487), and the CIG index showed the lowest variability (CV_{CIG} =33.7172). Indices NDVI and NBR showed intermediate variability, CV_{NDVI}=50.2002, and CV_{NBR}=86.9087.

The variation of the indices values taken into account was analyzed in relation to time, and the method used was regression analysis.

The variation of the NDMI index in relation to the time during the study period was described by equation (5), under conditions of R^2=0.964, p<0.001.

The variation of the DVI index in relation to time was described by equation (6), under conditions of R^2=0.976, p<0.001. The variation of the CIG index in relation to time, during the study period, was described by equation (7), under conditions of R^2=0.943, p=0.00038. The variation of the NBR index, in relation to time, over study periods, was described by equation (8), under conditions of R^2=0.802, p=0.0156.

As example, the graphical distributions of the NDMI and NDVI indices, figure 3, respectively of the NBR index, figure 4, was shown. In the case of the NBR index, deviations of the index values were found in the case of moments Id3 and Id4, from the theoretical model described by the graphical representation of equation (8), associated with the state of vegetation, the presence of weeds and culture maintenance works specific to that period of vegetation. Such highlights are useful as warnings about culture management.

$$NDMI = -0.7288\,E-07x^3 + 0.0001223\,x^2 - 0.0005697\,x - 0.1324 \quad (5)$$

$$NDVI = -7.503\,E-07x^3 + 0.0001263\,x^2 - 0.0004018\,x + 0.1311 \quad (6)$$

$$CIG = -3.436\,E-07x^3 + 3.685x^2 + 0.003621\,x + 0.2055 \quad (7)$$

$$NBR = -6.53\,E-07x^3 + 6.45\,E-05x^2 + 0.008317\,x - 0.1171 \quad (8)$$

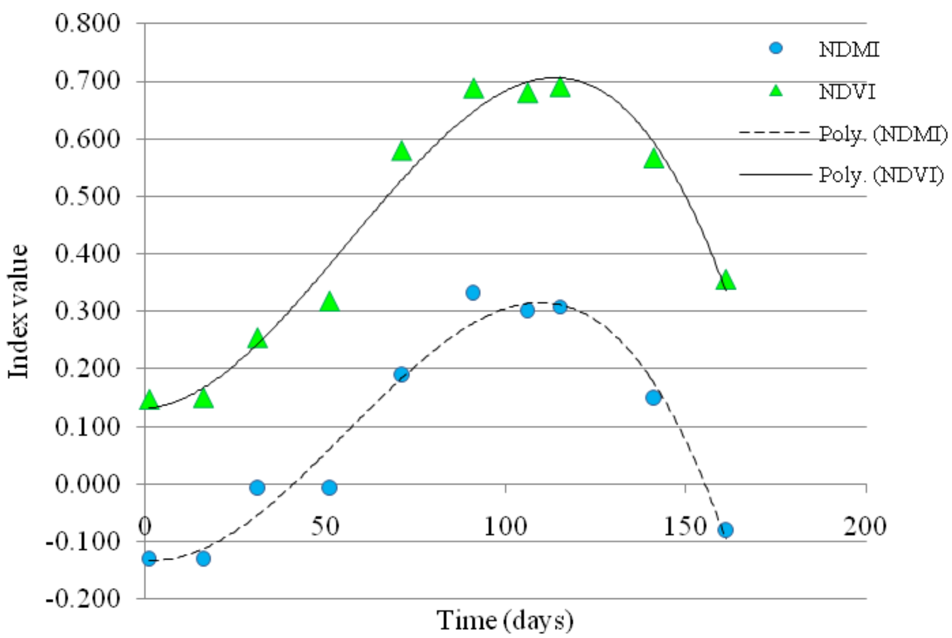


Fig. 3. Graphic distribution of NDMI (blue points) and NDVI (green points) index values in relation to corn crop time, the Pioneer 9911 hybrid
Source: original graph.

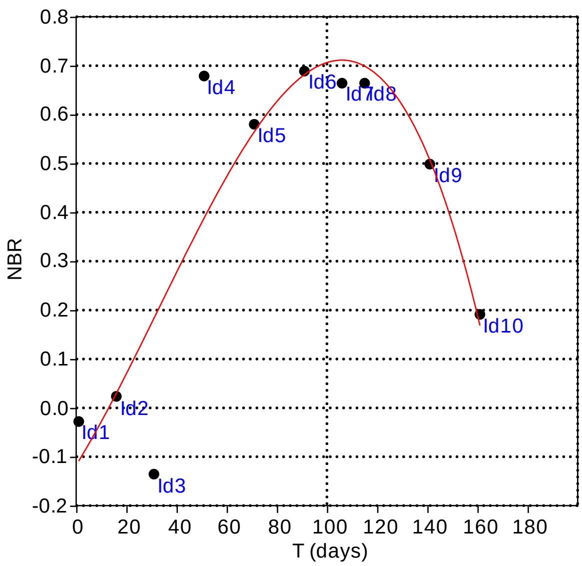


Fig. 4. Graphic distribution of NBR index values in relation to time, maize crop, the Pioneer 9911 hybrid
Source: Original graph

The regression analysis facilitated the obtaining of a general equation, equation (9), for predicting the maize production based on the indices calculated from the satellite images, in conditions of statistical accuracy; $R^2=0.999$, $p<0.001$ under the conditions of using NDMI and NDVI indices, and CIG and NBR indices for production prediction; $R^2=0.992$, $p<0.001$ under the conditions of using NDVI and NBR indices for production prediction.

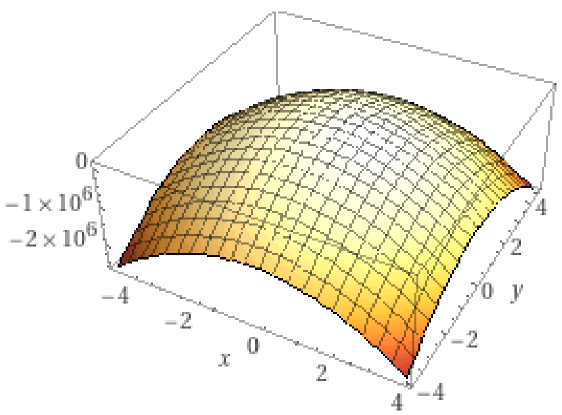
The values of the coefficients of equation (9), in relation to the combination of indices (x,y) used in the production prediction, are shown in Table 2. Graphical representation of production (Y), in the form of 3D models and in the form of isoquants, in relation with the indices used for prediction, is shown in Figures 5 - 8.

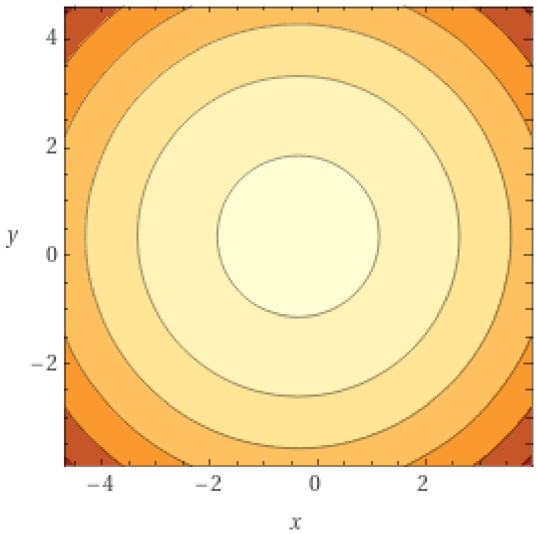
$$Y = ax^2 + by^2 + cx + dy + exy + f \quad (9)$$

Table 2. The values of the equation (9) coefficients

Coefficients of the equation (9)	Equation (9) where			
	x=NDMI y=NDVI	x=NDMI y=CIG	x=NDVI y=NBR	x=CIG y=NBR
a	-75,081.714842	-6,891.227446	-184,135.879732	-115,071.357980
b	-75,958.959869	-55,293.212306	-11,459.093204	-17,158.994608
c	-54,152.888015	-21,970.044962	84,748.843528	65,946.834016
d	53,856.744776	46,106.569634	-38,598.258185	-26,531.322385
e	150,350.421249	47,150.749243	148,673.198434	90,327.705029
f	0	0	0	0

Source: Original data obtained by calculation.





(a) (b)

Fig. 5. 3D model (a), and in the form of isoquants (b), regarding the variation of maize production, the Pioneer 9911 hybrid, in relation to indices NDMI (x-axis) and NDVI (y-axis)
Source: original graphics.

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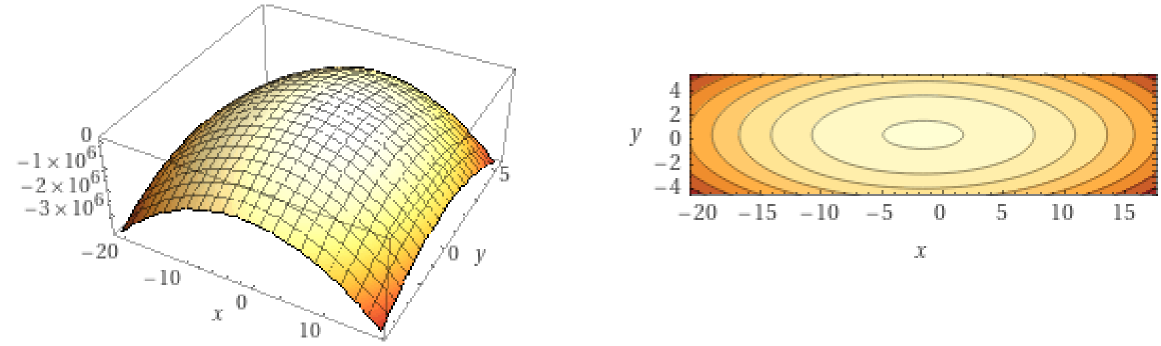
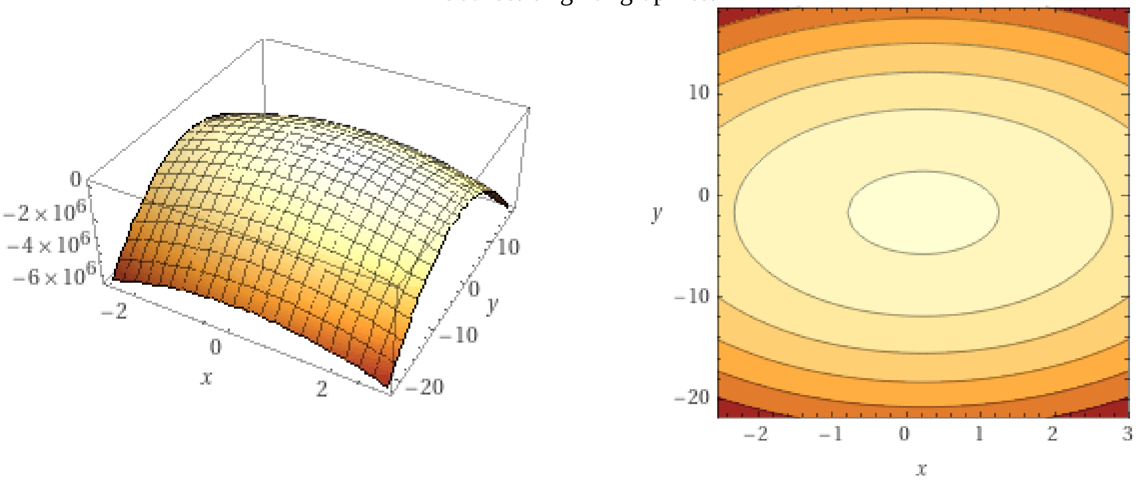


(a) (b)

Fig. 6. 3D model (a), and in the form of isoquants (b), regarding the variation of maize production, the Pioneer 9911 hybrid, in relation to indices NDMI (x-axis) and CIG (y-axis)

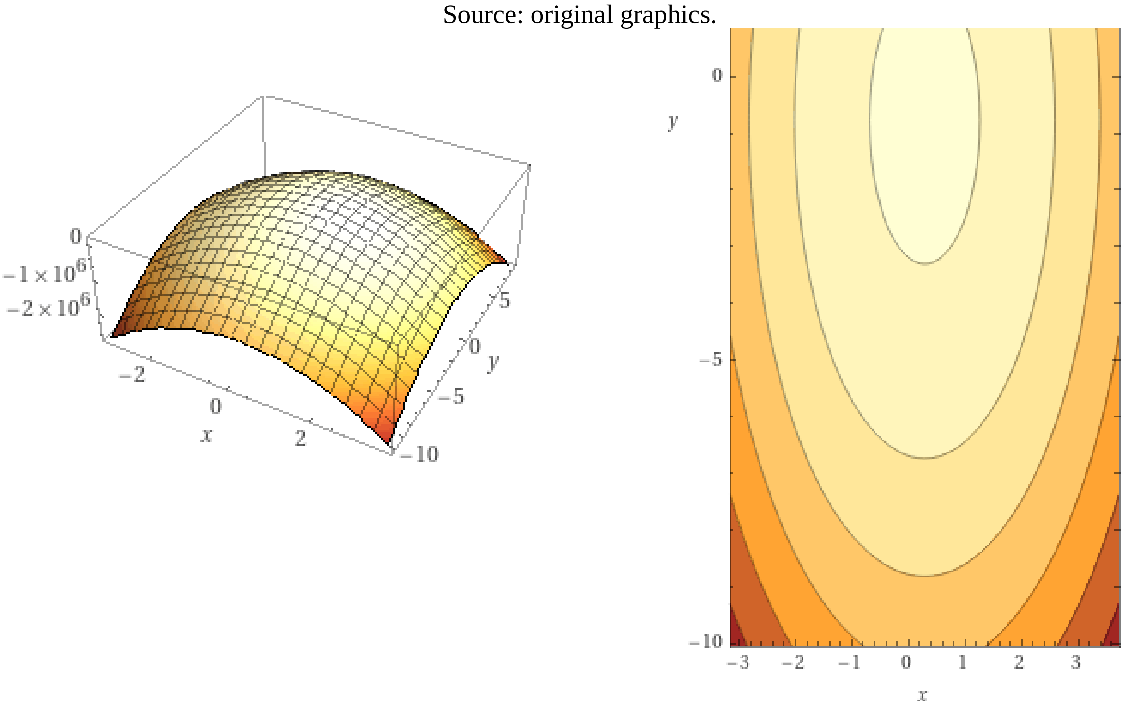
Source: original graphics.



(a) (b)

Fig. 7. 3D model (a), and in the form of isoquants (b), regarding the variation of maize production, the Pioneer 9911 hybrid, in relation to indices NDVI (x-axis) and NBR (y-axis)

Source: original graphics.



(a) (b)

Fig. 8. 3D model (a), and in the form of isoquants (b), regarding the variation of maize production, the Pioneer 9911 hybrid, in relation to indices CIG (x-axis) and NBR (y-axis)

Source: original graphics.

Prediction errors were calculated between real production (YR) and predicted production (YP) based on the indices considered, and calculated based on images taken at different times during the vegetation period, Table 3, with graphical representation in Figure 8.

Table 3. Production prediction errors in relation to image capture time and index combination used

Trial	Real production (Y)	Production prediction error			
		YP1	YP2	YP3	YP4
		x=NDMI y=NDVI	x=NDMI y=CIG	x=NDVI y=NBR	x=CIG y=NBR
	(Kg ha^{-1})	Kg			
Id1	9,170	-3.662	-69.781	-241.146	121.792
Id2		29.333	-9.573	-997.201	-79.163
Id3		-287.375	-374.909	373.211	-12.555
Id4		312.937	-128.807	-233.686	-48.867
Id5		83.158	96.213	1,811.730	92.414
Id6		15.793	-6.422	356.106	31.800
Id7		**0.477**	**-0.139**	-283.190	39.748
Id8		-31.353	-79.172	-1,026.688	-136.500
Id9		-84.408	163.921	-398.477	93.367
Id10		-56.698	371.328	**-9.381**	-110.133

Source: Original data from the calculation

From the analysis values obtained, negative and positive differences were observed, variable in order of size, in relation to the pair of indices used in the regression analysis and the moment of images acquisition on the basis of which they were calculated.

The prediction of production in agricultural crops is of interest in relation to organizing the harvesting process, transport and storage of production, in relation to the processing or exploitation of agricultural production, in relation to food safety [20, 31, 32].

Prediction of production is also important in relation to the behaviour of genotypes of cultivated plants [9], with the performance evaluation of agricultural technologies practiced [10, 11, 33] formulating models for correcting and optimizing technological sequences. Depending on the moment of production prediction and elements identified as potentially limiting, corrective measures can be taken in order to increase crop performance [4, 29].

Li et al. (2022) [25] used regression analysis and machine learning methods to estimate N content, N absorption in maize plants, and biomass production under conditions of statistical safety.

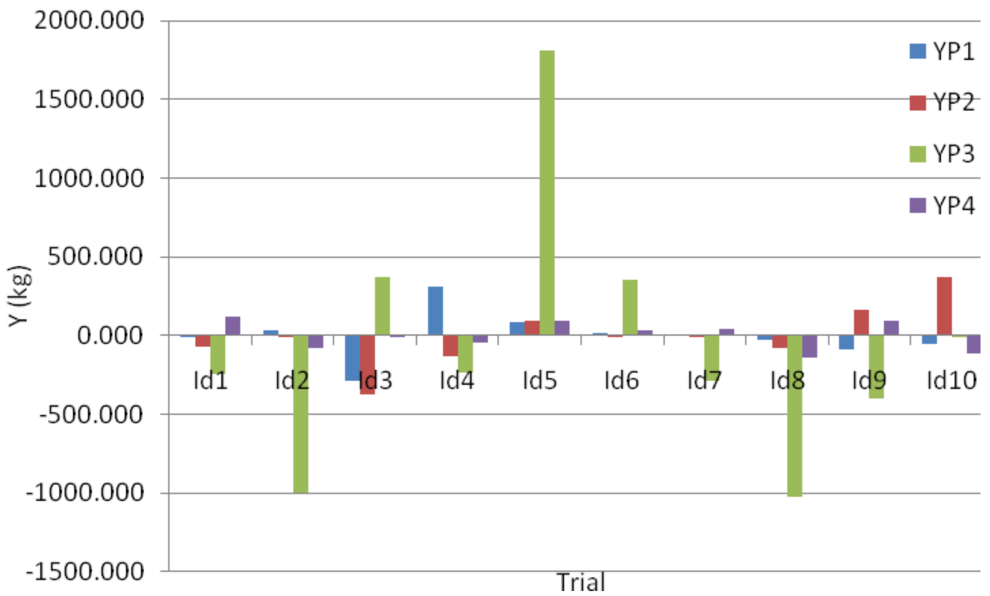


Fig. 8. Graphical representation of prediction errors for maize production, the Pineer 9911 hybrid, based on satellite images (YP1 – estimated production based NDMI and NDVI; YP2 – estimated production based on NDMI and CIG; YP3 – estimated production based on NDVI and NBR; YP4 – estimated production based on CIG and NBR)
Source: original graph.

They communicated different levels of safety (R^2=0.74 to R^2=0.90, respectively R^2=0.840 to R^2=0.930) in relation to the working mode, and high levels of safety were recorded in the case of an integrated approach, when complex information of type (plant genetics - environmental factors – management) were approached together.

In the context of the present study, regarding the safety of the prediction and the analysis of prediction errors in relation to the time of acquiring the images and the indices used, favourable combinations can be found (moment of taking the images and appropriate indices) to provide the most reliable predictions. In relation to these aspects, the management of the maize crop can be adapted, in the context of the purpose and the study conditions, in order to achieve a certain performance in terms of production and profitability.

CONCLUSIONS

Remote sensing imaging analysis, the Sentinel 2 system, has facilitated the obtaining of satellite images that captured the dynamics of maize cultivation under the study conditions, and the calculation of specific representative indices.

The dynamics of the index variation was evaluated in relation to the time during the study period, and based on the indices it was possible to assess the vegetation status of the maize crop, highlighting some deviations from the theoretical models in the case of the NBR index.

The regression analysis facilitated the prediction of the production based on the calculated indices, in conditions of statistical accuracy. The calculated prediction errors varied with respect to the image capture time and indices used in the regression analysis, which facilitates the choice of the appropriate combination (image capture time / index) for high-precision production prediction.

The information obtained can be considered for the improvement of the technology for maize cultivation and the proper management of the farm and agricultural crops.

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CURRENT SITUATION, PROBLEMS AND DIVERSIFICATION OF INSURANCE MODEL IN THE SPHERE OF CROP PRODUCTION IN AZERBAIJAN

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Abstract

Climate change has a significant impact on agricultural productivity, particularly crop production. Research has been focused on the examination of a traditional insurance model applied since 2020 based on state support for the management of agricultural risks. Based on the study of substantial statistical data, the advantages, challenges, and drawbacks of this model in the process of crop insurance are discussed. The study focuses on the frequency of covered risks occurrence, as well as the interrelationships between them based on the country's geographical and climatic characteristics. Risk assessment allows farmers to determine the most likely directions of behavior that may arise in the process of insuring their products. Drought risk was particularly emphasized that is not covered by Agrarian Insurance Fund. Droughts are becoming more frequent as a result of climate change, and their uniform role in crop loss necessitates that the need to address this problem be recognized in current times. The authors substantiate that an index-based insurance model based on weather parameters is a viable alternative to the traditional insurance model for assuring drought coverage, and they advocate using it to diversify the insurance system.

Key words*: *climate change, drought risk, index-based insurance, risk assessment, traditional insurance

INTRODUCTION

Azerbaijan, like many other countries, has designed and executed several actions plans such as procurement prices, tax incentives, direct subsidies, concessional loans in order to compensate agricultural farmers for losses and damages incurred as a result of natural catastrophes and market calamities. Measures to ensure agricultural products have recently risen to the top of the list. On June 18, 2002, Azerbaijan passed the Law of Stimulating Insurance in Agriculture. The law's goal was to encourage the development of insurance in the agricultural sector by insuring the state's involvement in the insurance of agricultural producers' property and to strengthen the economic basis of the guarantee for indemnification of the damage caused by the insured event [15].

It seems from the name of the law that the main goal was to insure the property of agricultural producers. This law has had a significant impact on the agriculture sector's development.

However, it should be noted that the goal of agricultural producers is to make a profit. From this perspective, the problem of minimizing the probability of income decline or loss of productivity caused by natural risks in the insurance mechanism of producers should be a priority.

In this context, the purpose of the paper is to analyze the insurance system adopted in Azerbaijan, its advantages and disadvantages as well as its development prospects.

MATERIALS AND METHODS

The National Hydrometeorological Service of Azerbaijan, the Ministry of Economy of the Republic of Azerbaijan, and the Agrarian Insurance Fund provided data for the article that was used for official reasons but not published in official statistics. The National Hydrometeorological Service's data on the parameters of hail, storm, hurricane, frost, and other catastrophic occurrences during the previous 20 years allows for the determination of the frequency of these events in the administrative areas (districts), as well as the link between them. The Ministry of Economy's statistical data on land balance was utilized as the major evidence in pinpointing the source of the crop insurance development concerns. The Agrarian Insurance Fund's categorization data of insurance premiums written and claims paid in 2021 based on the size of land owned by farms plays a significant role in the evaluation of catastrophic risks.

Furthermore, connecting the information supplied by these authorities to current economic data and statistics aids in the investigation of many of the traditional insurance system's flaws.

According to official data from the Central Bank of the Republic of Azerbaijan, the place of agriculture insurance in the general insurance system was determined by defining the share of insurance premiums written and claims paid in agriculture in total insurance premiums and claims paid in all areas of the country [5].

RESULTS AND DISCUSSIONS

The current situation in agricultural risk insurance

Although agriculture insurance in Azerbaijan is carried out by private companies until 2020, the insurance industry seems to have very little interest in this area. It is no coincidence that such a condition has been noticed in Azerbaijan in conjunction with the slow growth of agricultural insurance.

Even in previous years, the funds allocated from the budget to subsidize the agricultural insurance were not completely utilized. According to the Ministry of Finance of the Republic of Azerbaijan, despite the fact that the subsidies allocated for this purpose in 2013 and 2014 amounted to 1 million manats, its use was in 2013 amounted to 19 thousand manats (0.9%), and 23 thousand manats (2.3%) in 2014. Only 5 out of 26 companies in the insurance market offered their services for crop and livestock insurance during those years. In 2014, 82% of agricultural insurance premiums were on livestock and 18% on crop production. It is noteworthy that during those years share of crop products in claims paid was 64% of insurance premiums while livestock accounted for 8.6% [9]. These statistics have not altered considerably in recent years. Agricultural activities were naturally unappealing to private companies, as the number of insurance claims paid was more than insurance premiums in crop production, more than half in livestock.

Agriculture is one of the leading sectors in Azerbaijan. This sector accounts for 6-7 percent of the gross domestic product and employs around 36% of the population [21]. As a result, the agricultural insurance mechanism has a lot of potential and internal prospects for broad adoption and development. Despite this, agricultural insurance capacity has not expanded to the expected level. However, based on the current potential, this amount might be multiplied several times over.

Table 1. Share of agricultural insurance premiums in total premiums written in the Republic of Azerbaijan (thousand manats)

Indicators	2018		2019		2020		2021	
	Premiums	Claims paid	Premiums	Claims paid	Premiums	Claims paid	Premiums	Claims paid
livestock insurance	2,040.3	574.7	1,438.8	936.7	2,842.0	613.0	6,408.0	574.6
Share in total, %	0.42	0.24	0.21	0.31	0.39	0.0	0.76	0.13
crop insurance	639.8	180.3	183.8	0	9.2	0	6.171.0	28.7
Share in total, %	0.13	0.07	0.03	0	0.001	0.0	0.73	0.006
Total	486,074.2	237,250.6	556,866.6	257,109.6	728,634.1	465,153.1	843,897.3	458,726.3

Source: Data obtained from Central Bank of the Republic of Azerbaijan and processed by authors [5].

The distribution of agricultural insurance premiums in total premiums written in the Republic of Azerbaijan in the period 2018-2021 is shown in Table 1.

According to the analysis of the table, the share of crop products accounted for 0.13 percent of total insurance premiums received in Azerbaijan in 2018, while livestock accounted for 0.42 percent.

These data have altered with the implementation of the Agrarian Insurance Law in 2019. Following a dramatic drop in insurance premiums in 2020, rates will rise significantly in 2021. Agriculture premiums amounted for 1.5 percent of overall insurance premiums, with 0.76 percent in livestock and 0.73 percent in crop production, respectively. Despite the rise in insurance premiums, claims paid were a fraction of what they were in 2018. In livestock, claims paid was 8.9% of the premiums collected, while crop production received just 0.5 percent. It should be noted that in 2021, total claims paid in the country contains for approximately 62 percent of total insurance premiums collected [21]. This figure of 0.14 percent is unsatisfactory in agriculture.

The growth of the agricultural insurance industry is effective as a result of long-term and large-scale government support, according to systemic risk analysis. Otherwise, the insurance market in the agricultural sector is weak and unsystematic.

The President of Azerbaijan signed a decree on the adoption of the Law of the Republic of Azerbaijan on Agriculture Insurance and establishment of the Agrarian Insurance Fund in 2019 in order to promote and publicize the insurance system in the agricultural sector. The law recognizes agricultural crops and crop production products, live stock, and aquaculture products as the primary subjects of agricultural insurance and outlines the state's primary obligations in this field. Agricultural producers' risks in terms of agriculture insurance were also determined at the same time. The law specifies the following risks [16]:

- Natural disasters: hail, earthquake, storm, hurricane, landslide, fire - these risks are known as systemic risks.
- Plant diseases and pests, infectious diseases and poisonings, attacks by wild animals, the spread and attack of especially dangerous pests, the actions of third parties - these risks are idiosyncratic risks.

According to the adopted law, the terms of the insurance contract are determined by the Agrarian Insurance Fund and implemented under its control. The President of the Republic of Azerbaijan issued a decree on the formation of the Agrarian Insurance Fund which is the key entity in charge of assuring the agricultural insurance system's organization, development, and long-term viability [2].

As a governmental organization, the Agrarian Insurance Fund is a non-profit legal entity that carries out insurance payments bearing agricultural risks. According to the terms of the insurance contract, 50% of the sum insured is paid by the insurer and 50% by the state. Only 14 crop products were intended to be insured by the Fund in 2019. The law was revised by Cabinet of Ministers Decision No. 398 of December 21, 2021, which included 27 additional crops to the list, bringing the total number of insured crop products to 41 [25]. Mudflow and flood, downpour, significant snowfall, and frosts have all been included in the systemic risk covered by insurance since about 2021. Systemic risks such as mudflow and flood, downpours are expected to be applied to all crop products, and significant snowfall and frosts will be applied to only 19 types of crop products [26].

It is important to highlight that the draft law is based on the Republic of Turkey's experience (TARSIM). The insurance system's mechanism is based on public-private partnership principles in conformity with this practice.

Without a doubt, this regulation will have a significant impact on the future growth of Azerbaijan's agriculture insurance sector. The advantages of the newly established agrarian insurance system are:

- Using agricultural insurance companies as intermediaries. The involvement of private enterprises in the agricultural insurance system could boost the insurance market's activity and speed up the protection of agricultural producers from risk occurrences.

- Involvement of independent experts. Independent experts can ensure flexibility, time shortening, and improving the impartiality of the damage assessment procedure in the case of an insurance event. Because an expert is unable to engage both in risk assessment or evaluating the extent of the damage.
- Differentiation of insurance tariffs for different products and application of discounts. The 5% insurance discount for young farmers (aged 29 and under) seeks to engage and encourage young people in rural regions to participate in the agricultural sector's growth [24].
- Entry into force of the insurance contract for wheat crops and insurance coverage (hail, storm, hurricane risks) begins from the date of the sprout of the crop. Formerly, once the crop sprouted, all risks were covered by insurance.
- Establishment of the Board of Appeal of the Agrarian Insurance Fund.

In any country, however, the operation of the economic system and the techniques used to regulate it are not faultless. The conditions and rules of agricultural insurance cannot be deemed flawless from this perspective.

The applied insurance mechanism may face certain shortcomings, as it belongs to the traditional insurance system. These shortcomings are determined both by the characteristics of Azerbaijan's agricultural sector and by the internal contradictions of the traditional insurance system inherent in other countries. Azerbaijan's agricultural peculiarities arise from the country's territorial and geographical variety, and are shaped by variables such as climatic circumstances, farm activity structure, land reclamation system development, producer mindset, and so on. In our opinion, a detailed analysis of these features, the study of their impact on the development and diversification of the insurance market is of considerable scientific and practical relevance.

The source of problems in the process of applying the traditional insurance model

The overwhelming domination of small farms in Azerbaijan's agriculture is the cause of the traditional insurance system's slow development. According to statistics, the number of landowners with more than 10 hectares of land in 2020 was only 0.9%. This scenario is significantly more evident when measured in absolute numbers. The total number of landowners in the country in 2020 was 432,004 people and the total amount of land owned by producers was 1,288,703 hectares. The number of landowners with up to 3 hectares of land was 383,341 people (88.7%), and the total amount of land they owned was 720,639.2 hectares (55.9%). The number of the largest landowners (more than 50 ha) was only 298 people (0.1%), the total area of their land was 230,411.8 ha (17.9%). The remaining land plots were distributed among the owners of 3-10 hectares (Table 2) [27].

Table 2. Land ownership and distribution for 2020

	Owners by size, ha	Number of landowners	Land size owned by producers, ha	Share by numbers, %	Share by land plot sizes, %
1	≥ 50 ha	298	230,411.8	0.1	17.9
2	20-49.9 ha	1,027	44469.1	0.2	3.5
3	10-19.9 ha	2,634	51,873.4	0.6	4.0
4	5-9.9 ha	9,900	86,989.3	2.3	6.8
5	3-4.9 ha	34,804	154,320.2	8.1	12.0
6	≤ 3 ha	383,341	720,639.2	88.7	55.9
Total	+	432,004	1,288,703.0	100.0	100.0

Source: Data obtained based on the the reference “on submission of land balance” with the service number 02/16-08-18-859 issued by the Ministry of Economy of the Republic of Azerbaijan dated 10.04.2020. May 22, 2020 [27].

As it can be seen from the figures, smallholders definitely dominate the total share of landowners. It is no coincidence that currently 90% of agricultural production is accounted for by small farms (family farms, households and individual entrepreneurs), and

10% by agricultural farms with relatively large landowners [21]. According to the Agrarian Insurance Fund's figures, larger farms had a complete edge in terms of insurance premiums collected by the number of farms producing crop goods in 2021. Medium-sized farms with land between 10 and 100 ha accounted for 26.4 percent of the total, while tiny farms with property under 10 ha accounted for only 0.52 percent [10]. As it can be seen from the figures, large farms are usually interested in obtaining insurance policies. Because of the positive scale effect on large farms, high productivity, large cash flows and, accordingly, extensive financial resources make it necessary to obtain an insurance policy. Unlike large farms, small farms avoid traditional insurance. They claim that the absence of scale effect on tiny arable land has little impact on production, hence insurance is unnecessary. Simultaneously, small farmers' operations, along with their financial limits, make it difficult for them to pay insurance payments. On the other hand, traditional insurance of 2-3 hectares has no beneficial impact on the activities of insurance companies. Small farms are typically spread out over the region's villages, with a significant distance between them. The expense of signing insurance contracts is multiplied by the small size of farms and their distance. This is because, in the case of a risk occurrence, a large number of small farms need to be visited by independent experts to assess the damage. This significantly increases the cost of expert services. In most situations, however, insurance premiums do not fully cover the expenses of signing insurance contracts due to the modest quantity of insurance premiums for small farms. Small farms may be excluded from the insurance system due to the high degree of service and transaction expenses of contracts with small farms, which are not cost-effective for insurance companies. Such a structure of land ownership is one of the main obstacles to the sustainable development of the insurance market in agriculture.

Assessment of risks included in the agrarian insurance package

The occurrence of traditionally insured system risks usually depends on the geography, climatic conditions and sea level of the economic regions. The prevalence of hail occurrences in the Republic's regions during the last ten years (2011-2020), which are considered systemic concerns, demonstrates that this event is more often in the north-western areas. This is a rare occurrence in the central and south-eastern parts of the country. For example, last 12 years, hailstorms occurred 57 times in the Ganja-Dashkesan and Tovuz-Gazakh economic areas, 40 times in the Sheki-Zagatala economic region in the northern zone, and 25 times in the Guba-Khachmaz economic region. The economic regions of Baku and Absheron-Khizi, which are part of the eastern region, have never experienced anything like this. In the last 12 years, it has occurred 6 times in the Shirvan-Salyan and Central Aran economic regions, but only three times in Lankaran-Astara. Hailstorms hit the northwest's mountainous and foothill regions at the same time. Hail is uncommon in the lowlands. For example, hailstorms occurred 23 times in the northern territory of Sheki in May-September over the previous 9 years (2012-2020), and 10 times in Ganja and nearby territories in the same months of 2010-2020. Hail has only been seen three times in the previous ten years in the Kurdamir region, which is part of the Central Aran economic region - in 2013, 2014, and 2016 [19].

Analysis of the frequency of storms and hurricanes shows that these events vary depending on the region's geographical layout. Their frequency almost coincides with the areas with the highest hail. Stormy days were noticed almost every year in March in the Gadabay region, which is located in hilly terrain when the crop's vegetation phase began in the previous 20 years (2000-2019). The most recent hurricane, however, occurred in March of 2013. These occurrences are uncommon in the districts of Imishli and Sabirabad. Imishli witnessed hurricane in March 2006, May 2008, and June 2009, while Sabirabad had hurricane once in February, March, and May 2016, as well as twice in April. The occurrence was extremely infrequent in subsequent years and did not coincide with the crop's growth cycle [19]. Natural disasters, such as hurricanes, coincide geographically with climatic storms. In the previous 20 years, however, the number of hurricane days has been lower than the number of stormy days. The Ganja-Dashkesan and Tovuz-Gazakh economic regions have the most hurricane days, and they frequently occur during the growing season of agricultural crops. Hurricanes have hit the region 21 times in March-May during the last 20 years, but just twice in June and July in 2013, 2019. In March 2013, a hurricane struck the Gadabay district, which is part of the Ganja-Dashkesan economic region.

The classification and analysis of storm and hurricane threats pose certain concerns. A storm is defined as wind speeds ranging from 20.8 m/s to 32.6 m/s, according to meteorological science. It becomes a hurricane when the wind speed surpasses 32.6 m/s [19]. It's difficult to see how the Agrarian Insurance Fund will pay for storm risk insurance. This occurrence is regarded as follows in terms of insurance: Storm risk coverage includes damage caused by rain, snow, and hail with or without precipitation, as well as damage caused by the impact of objects overturned, dragged, or thrown by the wind at a height of 10 m and a speed of more than 25 m/s [24]. It is understood that if a wind with a speed of more than 25 m/s blows below a height of 10 m and damages the product, it is not considered an insured event. The question arises: Which crops and fruit trees have a height of more than 10 meters? Second question: By what criteria is a wind considered to be a storm only when the speed is more than 25 m/s? However, according to the accepted normative rule, the storm occurs when the wind speed exceeds 20.8 m/s. It should be noted that the insurance terms of the Agrarian Insurance Fund were approved by the Cabinet of Ministers. It's easy to see how insurance firms may take advantage of this type of storm risk assessment. As a result, a situation like this between insurers and insureds might dramatically raise moral hazards, resulting in an unresolved controversy. In our opinion, these insurance terms should be reconsidered and adjusted to properly determine the storm risk coverage.

Let's return to our topic's analysis. Farmers in various geographical and climatic zones of each economic region can forecast the frequency of hail, storms, and hurricanes in their areas based on personal experience. Accordingly, farmers could estimate the possibility of high or low risk as a result of these occurrences in their climate and geographical location. The probability of these catastrophes is minimal for farmers operating in the region's plains but high in the mountainous and foothill regions. As a result, producers in low-risk locations may refuse insurance, despite the fact that the average tariff rate for the economic region is reasonable. In this light, we argue that the differentiation of insurance tariffs by economic regions is ineffective. In our opinion, insurance tariffs should be differentiated according to geographical and climatic conditions within each economic region. The amount of the tariff rate in the high-risk portions of the economic region (mountainous and foothill) should be different from the low-risk areas (lowland) where the risk event is less likely to occur due to the hail event.

Local farmers commonly consider losses caused by fires, earthquakes, and landslides to be an emergency. They believe that since the government will assist them in an emergency and reimburse them for their losses, why should they invest money to insure such events? Furthermore, consider that earthquakes and landslides cause property damage (buildings and structures). Farmers see the expenditure as a loss or non-refundable charge because it is already covered by property insurance due to earthquakes and landslides. The expense of insuring such disasters is referred to as a "loss" or an "additional tax."

The occurrences that may arise as a consequence of the acts of third parties included in the insurance package and deemed an idiosyncratic risk are the most dubious in terms of the insurance. In terms of insurance, such an event is described as follows: The term "actions of third parties" refers to damage caused by other people's actions or inactions, excluding family members of the insured or beneficiary [24]. The classification shows that the insurance terms do not accurately explain this event and do not identify the particular events it covers. The general description of the damage caused by the actions of third parties can be interpreted differently by both the insurer and the insured. By resulting in diverse interpretations, such a generalization might generate a moral risk for both parties to the insurance contract. Damage caused by the actions of a third party occurs when one person's livestock enters and graze on the insured land. This occurrence will be considered a third-party act by the insured. However, the insurance company may assess the incident as either intentional or as an act of the insured's family members. As a result, the formation of a large dispute and mistrust between the insurer and the insured, as well as the requirement for a court-ordered resolution of the case, might result in a rise in transaction costs on both sides and can lead to the emergence of moral risks. In our opinion, clarifying the repercussions of third-party actions plays a significant role in resolving difficulties that may develop in many forms.

Farmers are intensely interested in the insurance package that covers crop disease and pests, the spread and assault of particularly severe pests, and frost risks. Incorporating these risks into the insurance of other systemic risks by making additional payments and combining them into a single package, on the other hand, dramatically raises the insurance tariffs for farmers. For example, in this case, the additional tariff payment of the insurance package for wheat producers is 3.84 percent in Ganja-Dashkesan and Gazakh-Tovuz economic regions, 3.59 percent in Sheki-Zagatala economic region, 8.1 percent including frosts and showers on grape products and in other locations, percentages range from 3.7 percent to 9%, depending on the product line [24]. When these additional tariffs are added to the base tariffs, the general insurance policy's cost rises even higher. Insurance tariffs for other crops that are the subject of the insured event have also been increased in this interval. This, in turn, may raise the overall amount of insurance payments while discouraging farmers from entering into package insurance contracts. The statistics on insurance payments support this viewpoint. According to AIF, payments for insurance events such as crop diseases and pests accounted for 87 percent of total claims paid in 2021 [10]. We consider that either the extra premium should be eliminated or the risks should be addressed separately in the insurance package. Individual risk coverage can help diversify the insurance market.

The analysis of risks included in the insurance package shows that farmers will not be interested in tariff rate differential based on economic areas. Because every farmer is primarily concerned with the dangers that are likely to arise in his locality and climate. If catastrophic occurrences such as hail, storms, hurricanes and etc. are rare in the territory where it operates, it will not require an insurance contract since the risk and likelihood of losses are minimal. On the other hand, policyholder experience indicates that the danger of moral risks is quite high. Farmers have a high level of distrust for insurance companies due to independent experts' assessments of systemic risks and competent authorities' confirmation of the existence of the event. Because there are serious issues about the objectivity of the experts' judgments and the accuracy of the risk assessment. At the same time, the insurance of crop diseases and pests, pest dispersion, and similar events such as frost can be an obstacle to the development of the insurance system, as the insurance coverage of risks arising from natural disasters doubles the amount of payment. For the reasons stated above, this indicates that anti-selection in the agriculture insurance market will become more intense. This process can be hastened since insurance of systemic risks in the agriculture industry is structured on a voluntary basis rather than being mandated by legislation. As a result, putting the rule of large numbers into practice in the insurance industry will be tough. In our opinion, it may be more efficient and rational to separate the insurance of crop diseases and pests, pest dispersion, frost-like events from the general insurance package and apply them independently. At the same time, it might be a significant step toward diversifying the insurance market and providing farmers with more options.

The inclusion of spring frosts, which are distinctive of Azerbaijan, in the insurance package as insurance risks in 2021 should be seen as a very beneficial development in the insurance regulations and conditions adopted by the Cabinet of Ministers. In agriculture, the spring season, which runs from March through April, is noted for crop germination and fruit tree blossom. During this time, even the tiniest spring frosts can result in significant losses of blossoming fruit trees and sprouting crops. However, it is remarkable that just 19 species of fruit are frost-protected, and other plant items are not insured. It's worth noting that the damage caused by spring frosts varies depending on the kind of crops and the degree of frost. For example, in order for cotton to germinate, the soil must have a positive temperature of 12-14 degrees in April. Temperatures of 1-2 degrees below zero and even frosty weather for a day cause a large loss of cotton. Grain is not adversely affected by frost up to 15 degrees.

Table 3. Number of frosty days during the growing season in seven administrative regions of Azerbaijan

Districts	**Barda**		**Shamkir**		**Tartar**		**Ismayilli**		**Shaki**		**Gadabay**		**Kurdamir**	
Years	Mar	Apr	Mar	Apr	Mar	Apr	Mar	Apr	Mar	Apr	Mar	Apr	Mar	Apr
2000	7		7		4		17		9		26	1	5	
2001							1				12	2		
2002	3		1				3		3		12	11		
2003	5	1	1		3		15	2	16	1	31	14	3	
2004	2	3	1				12	6	7	3	16	12		
2005	3		3		2		13	4	4	2	23	7		
2006	1		1				5		1		15	5	1	
2007	2		1		1		11	2	3		31	26	2	
2008			0				7				6	0		
2009	2	1	3				11	3	4	1	15	13		
2010	3		2		2		5		3		18	10		
2011	4		1		2		15	2	8		21	9		
2012	8		6		9		23				28	0	6	
2013	1		2		2		7		3		14	9	2	
2014		2	2		2		2	2	2	1	20	5		
2015	2		0				6		4		26	7		
2016	1		1				2		4		12	4		
2017			0				9	4			15	2		
2018			0						1		8	2		
2019	0	0	1				4	1	1	2		5	1	

Source: Data obtained based on the reference of the Azerbaijan Regional Hydrometeorology Center 20/326, dated 16.03.2021 and processed by the authors [19].

The 20-year analysis by month shows that frosty days in March, April, and in some mountainous areas, even in May, are typical for Azerbaijan. For example, spring frosts in March are common in the Ganja region. Even in April, this phenomenon may be seen in the mountainous Gadabay district. During the vegetative phase, frosty days have been noticed in the lowlands. However, there were relatively few frosts compared to mountainous areas. From 2000 to 2016, spring frosts were noticed regularly in March in the Barda district of Central Aran Economic Region, where cotton is widely grown, and again in April 2014 for the last time. Even in the Kurdamir region, which is located in the warmest zone of the country, this happens about every 4-5 years. Sheki region is one of the most widespread regions of grain production in the country. As can be seen from the table, the number of frosty days in the Sheki region is repeated every year in March, and occasionally in April. In general, a statistical investigation of the frequency of spring frost days reveals that this phenomenon is more prevalent in locations where hail, storms, and hurricanes occur and that there is a link between their occurrence. As a result, having frost in the insurance package, along with other products other than fruit, might raise agricultural producers' interest in signing an insurance contract and make it more appealing. This idea is confirmed by world experience. It is legitimate for risks connected with frostbite to cover all insured items in virtually all nations where conventional insurance is practiced, and it is considered that this phenomenon plays a significant part in inflicting losses to farmers. We believe that increasing the supply of frost-sensitive crops will improve the effectiveness of the agricultural insurance system.

An alternative to drought risk management

Climate change has increased the frequency of mudflow, floods, and droughts throughout the world in recent years, owing to the "greenhouse effect" on the earth. These occurrences are increasingly becoming one of the leading causes of agricultural output loss. In addition to the conditions adopted in 2021, the provision of mudflow and floods by the Agrarian Insurance Fund is commendable. However, on the other hand, drought was not included in the insurance coverage as a risk under the Agrarian Insurance Fund's terms. According to the study of risks covered in the package the selection of risks is based on three key factors: a) area coverage, b) frequency of occurrence, c) amount of loss or damage. Our study suggests that the main types of risks (hail, storm, hurricane) covered by the area coverage and probability of occurrence are usually typical for mountainous and foothill areas. As a result, farmers in these locations face significant losses. Despite the fact that farms are insured, they will not be able to obtain money in the case of a drought since the drought is not covered by the insurance package. Droughts, on the other hand, can occur regionally or even nationally, unlike localized dangers. Agricultural farmers, regardless of their location, might suffer significant losses as a result of this. Given that non-irrigated croplands account for 40 percent of the sowed area of agricultural crops in Azerbaijan, with 60 percent of the sown area in the Sheki-Zagatala and 78 percent in the Lankaran economic region, it's not difficult to see how critical it is to tackle this issue [11].

Drought insurance through the traditional insurance system, on the other hand, has shown to be a major problem and inefficient. The fundamental reason is that the drought is homogeneous, unlike the local hazards covered by typical insurance. Local risks generally arise in a specific area of the economic zone, and only those farms involved in agricultural production in such regions experience losses as a result of their negative effects. Local risks are short-term (one or more days) and the damage occurs during a certain period of the product's vegetation process. It is not difficult for experts to precisely quantify farmers' losses as a result of this. Insurance company payments for the covered event have no substantial effect on their financial situation. Because the risks are spread among a vast number of farms, according to the low of large numbers.

However, a homogeneous drought can affect several economic regions at the same time and due to its longevity (several months), it can have different levels of losses depending on the intensity of the product during the growing season. In purely economic terms, there is a correlation between drought and crop vegetation, and the intensity of drought is correlated with the level of productivity. In this case, the intensity of the drought changes, and the level of productivity becomes a dependent parameter. The intensity of drought can be mild, strong, or severe. Its level of intensity is formed under the influence of factors such as temperature, wind speed, soil moisture, humidity, and even the location, quality and slope of the soil. For example, prolonged lowering of the temperature during the growing season will keep the soil moist by reducing the level of evaporation. Even if the amount of precipitation is modest in this situation, it will have no effect on productivity, and vice versa. During a drought, the various impacts of different combinations and changes in meteorological parameters on productivity make it impossible to cover this risk with traditional insurance. Because it will be needed to have information on various meteorological parameters to assess the damage by experts in the insurance event. As a result, the risk of moral hazards will rise, making it harder to estimate the damage objectively. In terms of economics, the probability that the transaction costs associated with insurance companies collecting and processing meteorological data will be higher than profits does not justify traditional insurance coverage of drought (particularly on non-irrigated lands) as a risk.

For the reasons stated above, it is not appropriate to cover the drought with a traditional insurance scheme even on irrigated farms. First and foremost, this is explained by information asymmetry and the emergence of moral risks. For example, ensuring drought on irrigated lands discourages producers from irrigating their fields during droughts to reduce costs. They may think: “If the crop is insured and there is a drought, why should I irrigate the field at extra cost? The insurance company will already cover my losses.” This is already a moral risk for the insurance company by the producer. An insurance company may only avoid moral risks as a result of asymmetric information by placing a "guard" next to each producer. This can drive up transaction costs to the point where the insurance industry becomes economically irrelevant.

From our perspective, the introduction of weather-based index insurance as an alternative model which is a unique form of agricultural product insurance that has the capacity to alleviate the challenges caused by existing drought insurance techniques might represent a turning point in this sector [4, 3]. We do not intend to go into great depth on the nature and operation of the parametric insurance model in this paper. The nature, advantages, and disadvantages of indexed insurance have been and continue to be addressed in international scientific papers [1, 17].

It should be underlined that the co-authors of this work did a thorough investigation into the nature of index insurance and the necessity for its application in agriculture in Azerbaijan and made relevant proposals [13]. In 1949, American scientist Harold G. Halcrow suggested the notion of insurance based on air parameters for the first time [7], In the 1990s, this strategy was initially implemented in the United States and England. Currently, many developing countries (Morocco, India, Mexico, Kazakhstan, etc.) are implementing pilot insurance programs based on weather indexes to protect farmers from drought or excessive rainfall [12, 14],

As previously said, the drought has a homogenous power and is highly long-lasting, affecting a vast region. As a result, there is a high correlation between drought and productivity. This enables you to compensate for the loss of the insured object using an index created using a specific set of weather parameters. This is due to the fact that the predefined index exceeds the specified boundaries (triggers) of air parameters, resulting in product loss. Parameters such as soil moisture, air temperature, or precipitation are used as a digital index during the growing season of the product. The amount of coverage for losses due to drought depends on the degree of change in the insurance index. For example, the value of the index is determined by the fact that the amount of precipitation exceeds the set triggers for every 1 mm^2 less than the norm.

In the previous 20-30 years, the experience of using index insurance in many countries has proven the following advantages over traditional insurance:

- Drought data from hydrometeorological and agrometeorological stations is used as an independent source, ensuring information independence, openness, and objectivity. As a result, policyholders and insurers are unable to affect the index. This, in turn, eliminates the problem of asymmetric information, moral risk, and anti-selection [28].
- Because the indexed insurance model ensures the cause of the covered event rather than the consequence, agricultural producers do not need to report losses or prove reimbursement to the appropriate authorities. This implies that expert evaluations and judgments aren't required to assess the damage caused by the insured event.

- Because of its simplicity and low transaction costs, this model appeals to small farmers, and they become active players in the insurance market. It's no wonder that parametric insurance is more popular in developing countries, where small farms are more dominated [18, 8].
- The experience of countries that have widely applied the index insurance model shows that that it greatly boosts agricultural investment. The majority of Ethiopian farmers choose to save their money rather than invest it. Because there is no typical drought protection system in the country, so, they are hesitant to invest in the sector and use allocated funds as a "safety bag". On the contrary, farmers in Ghana and India are not frightened of drought and are willing to take new risks in order to boost yield. The availability of insurance based on the precipitation index is what drives people to invest [29].
- Improves agricultural producers' access to financing and promotes the growth of the financial industry in general. Commercial banks are usually more interested in lending to insured entities.

However, the parametric insurance model should not be taken as a universal tool that can be applied in the event of a drought. The point is that there are several restrictions to this model's applicability. For example, the application of an indexed insurance model for water-loving products (grapes, orchards, cotton, etc.) is almost inefficient. The experience of India, Kazakhstan, and other countries applying this model shows that index-based insurance is more effective in the insurance of grain products. Because grain products are more resistant to drought. Even in the case of a severe drought, according to statistics, farmers in Azerbaijan get a minimum of 10-12 quintals per hectare, which fully covers 50% of the cost of production. It's no wonder that wheat and barley products accounted for 59 percent of insurance premiums collected in the sector of agricultural production in 2021 [10]. Because these crops are mostly produced on large farms and are heavily reliant on natural disasters, they collect a significant amount of coverage. Given that just 68.1 percent of the country's cereal demand (excluding rice) is now satisfied, including 57.1 percent for wheat [22], the use of this methodology might help the country become more self-sufficient.

Another issue with this model's implementation is the danger of the base. The problem is that even if the air temperature and precipitation are relatively equal throughout the region, productivity in this region can vary from site to site for a variety of reasons (eg, soil quality differences). According to the terms of the index-based insurance contract, farms operating in the existing area must receive an equal amount of coverage, although productivity may vary from field to field for these reasons. In this case, a situation may arise in which some farms will be guaranteed despite a decrease in productivity, or, conversely, some of the local losses of a farm will remain unsecured. Therefore, farmers who receive an insurance policy are at risk of loss in the event of an accident. Because the general index is based on the average for the entire region. This is known as basic risk, and it is the most significant disadvantage of indexed insurance [6, 20].

If the variety in the productivity of farms operating in a region increases, the base risk level rises; conversely, as the variance reduces, the base risk level falls.

Analysis of statistical data on grain production shows that the country's productivity varies mainly between regions, depending on the climatic zone and geographical area. The average grain output in the Sheki-Zagatala economic region, for example, was 32.7 quintals in 2020. However, in the administrative districts included in the economic region, this productivity was 30.5 quintals for Sheki, 39.5 for Balakan, 36.8 for Zagatala, 36.2 for Gakh, 31.4 for Oguz, and 32 for Gabala [23]. If we compare the productivity of the six administrative districts in the economic region, we find that the productivity of the three administrative districts (Sheki, Oguz, and Gabala) is nearly identical, at around 31 quintals. Despite their great output, the other three areas (Zagatala, Gakh, and Balakan) have nothing in common. When these conditions are equal, the variation between the productivity of grain producers operating within the regions is negligible. This means that the probability of base risk within the administrative district is significantly reduced and, accordingly, the possibility of applying the model increases.

In the paper, the results of our study can be summarized and discussed in the form of brief theses.

- The current status of agricultural crops and crop products insurance in the country is several times lower than the sector's potential. Crop insurance premiums and claims paid account for the smallest percentage of overall insurance premiums and claims paid obtained in the country.
- The prevalence of small farms in this area is the major cause of this scenario. According to statistical data, large farms are more interested in insuring against natural risks, and their share of the collected insurance premiums is 2/3.
- The majority of collateral risks are found in mountainous and foothill locations, whereas they are uncommon in lowland areas, according to a study of their prevalence during the last 20 years. The use of identical insurance rates for economic areas ignores the diverse geographical and climatic characteristics of the territories that make up these regions. This can accelerate the anti-selection problem in the applied model. It is more practical to differentiate tariff rates based on each administrative region's geographical and climatic circumstances.
- Certain risks (earthquakes, landslides, fires) are more often accepted by farmers as the subject of property insurance.
- There is a need to clearly identify the signs of several risks (storm, hurricane, third party intervention) in the insurance.
- Covering the most significant risks in agriculture, such as frost, crop diseases, and pests, with the primary insurance package and the payment of supplementary insurance premiums, doubles the entire insurance cost and makes it inaccessible to many farmers. Independent collateral for these risks can play an important role in the diversification and development of the insurance market.
- Traditional insurance cannot cover droughts (particularly in non-irrigated areas), hence an index-based insurance model can be utilized as an alternative. Many other countries' experiences also show that the index insurance approach is more successful and plays a key role in limiting drought damage. The necessity for index-based insurance is explained by the fact that droughts' extended duration, which covers a systemic risk of a homogenous nature, and their widespread coverage strongly correspond with agricultural production (particularly grain), necessitating the use of the air index.

CONCLUSIONS

Despite several flaws in the implementation of the traditional insurance system in agricultural risk insurance, we believe that the adoption of legislation in the field of agricultural insurance in 2019 was a significant step in risk management. Its diversification, on the other hand, might be critical to the growth of the agricultural insurance industry. In particular, the application of an air index-based insurance model in the effective management of drought risk can eliminate the problem that traditional insurance cannot solve in this area.

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COSTING POSTHARVEST LOSSES IN SELECTED LEAFY VEGETABLE MARKETING IN LAGELU LOCAL GOVERNMENT AREA OF OYO STATE, NIGERIA

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Abstract

Global efforts at improving food and nutrition security should tackle the menace of crop losses. This study assessed postharvest losses in selected leafy vegetables marketing in Lagelu Local Government Area, Oyo State Nigeria. Multistage sampling procedure was utilized to select one hundred and ten (110) leafy vegetable marketers as study sample while structured interview schedule was used to gather relevant data on marketing costs and returns, cost of post-harvest losses to marketing as well as constraints to vegetable marketing in the study area. Data collected were analyzed with appropriate descriptive and inferential statistical tools. Results show that the sampled leafy vegetable marketers were female (100.0%) and married (80.9%) having average household size of 7±1.60 members. Age, years of formal education and marketing experience averaged 44.6±10.23, 3.35±1.52 and 14±3.2years, respectively. The average amount invested in leafy vegetable marketing per month was ₦52,932.73±16,698.78 while the average monthly income from leafy vegetable marketing was ₦72,354.91±25,599.35 leaving a marketing margin of ₦19,422.18. The monetary values for the monthly estimated postharvest losses incurred on marketing of Corchorus olitorus, Celosia argentea, Telfeira occidentalis, Solanum macrocarpon and Amaranthus spinosus were ₦898.19±206.14, ₦685.45±157.25, ₦810.90±186.03, ₦674.18±154.67 and ₦567.27±130.14, respectively. Perishable nature of vegetables (1.53) and inadequate storage and processing facilities (1.44) were reported as the most severe constraints to leafy vegetable marketing in the study area. Age (t=3.785), years of formal education (t=-2.072), marketing experience (t=-5.226), amount invested in vegetable marketing (t=-22.637) and monthly income (t=21.36) all at $p\leq0.05$, significantly determined postharvest losses in leafy vegetable marketing in the study area. In conclusion, the study established an appreciable level of postharvest losses to leafy vegetables marketing and recommended that marketers should be adequately trained in the areas of postharvest handling, processing and storage of leafy vegetables.

Key words: *food and nutrition security, leafy vegetables, postharvest losses, Oyo State Nigeria*

INTRODUCTION

Post-harvest losses (PHL) describe losses that occur along the food supply chain basically from the farm gate to the table of the final consumer. Losses are encountered in handling, storage, transportation and processing thus resulting in the reduction of quantity, quality and market value of agricultural commodities [1]. Food losses and waste are a global problem, with an estimated 1.3 billion tons lost annually [5]. Over the past few decades, researchers have developed many different methods for measuring postharvest losses for fruit and vegetable crops, each focusing on different aspects of the value chain and on varying types of food losses [11].

Mechanical damage coupled with physiological and biological deterioration to insect pest and postharvest diseases are the main causes of postharvest losses [7]. Also, rodents and birds cause significant postharvest losses in fruits and vegetables. Losses caused by rodents and birds tend to be relatively small for vegetables when compared with damages incurred to rough handling, poor packaging and loss of quality to temperature stress. Postharvest losses of vegetables are sometimes attributed to socioeconomic and institutional factors like inappropriate transportation facilities, inadequate marketing information and support systems, unfavourable government policies, inability to implement regulations and legislations, lack of appropriate tools and equipment and poor maintenance culture for available facilities and infrastructure among others [14].

Postharvest losses vary greatly with commodities, seasons, production areas and the level of infrastructural and technology development for postharvest management and market system [8] [10]. Huge knowledge gap exists in postharvest handling and management in spite of the existing rich knowledge of postharvest losses in vegetable production and marketing around the world [6]. Vegetables are severely damaged, with the exception of intensive treatment during harvesting, handling and transport. In African countries, vegetable losses are estimated to account for over 50% of total food production. Therefore, minimising these losses between yield and consumption of already produced food is generally more sustainable than higher production [9]. Most vegetables are naturally low in fat and calories. Therefore, they help to maintain healthy blood pressure. Dietary fibre from vegetables as part of an overall healthy diet helps to reduce blood cholesterol level and may lower the risk of heart diseases. Folate (folic acid) in vegetables helps the body form red blood cells. Vitamin A in vegetables keeps eyes and skin healthy and helps to protect against infections. In Nigeria, marketers suffer a lot because of the marketing techniques they employ. Transportation of the vegetables during different phases of marketing is mainly by the use of motor vehicles, cart, bicycles and farm animals while the transportation around urban centres is mainly by open, non-refrigerated trucks with capacities within the range of 10t to 30t [2]. Postharvest losses are as high as 30% in cereals, 50% in root and tubers and up to 70% in fruits and vegetables [7]. This can be attributed to the highly perishable nature of fruits and vegetables. In Nigeria like most developing countries, storage and packaging system are still very intolerable and so also is transportation which is very undependable. Market infrastructure in the traditional system is also poorly established. All these lead to post harvest losses which could be attributed to mechanical, physiological and pathological stress. Consultations on nutrition and chronic disease prevention recommended adequate consumption of fruits and vegetables [8]. Therefore, it is important not only to increase production, but also to minimize post-harvest losses in order to bridge the gap between the recommendations.

Against this background, this research sought to evaluate the cost of postharvest losses to leafy vegetable marketing in Lagelu Local Government Area, Ibadan, Oyo State, Nigeria. Specifically, the study described socioeconomic and enterprise characteristics of vegetable marketers; examined marketing margins of selected vegetables, estimated the cost of post-harvest losses to leafy vegetable marketing and identified major constraints to vegetable marketing in the study area. The study also tested relationship between selected socioeconomic and enterprise characteristics and cost of post-harvest losses to vegetable marketing in the study area.

MATERIALS AND METHODS

This study was carried out in Lagelu Local Government Area of Oyo State, Nigeria. The headquarters of Lagelu LGA is located in Iyana Offa area in Ibadan. Lagelu has a total land area of about 338km^2 and a population of 147,957 as given by census (2006). Farming is the main occupation of the people of Lagelu L.G.A. This includes large production and marketing of leafy vegetables, oil palm and black soap; thus traditional palm oil and soap making industries also thrive well in the study area. The population of the study consisted of all leafy vegetables marketers in Lagelu local Government Area of Oyo State.

The study utilized multistage sampling procedure to select the sampled respondents. At the first stage, 30% (5) of the 17 wards in the study area were purposively selected. The selected wards were Oyedeji, Monatan, Lalupon, Ejioku and Kuffi being the wards with the highest concentration of markets.

Second stage involved proportionate random sampling of 50% of the total number of markets having preponderance of leafy vegetable marketers from the selected wards resulting to 3 markets in Oyedeji, 2 markets in Monatan, 2 markets in each of Lalupon and Ejioku and lastly, 1 market from kuffi ward making up 10 markets in all.

Third stage involved proportionate random sampling of 50% of the total number of leafy vegetable marketers from each of the ten selected markets summing up to a total of one hundred and ten (110) leafy vegetable marketers as the study sample.

Primary data were collected from the selected leafy vegetable marketers selling five (5) selected leafy vegetable species, using structured interview schedule. Relevant information were collected on socioeconomic and enterprise characteristics, marketing margin, worth of vegetables loss to marketing and constraints to leafy vegetable marketing in the study area.

Descriptive and inferential statistics were utilized to analyze data collected. These include frequencies, percentages, mean and standard deviation, marketing margin analysis, weighted mean score, ranking and multiple regression analysis at $p \leq 0.05$.

Table 1. Selected leafy vegetables (LVs) considered in the study

No.	Scientific name	Common name	Local name
1.	*Celosia argentea*	Celocia	Efo-Soko
2.	*Amaranthus spinosus*	Amaranthus	Efo-Tete
3.	*Solanum macrocarpon*	Solanum	Efo-Gbagba
4.	*Telfeira occidentalis*	Telfeira	Efo-Ugwu
5.	*Chochorus olitorius*	Jute mallow	Ewedu

Source: Compiled by Authors, 2021,

Marketing margins of leafy vegetable marketing was determined using marketing margin analysis which is widely used in agricultural marketing researches e.g. [4]. Marketing margin amongst vegetable marketers refers to the difference between the selling price (SP) and purchase price (PP) by the vegetable marketers including cost of vegetables, transportation and other logistics:

$$MM = SP - PP \quad (1)$$

where:

MM = Marketing margin
SP = Selling price
PP = Purchase price

RESULTS AND DISCUSSIONS

Socioeconomic Characteristics of Leafy Vegetable Marketers in the Study Area

Results in Table 2 reveal that all the sampled leafy vegetable marketers were female most (80.9%) of who were in the age range of 30 to 59 years. Mean age was 44.6±10.23 years. Most (81.8%) of the respondents were married with an average household size of 7.0±1.60 persons. Agricultural production is dominated with male in Nigeria and sub-Saharan Africa as a whole while female dominates the agricultural products marketing terrain along the value chain. In the same vein, 90.0% of South African leafy vegetable marketers were female who were mainly above 60 years of age having average household size of 6 members [12]. Conversely, 35.0% of carrot and cucumber marketers in Enugu State, Nigeria were male [13]. Corroborating this, male involvement in fruit vegetable marketing is very common in the literature, unlike leafy vegetables.

Table 2 further shows that few (18.2%) of the respondents never attended school while the average years of formal education was 3.35±1.52 years. Level of formal education should impact vegetable marketers' postharvest handling knowledge thereby reducing losses to the barest minimum. Contrarily, more than half of carrot and cucumber marketers in Enugu State, Nigeria had secondary education [13] while over forty percent of South African leafy vegetable marketers had primary education [12]. Over a quarter (26.4%) of the respondents had leafy vegetable marketing experience of 6-10 years with mean of 14.0±3.2years. Respondents' vast experience is expected to help reduce post-harvest losses to marketing meaningfully. Fruit vegetables marketers had about 6 years of marketing experience in Enugu State, Nigeria [13]. Majority (67.3%) of the respondents had no secondary occupation which implies that their livelihood is mainly earned from leafy vegetable marketing.

Table 2. Socioeconomic characteristics of leafy vegetable marketers in the study area

Variables	Freq.	%	Mean
Age (years)			
20-29	09	8.2	**44.6±10.23**
30-39	26	23.6	
40-49	37	33.6	
50-59	27	24.5	
60 & above	11	10.0	
Gender			
Female	110	100.0	
Marital status			
Single	04	3.6	
Married	89	80.9	
Widowed	17	15.5	
Household size			
1-5	30	27.3	**7±1.60**
6-10	73	66.4	
11-15	07	6.4	
Years of Formal Education			
No formal education	20	18.2	**3.35±1.52**
1-6	52	47.3	
7-12	38	34.5	
Veg. Marketing Experience (years)			
1-5	24	21.8	**14±3.2**
6-10	29	26.4	
11-15	16	14.5	
16-20	19	17.3	
21-25	22	20.0	
Secondary Occupation			
Artisanal engagements	30	27.3	
Trading	06	5.5	
None	74	67.3	
Membership of Veg. marketing association			
Members	87	79.1	
Non-members	23	20.9	
Marketing channels			
Directly to consumers only	93	84.5	
To both consumers & retailers	17	15.5	

Source: Field survey, 2021.

Most (81.8%) of the leafy vegetable marketers belonged to vegetable marketing associations which suggests ready availability of social capital base among the vegetable marketers which can readily avail them the opportunity to access business loan and high value bulk sales outlets among other benefits. Contrarily, none of the fruit vegetables farmers in Enugu State Nigeria belonged to any cooperative or marketing association [13].

Furthermore, 84.5% of the respondents (Table 2) market their leafy vegetables directly to the consumers, while 15.5% market their vegetables to both consumers and retailers. This indicates that the marketers strived to explore alternative marketing channels in order to minimize postharvest losses incurred.

Enterprise characteristics, marketing margin and benefit cost ratio of leafy vegetable marketing in the study area.

Table 3 shows that more than half (51.8%) of the sampled leafy vegetable marketers invested ₦44,000 - ₦63,000 on leafy vegetable marketing per month, while the average amount invested in leafy vegetable marketing per month was ₦52,932.73±16,698.78.

Table 3. Enterprise characteristics of leafy vegetable marketers in the study area

Variables	Freq.	%	Mean
Amt. invested in Veg. Marketing/Month			
₦24,000 - ₦43,000	27	24.6	₦52932.73 ±16,698.78
₦44,000 - ₦63,000	57	51.8	
₦64000 - ₦83000	22	20.0	
₦84000 - ₦103000	04	3.6	
Income from Veg. Marketing/Month			
₦31,600-₦56,900	24	21.8	₦72,354.91 ±25,599.35
₦57,000-₦82,200	52	47.3	
₦82,300-₦107,500	27	24.5	
₦107,600-₦132,800	07	6.4	
Total	**110**	**100.0**	
SP = Ave. Income from veg. marketing/month			₦72, 354.91
PP = Ave. Amt. invested in veg. marketing/month			₦52, 932.73
Marketing margin = SP - PP	₦72,354.91-₦52932.73		₦19, 422.18
BCR = TR/TC	₦72,354.91/₦52932.73		1.36

Source: Field survey, 2021.

This suggests that respondents were small scale marketers and the amount they invest in leafy vegetable marketing tends to limit their profit accordingly. However, 47.3% of the respondents earned between ₦57,000-₦82,200 as their monthly income from leafy vegetable marketing, while the mean monthly income from leafy vegetable marketing stood at ₦72,354.91±25,599.35. Respondents realized an average marketing margin of ₦19,422.18 while the benefit cost ratio of their enterprise was 1.36. This implies that the respondents realized 36% return on investment. That is, for every ₦1 invested in leafy vegetable marketing, they realized 36 kobo profit. The enterprise is profitable and marketers tend to make higher profits during the dry season when vegetables command better value.

Cost of post-harvest losses to leafy vegetable marketing in the study area

Table 4 shows that more than half (54.5%) of the respondents incurred losses range of ₦200 – ₦599 per month on Celosia argentea marketing. Mean of postharvest losses in Celosia argentea marketing is ₦685.45±157.25. Table 4 further reveals that 74.5% of the respondents incurred losses between ₦200 - ₦399 to marketing of Amaranthus spinosus, while mean of monetary loss was found as ₦567.27±130.14. This may indicate a higher rate of Amaranthus spinosus consumption or reduced perishability compared to celocia. Over sixty eight percent (68.2%) of respondents incurred loss of ₦200 - ₦2,199 to Solanum macrocarpon marketing per month with an average postharvest loss of ₦674.18±154.67 monthly (Table 4). This portends low rate of Solanum consumption in the study area. Table 4 also shows that 36.4% of the respondents incurred loss of ₦400 - ₦649 per month with a mean loss of ₦810.9±183.1 to Telfaria occidentalis marketing per month. Though Telfeira has longer shelf life due to lower moisture content compared to other vegetables which should reduce the quantity lost to marketing but it commands higher premium also which would expectedly affect the cost of its postharvest losses compared to other leafy vegetables marketed in the study area. The estimated losses varied among marketers as a result of respective amount invested in vegetable marketing. Lastly, Table 4 shows 61.8% of the respondents incurred losses of ₦600 – ₦999 to Corchorus olitorius marketing per month, while the mean monetary loss was ₦898.19±206.14. This loss can be reduced if marketers could gain access to marketing outlets of better value. However, the proportion of marketing margin that is lost to postharvest marketing is highest in Corchorus (4.62) and least in Amaranthus marketing (2.92).

Table 4. Cost of post-harvest losses incurred by leafy vegetable marketers

Cost of estimated vegetable losses to marketing	Freq.	%	% of MM lost to PHL in leafy vegetable marketing
Celosia argentea			**Marketing margin for all vegetables =₦19, 422.18**
₦200 – ₦599	60	54.5	3.53
₦600 – ₦999	23	20.9	
₦1000 – ₦1399	25	22.7	
₦1400 – ₦1799	02	1.8	
Mean = ₦685.45±157.25			
Amaranthus spinosus			
₦200 - ₦399	82	74.5	2.92
₦400 - ₦599	22	20.0	
₦600 - ₦799	06	5.5	
Mean = ₦567.27±130.14			
Solanum macrocarpon			
₦200 - ₦2199	75	68.2	3.47
₦2200 - ₦4199	24	21.8	
₦4200 - ₦6199	08	7.3	
₦7200 - ₦9199	03	2.7	
Mean = ₦674.18±154.67			
Telfeira occidentalis			
₦400 - ₦649	40	36.4	4.18
₦650 -₦ 899	22	20.0	
₦900 - ₦1149	32	29.1	
₦1150 - ₦1400	16	14.5	
Mean = ₦810.90±186.03			
Corchorus olitorius			
₦200 - ₦599	17	15.5	4.62
₦600 - ₦999	68	61.8	
₦1400 - ₦1799	25	22.7	
Mean = ₦898.19±206.14			
Total	**110**	**100.0**	

Source: Field survey, 2021.

Constraints to leafy vegetable marketing in the study area

Respondents pointed out the major constraints to leafy vegetable marketing in the study area as presented in Table 5. Perishable nature of vegetable was ranked first as the most severe constraint to leafy vegetable marketing. Inadequate storage and processing facilities ranked second, while high cost of transportation was ranked third. However, insufficient capital availability and instability of vegetable prices were the least severe constraints faced by respondents in leafy vegetable marketing.

Table 5. Constraints to leafy vegetable marketing in the study area

Constraints	WMS	Rank
Perishable nature of vegetables	1.53	1st
Inadequate storage and processing facilities	1.44	2nd
High cost of transportation	1.32	3rd
High postharvest losses	1.15	4th
Poor demand for vegetable by consumers	0.65	5th
Insufficient capital/poor credit availability	0.6	6th
Instability of vegetable prices	0.34	7th

Source: Field survey, 2021.

Test of relationship between selected socioeconomic characteristics and postharvest losses to leafy vegetable marketing among respondents

Result of regression analysis is presented in Table 6. The coefficient of R^2 and Adjusted R^2 indicates that the model is well fitted. The number of significant variables is shown by t-value and their corresponding level of significant is shown by the p-value at ($p \leq 0.05$). Age (t=3.785), average amount invested in leafy vegetable marketing (t=22.637) and average monthly income realized from leafy vegetable marketing (t=21.36) were positively significantly related to postharvest losses to marketing. This suggests that aged marketers experience higher postharvest losses due to reduced agility that limit marketing activities among other reasons. Also, the higher the amount of money invested in leafy vegetable marketing, the higher the postharvest losses incurred by marketers and the same narrative goes for the average monthly income realized from leafy vegetable marketing. However, years of formal education (t= -2.072) and marketing experience (t= -5.226) were negatively related to postharvest losses of leafy vegetable marketing in the study area. This implies that educated marketers have access to high value markets like grocery stores and co thus minimizing postharvest losses. Also, as the vegetable marketers spend more years in leafy vegetable marketing, their experience increases and they tend to understand marketing dynamics better thereby lowering the post-harvest losses incurred to marketing. Negative relationships were found between years of education, household size, cooperative membership as well as extension support services and post-harvest losses of crops [3]. Similarly among other variables tested, significant relationship existed between educational status as well as selling price and postharvest losses of horticultural crops [15].

Table 6. Result of Multiple Regression Analysis

Variable	Coefficient	t-value	Probability
Constant	0.000	80.247	0.000
Age	0.02**	3.785	0.000
Family size	0.002	0.178	0.859
Years of formal education	-0.046**	-2.072	0.041
Vegetable marketing experience	-0.03**	-5.226	0.000
Ave. income from veg. marketing/Month	0.001**	21.36	0.000
Ave. amount invested in veg. marketing/Month	0.000**	22.637	0.000
R^2	0.847		
Adjusted R^2	0.836		
F (6,101)	92.862		
Prob>F	0.000		

Source: Field survey, 2021.

CONCLUSIONS

Based on the findings of this study, it was concluded that most of the leafy vegetable marketers are middle aged married women with little or no formal education. The cost of postharvest losses in leafy vegetables marketing was relatively appreciable. The most severe constraints to marketing faced by the marketers included perishable nature of vegetable, inadequate storage and processing facilities and high cost of transportation while the least severe constraint was capital/poor credit availability and instability of vegetable prices, these accounted for the high post-harvest losses in leafy vegetable marketing. Significant variables related to the level of postharvest losses included age, years of formal education, vegetable marketing experience, average monthly income from vegetable marketing and average amount invested in vegetable marketing per month. Based on major findings of this study, it is recommended that leafy vegetable marketers should be encouraged to explore training opportunities on improved postharvest handling and better marketing strategies through their cooperative societies. Specialised distinct markets should be organized for the leafy vegetable marketers by the government as it is done in developed countries to attract consumers and gain better marketing values. Government and other private investors should invest in postharvest processing technologies and establish processing industries to reduce postharvest losses while leafy vegetable marketers are adequately trained in the areas of vegetable handling, storage and transportation.

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IMPACT OF FOLIAR ORGANIC FERTILIZING ON THE QUALITY OF FODDER FROM NATURAL MEADOW AND PASTURE GRASS STAND

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Abstract

Foliar fertilizing of meadow grass stand of type Chrusopogon gryllus L. type and pasture grass stand of Nardus stricta L. type with humate fertilizer, such as Biostim (400 ml/da) increases the crude protein content in dry matter by 34.2% and 31.3%, respectively. The highest energy and fodder nutritional value is the fodder mass of the variants treated with a dose of 400 ml/da (for Chrusopogon gryllus L.) and 200 and 300 ml/da (for Nardus stricta L.). The amount of gross energy in meadow grass stands is 1.0% lower than in pastures. The efficiency of the applied biofertilizer is most pronounced in the variants with 100 ml/da dose, where the amount of dry matter and crude protein reaches 808.80 kg and 79.55 kg - for meadow and 509.60 kg and 28.79 kg - for pasture grasslands. There is no difference in the total costs (7.87 BGN/da) regarding the application of foliar fertilizers in pasture and meadow grass stands. The total revenue, total profit, profitability and critical level of the yield from the conducted agrotechnical measure in the meadow grass stands are higher by 19.9%, 25.4%, 27.7% and 92.1% respectively compared to those of the pastures, but at a lower cost price.

Key words: *foliar fertilizing of natural grass stands, humic fertilizer Biostim*

INTRODUCTION

Natural meadows and pastures are a low-cost and environmentally friendly resource for raising ruminants [9]. The applied technologies in their use and maintenance must ensure: optimal biodiversity and sustainability in local ecosystems, maintenance and improvement of soil fertility with the best economic results.

In this regard, organic farming integrates a number of biological, mechanical and agrophysical methods to improve soil structure and fertility [16]. The application of natural substances and processes favours the management of nutrients in the soil, plant growth and biodiversity in the composition of grass stands [3]. Biofertilizers are a technological solution in modern agricultural practices for the creation of environmentally friendly fodder products with high economic value [18, 22]. The use of bioproducts of organic origin has a specific effect on certain physiological functions and biochemical reactions in plants with morphogenetic or metabolic effect [8, 21, 5]. The effect of the compositions stimulates the biological potential of grass species, which leads to improved economic production indicators of grass mass [11].

Supplying of grass stands with biofertilizers promotes the realization of natural processes, preserves the environment and affects the quantity, quality and efficiency of fodder and animal products [7, 12]. Treatment with humate products (8 t/ha) increases the content of essential nutrients in the soil (by 0.2 to 4 mg/100 g), density and yield in natural grass stands [13]. Humus substances (HS) are the dominant components in soil organic matter and natural, effective growth stimulants in sustainable agriculture [14].

The application of foliar humate fertilizers with rich mineral composition increases the efficiency of nutrient utilization (including more inaccessible phosphorus) of plants, improves their photosynthetic activity, nitrogen and carbohydrate metabolism [10].

The aim of the present study is to determine the impact of annual treatment with foliar organic fertilizer Biostim on the quality and some economic indicators of fodder of natural

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meadow grass stand of *Chrysopogon grullus* L type and pasture grass stand of *Nardus stricta* L., type located in the Central Balkan Mountains (Bulgaria).

MATERIALS AND METHODS

The experiment was conducted in the period 2011-2013 on a natural meadow - *Chrysopogon grullus* L. type (460 m above sea level) and natural pasture of *Nardus stricta* L. type (1,400 m above sea level) in the region of the Central Balkan Mountain. The effect of universal humic fertilizer Biostim was tested, and Table 1 shows the composition of the organic substance.

Table 1. The agrochemical analysis of the imported biological product includes

reaction (Ph)	**6.8**	**nitrogen (N)**	**2.1%**
salt concentration	20.15	phosphorus (P)	1.54%
organic content	2.25	potassium (K)	11.2%
humic acids	up to 14%	calcium (Ca)	0.15%
fulvoacid	up to 7%	magnesium (Mg)	0.01%
zink (Zn)	0.037	iron (Fe)	0.024%
Macroelements:/total amounts/			
N	mg/l	1,650	
P_2O_5	mg/l	570	
K_2O	mg/l	10,700	
CaO	mg/l	87.9	
MgO	mg/l	22.5	
Macroelements:/digestible quantities/			
$N\text{-}NO_3$	mg/l	123	
$N\text{-}NH_4$	mg/l	48.3	
P_2O_5	mg/l	88	
K_2O	mg/l	7,712	
Na	mg/l	86	

Source: Ministry of Agriculture and Food, National Plant Protection Service, Central Laboratory for Chemical Testing and Control with test report № 1161-01-02 / 12.08.2008.

The experiment is based on the block method, in 4 replications and a plot size of 5 m^2. Experimental variants are:
1.Control (no fertilizing);
2.Foliar treatment at a rate of 100 ml/da;
3.Foliar treatment at a rate of 200 ml/da;
4.Foliar treatment at a rate of 300 ml/da;
5.Foliar treatment at a rate of 400 ml/da;

The treatment of grass stands is in a period of active vegetation of grasses, once in each experimental year. The mowing in the bunch grass meadow was conducted in the tasseling phase until the beginning of blossoming of *Chrysopogon grullus* L, and in the matgrass pasture until the ear formation of *Nardus stricta* L.
Samples for chemical analysis of fodder were taken from each regrowth, dried in a laboratory dryer at 60°C and ground in a laboratory mill to a particle size of 1.0 mm.
The main chemical composition of the dried grass mass was analyzed, including the following indicators:
-Crude fiber (CFr, g/kg) according to the *Weende* analysis - the sample was treated sequentially with solutions of 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH under special conditions. The residue was dried and incinerated;
-Crude protein (CP, %) according to *Kjeldahl* (according to BDS - ISO-5983)
-Crude fats (CF, %) by extraction in an extractor of Soxhlet type (according to BDS - ISO-6492). After extraction, the sample was dried at 95°C;
-Ash (%) - decomposition of organic matter by gradual combustion of the sample in a muffle furnace at 550°C (according to BDS - ISO-5984);
-Moisture content (%) - (according to BDS - ISO-6496) - drying of the sample at a temperature of 105ºC to constant weight;
-Dry matter (DM, %) - empirically calculated from % of moisture;
-Calcium (Ca, %) - according to Schottz (complexometric);
-Phosphorus (P, %) - with vanadate-molybdate reagent by the method of Guericke and Curmis and spectophotometer (*Agilent* 8453 UV - *visible Spectroscopy System*), measuring in the range of 425 ηm.
-NFE = 100 (CP, % + CFr, % + CF, % + Ash, % + Moisture, %);
The energy nutritional value [20] of biomass from grass stands was determined, which includes:
Gross energy (GE) = 0.0242*CP + 0.0366*CF + 0.0209*CFr + 0.017*NFE - 0.0007*Zx.

-Exchangeable energy (EE) = 0.0152*DP (Digestible Protein) + 0.0342*DF (Digestible Fats) + 0.0128*DF (Digestible Fibers) + 0.0159*DNFE (Digestible Nitrogen-Free Extractable substances) - 0.0007*Zx.
-Net energy (NE) = EE-HI, where HI is a heat increment (energy loss due to metabolic inefficiency).
-Feed units for milk (FUM) = EE*(0.075 + 0.039q).
-Feed units for growth (FUG) = EE*(0.04 + 0.1q).
The economic indicators are calculated on the basis of the obtained yield and the established values regarding the quality of the dry mass in the treated variants.

Climatic characteristics in the experimental area

In terms of climate, the territory of the experiments is included in the Pre-Balkan (foothill) climate region of the temperate-continental climate subregion [17]. The climate is characterized by great diversity due to the physical and geographical conditions of the Troyan region assigned to the Stara Planina region, including the Balkan Mountains and the Pre-Balkans [6]. Temperatures bear the marks of continental influence. The average annual temperature is 10-11°C and is characterized by territorial differentiation (from north to south) with increasing altitude [15]. The distribution of precipitation was uneven (maximum in summer: 309.0 mm and minimum in winter: 168.0 mm). In spring and autumn the registered rainfall was 242 mm and 209 mm, respectively. The annual amount of precipitation in the Pre-Balkans reached from 567 mm to 1,200 mm.

RESULTS AND DISCUSSIONS

Main chemical composition of fodder from natural grass stands treated with humic fertilizer

Foliar fertilizing with humic fertilizer Biostim led to positive changes in the chemical composition of the dry mass in meadow and pasture grass stands (Table 2).
In **the meadow grass stand of *Chrysopogon gryllus*** L., type with the highest content of crude protein (87.38 g/kg DM) and crude fat (19.52 g/kg DM) was the variant treated with a dose of 400 ml/da. The values of the indicators exceeded the average by 14.7% and 19.9%, respectively. The foliar treatment variants registered higher values regarding the concentration of nitrogen-free extractable substances (by 1.1 to 5.8%), ash (by 5.1 to 14.0%) and calcium (by 26.1 to 48.5%) compared to the control. The treated variants also had a lower content of crude fiber (by 3.6 to 13.2%) compared to the untreated ones.

Table 2. Main chemical composition (g/kg DM) of natural meadow and pasture grass stand treated with biofertilizer (average for the period)

Variants	CP	CF	CFr	NFE	Ash	Ca	P
***Chrysopogon gryllus* L.**							
Control	65.12	16.31	396.17	452.47	69.92	4.60	0.93
100 ml/da	71.84	14.08	382.50	457.24	74.34	6.03	0.77
200 ml/da	69.49	15.54	362.32	478.79	73.86	5.80	0.83
300 ml/da	87.04	15.93	350.03	467.26	79.74	6.83	1.20
400 ml/da	87.38	19.52	359.49	460.12	73.49	6.37	1.14
Average	***76.17***	***16.28***	***370.10***	***463.18***	***74.27***	***5.93***	***0.97***
SD	***10.36***	***2.00***	***18.77***	***10.24***	***3.52***	***0.84***	***0.19***
***Nardus stricta* L.**							
Control	59.48	16.77	356.41	510.00	57.34	6.27	0.95
100 ml/da	56.65	16.02	370.21	499.83	57.29	4.43	1.10
200 ml/da	59.95	10.85	382.84	492.49	53.88	4.90	1.49
300 ml/da	59.79	13.95	390.72	485.59	49.94	5.33	1.57
400 ml/da	78.12	14.72	354.52	489.91	62.73	5.87	1.47
Average	***62.80***	***14.46***	***370.94***	***495.56***	***56.24***	***5.36***	***1.32***
SD	***8.67***	***2.30***	***15.92***	***9.59***	***4.74***	***0.74***	***0.27***

Source: Own research.

With a higher phosphorus content was the dry matter of grass stands treated with 300 ml/da (1.20 g/kg DM) and 400 ml/da (1.14 g/kg DM). The excess in the values of the indicator compared to the average and the control is respectively 23.7 and 29.0% (for the variant with a dose of 300 ml/da) and 17.5 and 22.6% (for the variant with a dose of 400 ml/da).

In **the pasture grass stand of *Nardus stricta* L. type**, the variants treated with the highest dose of humate fertilizer (400 ml/da) had again the highest content of crude protein (78.12 g/kg DM). In contrast to the results obtained in meadow grass stand, the content of crude fiber in the dry matter of treated pasture grass stands is higher by 3.9 to 9.6% compared to the control (except for the fertilizer variant with 400 ml/da, where the values are insignificantly lower compared to the control by 0.5%). A significant difference in the composition of pasture grass stands with foliar fertilizing compared to meadow is the lower content of nitrogen-free extractable substances, ash (exception is the variant with imported dose - 400 ml/da, where the excess over the control is 9.4%) and calcium compared to untreated variants. The biomass of the treated pastures has a high concentration of phosphorus. The values of the indicator exceeded the control from 15.8 (100 ml/da) to 65.3% (300 ml/da).

Energy nutritional value of fodder from natural grass stands treated with humic fertilizer

Nutritional energy value is the main criterion for assessing the quality of fodder, determined by the feed units for milk and growth [19]. The production of biomass with high nutritional value and degree of digestibility implies its full absorption and assimilation by ruminants [1, 2, 4].

In the case of **meadow grass stand of *Chrysopogon gryllus* L. type**, the total energy value of the fodder after applied foliar biofertilizer varied from 17.95 MJ/kg (300 ml/da) to 18.17 MJ/kg (400 ml/da). The excess (by 0.7%) compared to the average value of the indicator (18.05 MJ/kg) is observed only in the variants with the maximum treatment dose. Biomass in the variants with doses of 200 ml/da and 400 ml/da is characterized by a slightly higher content of exchangeable and net energy compared to the untreated control and the average value of the indicators.

The predominance (compared to the control) in the number of feed units for milk and growth (FUM = 0.79 units in kg DM and FUG = 0.74 units in kg DM) registered the grass stand treated with a dose of 200 ml/da.

Table 3. Energy and feed nutritional value of natural meadow and pasture grass stand treated with biofertilizer (average for the period)

Variants	**GE, MJ/kg**	**EE, MJ/kg**	**NE, MJ/kg**	**FUM**	**FUG**
***Chrysopogon gryllus* L.**					
Control	18.15	8.42	4.70	0.78	0.73
100 ml/da	18.02	8.39	4.69	0.78	0.73
200 ml/da	17.96	8.46	4.74	0.79	0.74
300 ml/da	17.95	8.40	4.70	0.78	0.73
400 ml/da	18.17	8.46	4.73	0.79	0.73
Average	***18.05***	***8.43***	***4.71***	***0.79***	***0.73***
SD	***0.10***	***0.03***	***0.02***	***0.00***	***0.00***
***Nardus stricta* L.**					
Control	18.17	6.97	3.76	0.63	0.54
100 ml/da	18.19	6.97	3.76	0.63	0.54
200 ml/da	18.22	6.98	3.77	0.63	0.55
300 ml/da	18.38	7.03	3.79	0.63	0.55
400 ml/da	18.17	6.94	3.75	0.62	0.54
Average	***18.23***	***6.98***	***3.76***	***0.63***	***0.54***
SD	***0.09***	***0.03***	***0.02***	***0.00***	***0.00***

Source: Own calculation.

In **the pasture grass stand of *Nardus stricta* L**. type, the total energy in the dry matter of the fodder is higher (by 1.0%) compared to that in the meadow grass stands (18.05 MJ/kg). The values of the indicator vary from 18.17 to 18.38 MJ/kg, as the grass stands with imported dose of 100 ml/da (by 0.1%), 200 ml/da (by 0.3%) and 300 ml/da (by 1.2%) humate fertilizer had an excess compared to the untreated control. The amount of exchange and net energy in the variants fed with Biostim, at a dose of 200 and 300 ml/da exceeds the controls by 0.1-0.9% (for EE) and 0.3-0.8% (for NE), respectively. In both variants, the number of fodder units for growth in dry matter was 1.9% higher compared to the number of fodder units for growth in dry matter of untreated variants (0.54 units in kg DM).

Biofertilizers efficiency expressed by the amount of dry matter and crude protein when applying 1 kg of liquid humic fertilizer

On average for the period, the amount of dry matter and crude protein obtained from 1 kg of liquid foliar fertilizer Biostim, in meadow grass stand of *Chrysopogon gryllus* L. type are 502.75 kg and 58.03 kg, respectively (Table 4).

Table 4. Efficiency of biofertilizers for meadow grass stand of *Chrysopogon gryllus* L. type expressed by the amount of dry matter and crude protein with the application of 1 kg liquid biofertilizer

Variants	**2011**	**2012**	**2013**	**Average for the period**
		Dry matter		
Control	-	-	-	-
100 ml/da	-155.40	1524.10	1057.60	808.80
200 ml/da	-270.80	1036.80	329.90	365.30
300 ml/da	-3.50	905.10	820.60	574.10
400 ml/da	-17.60	509.90	296.10	262.80
Average	***-111.83***	***993.98***	***626.05***	***502.75***
		Crude protein		
Control		-	-	-
100 ml/da	11.11	149.77	77.78	79.55
200 ml/da	-15.90	96.78	19.45	33.44
300 ml/da	22.91	126.08	73.50	74.16
400 ml/da	48.69	65.86	20.37	44.97
Average	***16.70***	***109.62***	***47.78***	***58.03***

Source: Own calculation.

Table 5. Efficiency of biofertilizers for pasture grass stand of *Nardus stricta* L. type according the amount of dry matter and crude protein when imported 1 kg of liquid biofertilizer

Variants	**2011**	**2012**	**2013**	**Average for the period**
		Dry matter		
Control	-	-	-	-
100 ml/da	-528.70	-401.10	2458.60	509.60
200 ml/da	-416.60	-156.00	599.80	9.10
300 ml/da	-294.50	-96.90	236.90	-51.50
400 ml/da	-104.40	-21.50	17.80	-36.00
Average	***-336.05***	***-168.88***	***828.28***	***107.80***
		Crude protein		
Control		-	-	-
100 ml/da	-80.02	-8.49	174.87	28.79
200 ml/da	-42.42	-1.37	48.25	1.49
300 ml/da	-28.71	-1.65	21.57	-2.93
400 ml/da	-6.51	-1.00	20.66	4.38
Average	***-39.42***	***-3.13***	***66.34***	***7.93***

Source: Own calculation.

The fodder in the second experimental year (993.98 kg and 109.62 kg) had the highest values. Negative dry matter values in the first year are a result of the difference in dry matter values in the treated and non-treated variants.

For the experimental period, the fodder mass of the lowest dose variants (100 ml/da) recorded the highest amount of dry matter (808.80 kg) and crude protein (79.55 kg) per unit of liquid fertilizer.

In ***Nardus stricta* L.** pasture grass stand, fertilizing with biofertilizers in the first and second experimental years was with low efficiency in terms of dry matter and crude protein, which correlated with the negative values obtained when 1 kg of liquid Biostim was introduced (Table 5).

Positive values in the third experimental year determine of 100 ml/da as the most effective treatment. The highest amount of dry matter and crude protein was registered in these variants. The values of the indicators per year and average for the period of the experiment are respectively 2,458.60 kg and 509.60 kg (dry matter) and 174.87 kg and 28.79 kg (crude protein).

Economic efficiency of biofertilizer Biostim for natural grass stands

Quantitative assessment of economic indicators is a key criterion for the effect of applied organic fertilizing [11]. The comparison of invested and received funds are the main economic indicators of economic significance of the factors for intensification of production.

In assessing the effectiveness of fertilizing in natural meadow and pasture grass stands, the costs incurred, revenues, profits and profitability are essential (Table 6). There is no difference in the total costs (7.87 BGN/da) regarding the application of foliar fertilizing in pasture and meadow grass stands. The total revenue, the total profit, the profitability and the critical level of the yield from the conducted agrotechnical measure in the meadow grass stands are higher by 19.9%, 25.4%, 27.7% and 92.1% respectively compared to those of the pastures, but at lower cost price.

In the case of meadow **grass stands**, the variants treated with the highest dose (400 ml/da) of foliar fertilizer have the highest values of total revenues (43.61 BGN/da) and total costs (9.84 BGN/da). With the highest total profit (43.15 BGN/da), profitability (628.72%) and critical yield level (89.49 kg/da) are the variants fertilized with a dose of 300 ml/da. There is no difference in the costs of biofertilizers in the variants with meadow grass stands.

Table 6. Economic efficiency of biofertilizers for natural meadow and pasture grass stands (average for the period)

Variants	**Total expenditures BGN/da**	**Total revenues BGN/da**	**Total profit BGN/da**	**Cost price BGN/da**	**Profitability %**	**Critical level of yield kg/da**
***Chrysopogon gryllus* L.**						
Control	5.35	34.88	29.52	0.02	551.44	53.54
100 ml/da	7.16	43.48	36.32	0.02	507.55	70.93
200 ml/da	8.05	42.18	34.13	0.02	423.81	80.53
300 ml/da	8.95	52.1	43.15	0.02	628.72	89.49
400 ml/da	9.84	45.39	35.54	0.02	361.03	83.48
Average	***7.87***	***43.61***	***35.73***	***0.02***	***494.51***	***75.59***
***Nardus stricta* L.**						
Control	5.35	35.45	30.09	0.03	562.10	26.77
100 ml/da	7.16	45.64	38.48	0.04	537.69	35.78
200 ml/da	8.05	35.81	27.76	0.05	344.68	40.26
300 ml/da	8.95	32.36	23.41	0.06	261.58	44.74
400 ml/da	9.84	32.57	22.72	0.06	230.79	49.22
Average	***7.87***	***36.37***	***28.49***	***0.05***	***387.37***	***39.35***

*Critical level of yield (C) – this is the yield, where there is no profit, neither loss. C = (Y*R)/P; Y – yield (kg/da); R – expenditures (BGN/da); P – revenues (BGN/da)

Source: Own calculation.

In the case of **pasture grass stands**, the total income and the profit after the applied foliar fertilizing are the highest in the variants treated with a dose of 100 ml/da. The values exceed the average by 25.5% and 35.1%, respectively. At all rates of treatment in the pasture grass stands, the profitability of the leaf spray is lower than the control. The critical yield shows at what values the revenues are equal to costs and no profit is formed. The excess in the average values of the indicator are by 2.3% (200ml/da), 13.7% (300 ml/da) and 25.1% (400 ml/da), respectively.

Foliar fertilizing with humate fertilizer Biostim (dose - 400 ml/da) increases the content of crude protein in the dry matter of meadow and pasture grass stands by 34.2% and 31.3%, respectively.

The highest energy and feed nutritional value is the feed mass of the variants treated with 400 ml/da dose (for *Chrusopogon gryllus* L.) and 200 and 300 ml/da (for *Nardus stricta* L.). The amount of gross energy in meadow grass stands is 1.0% lower than in pastures.

The efficiency of the applied biofertilizers is most pronounced in the variants with 100 ml/da dose, where the amount of dry matter and crude protein reaches 808.80 kg and 79.55 kg - for meadow and 509.60 kg and 28.79 kg - for pasture grass stands.

CONCLUSIONS

Foliar fertilizing with humate fertilizer Biostim (dose - 400 ml/da) increases the content of crude protein in the dry matter of meadow and pasture grass stands by 34.2% and 31.3%, respectively.

The highest energy and feed nutritional value is the feed mass of the variants treated with 400 ml/da dose (for *Chrusopogon gryllus* L.) and 200 and 300 ml/da (for *Nardus stricta* L.). The amount of gross energy in meadow grass stands is 1.0% lower than in pastures.

The efficiency of the applied biofertilizers is most pronounced in the variants with 100 ml/da dose, where the amount of dry matter and crude protein reaches 808.80 kg and 79.55 kg - for meadow and 509.60 kg and 28.79 kg - for pasture grass stands.

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THE USE OF SOCIAL NETWORKS IN THE PROMOTION AND EVALUATION OF RURAL CULTURAL ACTIVITIES

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Abstract

Both during the pandemic period and the period immediately following, restrictions and limitations were imposed on the entire economy, including access to culture and education in the countryside. Promoting online events as a safe medium of manifestation has attracted the public's attention by creating reactions in social media. The present work aims to analyze the reactions of members of social networks, both to the promotion of cultural events and to the dissemination of key moments of cultural programs. In the proposed analysis we studied the data counted and made available through social network applications.

Key words*: *education, culture, rural environment, social media, Apps, evaluation

INTRODUCTION

The use of computer networks has brought a radical change both economically and socially. Their evolution through the development of social networks has created new paradigms in the promotion and evaluation of services. Nowadays, all activities are closely related to their social branch. Practically, the promotion of an online activity can be quantified by the status of the social networks used. The problem of using social media in the evaluation of activities is studied in numerous publications and conferences of which we mention: IEEE Global Engineering Education Conference.

Social media-enhanced learning systems bring new challenges to the evaluation of learning environments. Many features are common to any website and can be evaluated with common criteria. But with the help of social networks, users can also contribute content, exchange opinions and create communities for different needs, which bring new dimensions to a quality assessment. The research by (Silius et. al. 2011) focused on the objective of finding out which are the most important people and functions in the social media enhanced learning system in the context of higher education. The paper presents the results of previous research that were used as a starting point for this study. Previous research was conducted in 2008-2009 and focused on how to evaluate social media sites. Issues such as: what are students' expectations and what motivates them to use social media in the context of higher education were addressed [8].

In the article "Integrating Social Media into Education", Hadewijch Vanwynsberghe and Pieter Verdegem proposed a framework for integrating social media literacy into an educational setting. They believe that in today's society, students and pupils are users of new media appearances, and therefore, the relevance in programs to include social media literacy. Vanwynsberghe and Verdegem propose a multidimensional conceptual framework of social media literacy that includes the practical, cognitive, and affective skills needed to process social media information, communicate with others through social media, create social media content, and manage consequences related to these three activities. At a theoretical level, the construction of social media literacy, including its connection with the educational system, is based on the notion of cultural capital developed by Pierre Bourdieu [12].

In developed countries, pupils and students lead rich digital lives that include maintaining connections through image-based social networks such as Instagram, Snapchat and Tinder. These ubiquitous technologies shape student and student identities as well as social practices in an ongoing manner. Social media is used to build identity through visual branding, where individuals use images designed to attract followers and maintain a close grooming of an online person. In this digital economy, social capital is attached to attributes such as trust, authenticity and attractiveness. Regular use of social media helps develop sophisticated visual practices through which the everyday user changes their own representation.

Stokes and Price (2017) believe that attractiveness and creativity are becoming dominant factors in these online forums, while the widespread use of image editing tools calls into question the factors of trust and authenticity. Their published paper uses Social Learning Theory to explore the use of social media for identity construction, identifying the problems inherent in students placing themselves in constant comparison with a wide range of peers and ways in which educators can use these insights to inform teaching [9].

Social media presents both opportunities and risks for any organization. The secure integration of social media platforms into organizational ICT infrastructures tends to focus mainly on technical aspects. Social media security management usually ignores the human dimension, but protection can only be achieved through a holistic approach. Social media security culture must be part of the overall organizational culture. The research, led by Oehri and Teufel (2012), is based on a survey conducted to determine social media guidelines. Following this survey, a management model for creating, monitoring and controlling the security culture of social networks was developed, which is intended to be the basis of an evaluation and reporting tool [5].

In the paper Social Network Analysis for Program Implementation published by (Valente et al. [11], the use of social network analysis theory and tools for implementation research is presented. The social network perspective is useful for understanding, monitoring, influencing, or evaluating the implementation process when programs, policies, practices, or principles are designed and expanded or adapted to different settings. In the paper, the authors briefly describe common barriers to implementation success and relate them to the social networks of implementation stakeholders. They introduce some simple measures commonly used in social network analysis and show how these measures can be used in program implementation [11].

Social networks can complement the organizational communication strategy, especially of culture and worship units at the rural level. As an example, (Rasheed et. al. 2021) [6] describes the design, implementation and evaluation of a social media-based communication strategy in a tertiary care hospital in Pakistan. Thus, an online communication platform - the Facebook page - was created for all employees of the pediatric service line. The strategy to influence employees was based on Cialdini's six principles of persuasion. Implementation of the strategy between October 2017 and December 2019 was assessed for coverage, discussion topics and outcomes using the framework by Murdough (2009). Quantitative metrics included total posts, average comments, and reactions per post [8]. The results of the study were that the posts were analyzed qualitatively with an emergent approach for insights into the discussion. The analysis revealed a total of 9,085 posts, with average reactions per post of 8.4, average comments of 7.2, and active viewing by 90% members on average. In terms of post types, photos were the most (4,779), while videos were the fewest (1,163). Qualitative analysis indicated that 54% of the posts were on the theme of “inspiring and thought-provoking”, while the highest engagement was generated on the theme of “challenges and solutions” [8].

MATERIALS AND METHODS

Promotion through social media is vital to the success of disseminating the posted information. Evaluating cultural activities based on dissemination through posts in social media accounts leads to measuring the success of promoting cultural activities in rural areas. In this regard, we will use a method based on the use of social network APIs in the promotion and evaluation of social activity posts. The indicators taken into account are: quantitative indicators: total posts, number of followers per page, number of posts; qualitative indicators: number of followers per post, reactions per post (positive, negative).

To collect the data needed to analyze the proposed indicators, we used the Events Manager API, with which we could view the data about various online events posted on social media. The data was obtained by adding the basic code of the Facebook pixel and the event code of the website after setting up the Conversion API. When accessing the Events Manager, the system offers four modules, as follows: Activity center; Data sources; Personalized conversions; Integrations with partners.

At a theoretical level, the Activity Center is the module where you track, complete and get information about activities, to better leverage Facebook Tools (Facebook pixel and Conversion API). In the Data Sources module, select the statistics and administration tools pixel, where 5 tabs will be displayed: General presentation; Test; Events; Diagnostics; Historic; Settings.

The Events Manager module displays the number of events received from the integration, such as the Facebook pixel and the Conversion API. This number may be different from the one in "Ads Management", which only counts events attributed to personal ads [4].

Events Manager displays both assigned and unassigned events from Meta Pixels, mobile app SDKs, offline event sets, and conversion APIs. This includes organic traffic, events attributed to published ads, meta and traffic driven from other platforms. Events Manager reports events even if they are not from a Meta user and can report events from a person performing the same action multiple times [4].

For web events: The Pixel/Conversions API tab displays assigned and unassigned events received from the analyzed website. The Aggregated Event Measurement tab displays only the highest priority assigned events received from the analyzed site during a conversion window, from people using iOS 14.5 or later devices. Metrics that report the number of events (for example, “Events received” and “Total events”) are reported before deduplication. This means that if events are sent by the user's account from both the browser and the server, "Total Events" displays the total number of events from both sources before deduplication. In this case, when someone completes the same action more than once, the Events Manager usually includes each of these events in the “Total Events”.

Custom conversions are used to: Filter events, add rules to standard events, custom events, or all traffic URLs to provide more granular action to followers of the analyzed post.

RESULTS AND DISCUSSIONS

Social Media represents a set of electronic platforms, applications, websites that offer various services through an Internet network and has the ability to facilitate the creation of links based on various criteria that allow the connection and interaction of users with each other.

There is a clear difference between Social Media and traditional media. Before the advent of the Internet, there were mass media in the form of newspapers, cable TV news channels, radio, and other magazines that published articles related to social issues. When the media moved into the web (online) area, it became interactive as it allowed people to immediately react to stories and comments on various issues in online articles, as well as participate in online opinion polls. The concept of "Social Media" should not be confused only with online papers or forums, it comes in many forms, such as blogs, micro-blogging, video sharing sites, photo and video sharing, and even bookmarking.

Many have tried to classify social media and according to experts, there are the following types of Social Media [4]: collaborative projects, where people share their knowledge, such as Wikipedia; blogs like celebrity blogs and microblogging site like Twitter; video sharing sites such as YouTube; exclusive social media networks such as Facebook; virtual games;

The present analysis was done on a social media account belonging to the Facebook system.

Within the account, cultural activities carried out in the countryside were promoted. Stoyanova-Toneva mention that cultural heritage, insofar as it is preserved, in symbiosis with the history of each region, has the potential to become a successful tool for the social and economic development of rural communities [10].

Promoting various activities within social networks often brings great success. In the present research, we aimed to evaluate the initiatives of culture units in the rural environment. In this sense, the main promoters of culture are identified as being, on the one hand, educational units and libraries, and on the other hand, religious institutions.

Professor Banciu D. claims that in a modern and dynamic world, where information is updated every second, every person, regardless of age and occupation, is obliged to learn and improve continuously. In the era of new information and communication technologies, the Internet has revolutionized all areas of social and professional life, including education, training and culture. Internet education represents a new way of learning for the student and also a new way for the teacher to teach [3].

The proposed analysis takes into account the promotion on social networks (Facebook) of cultural events during the pandemic period as well as the beginning of the relaxation period.

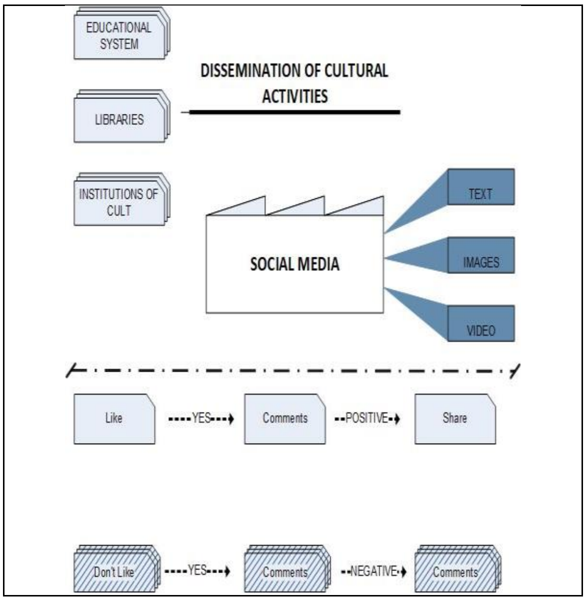

Fig. 1. Evaluation of cultural activities using data from social networks
Source: Own determinations.

According to Figure 1, the initiatives of those responsible for cultural activities (the educational system, libraries and religious institutions) are analyzed through posts on social media, which provides the opportunity to promote cultural activities through images, small films and text comments.

In general, there are two options by which a post can be accepted, either by giving a comment (positive or negative), or by marking it with (like/dislike). Qualitative indicators reinforce that a post is considered either positive or negative. In this regard, whether it is an acceptance of posts or perhaps even a rejection of posts from the public, the post has been traced to the mode of distribution.

From the statistical data provided by the APIs used, the analyzed Facebook account through which social media promotion was ensured had a total of 7,832 followers.

The first project targeted by our analysis was promoted on social networks with 3 posts that quantitatively attracted the attention of over 89% of the total number of people following this account. According to Table 1, quantitatively, posts were made in all three forms (Video, Images, Text), and according to the evolution of the data provided by the APIs used, posts containing video files tend to increase the attention of followers.

Table 1. Quantitative analysis of posts from the project Celebration of Voivode Mihai Viteazul at Dealu Monastery

Total posts	Posts			Number of post followers
	V	P	T	
1	0	1	1	5,158
2	2	0	2	6,971
3	1	1	1	6,200

Source: Own determinations based on APIs.

From a qualitative point of view, the first analyzed project was appreciated by more than 120 users who appreciated the page using the like symbol. The user reactions presented in figure 2. show that 10 users used positive words in the posted comments and the posts were distributed on the pages of over 100 users.

From a quantitative point of view, the second project for which data filtering was done in the presented APIs and which was presented in Table 2, attracted the attention of more than 90% of users who frequently follow the account's posts. At the level of posts, the most followers were within the posts that have content and presentation videos, and here we can say that there are more than 90% of users.

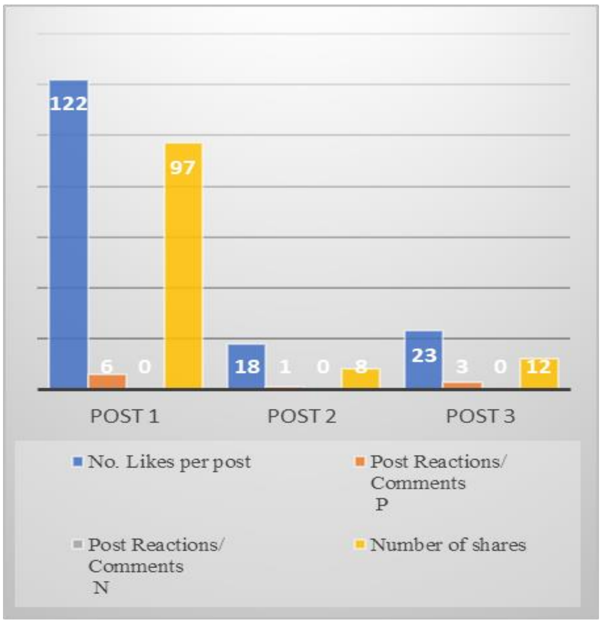

Fig. 2. Qualitative analysis of the posts from the project Celebration of Voivode Mihai Viteazul at Dealu Monastery
Source: Own determinations based on APIs.

Table 2. Quantitative analysis of posts from the March for Life project

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	5,158
2	2	1	2	6,971
3	1	0	2	6,458

Source: Own determinations based on APIs.

In terms of quality, the posts for this project have gathered approximately 500 appreciations in the form of likes. The recorded reactions show that the number of likes through positive words and posts has been reached by more than 50 visitors. As shown in the graph in Figure 3.
The project was shared by more than 450 people, and at the post level we can see that there are people who did not leave appreciations but shared the posts in personal groups of users.
The third project that is the object of our analysis also presented in Table 3, was promoted and disseminated in two posts that attracted the attention of almost 90% of people who frequently follow the account's activity.
Within this project, 2 posts were made that contained both text and pictures and videos. In this context, we note that social network users accessed the post that contained images and text in a smaller proportion (over 65% of views).

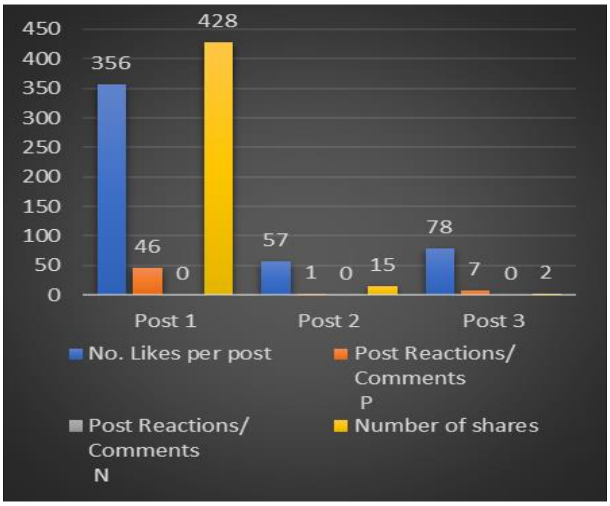

Fig. 3. Qualitative analysis of posts from the March for Life project
Source: Own determinations based on APIs.

Table 3. Quantitative analysis of the posts from the Prayer in my life project

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	5,158
2	2	1	2	6,971

Source: Own determinations based on APIs.

From a qualitative point of view, the posts were appreciated with more than 130 likes and collected 3 comments containing 100% positive words. According to the graph in Figure 4, the posts made were shared in over 65 different user groups.

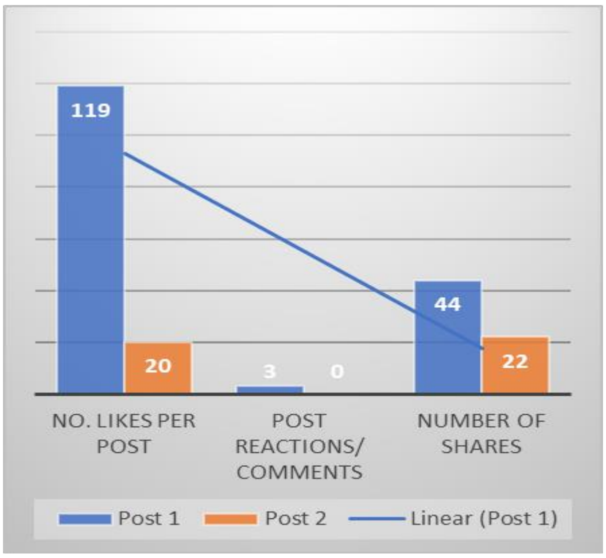

Fig. 4. Qualitative analysis of the posts from the Prayer in my life project
Source: Own determinations based on APIs.

Religious holidays at the rural level are key calendar points where traditional cultural elements of customs are intertwined with the traditional Christian gastronomic art. The pandemic period significantly slowed down these processes in the physical environment. The promotion of religious holidays was the subject of the analysis of the project presented in Table 4.

Table 4. Quantitative analysis of posts from the Let's celebrate Christmas authentically, traditionally and confessing project

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	5,158

Source: Own determinations based on APIs.

From a quantitative point of view, the post, which contained video elements, images and text, was followed by more than 65% of users who follow the analyzed Facebook account.
Analyzing from a qualitative point of view the data also presented in Figure 5, we notice that the images, videos and published text attracted almost 1,000 likes, of which more than 35% brought positive likes in the form of cements. Positive reactions from interested followers led to more than 350 shares in various user groups.

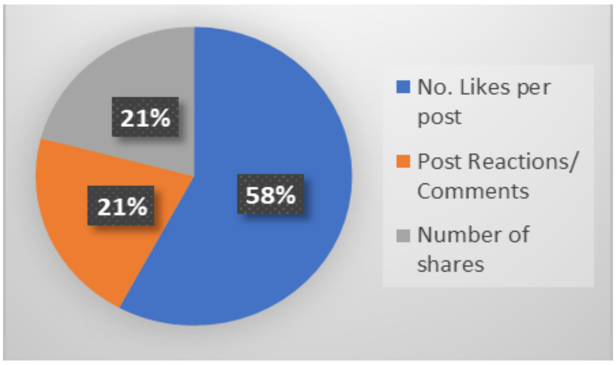

Fig. 5. Qualitative analysis of posts from the Let's celebrate Christmas in an authentic, traditional and confessional way
Source: Own determinations based on APIs.

Arts and culture can play an important role in improving rural areas and the quality of life of the people who live there. Among other things, they can help create new connections and bring together different communities (e.g. urban and rural, farmers and customers, communities and rural administrations), improve communication about rural areas, contribute to the improvement of shared cultural identity and involve disadvantaged groups (such as young people or migrants)[1].
Another project analyzed through the prism of posts on social networks combines education, culture and faith at the level of Romanian rural organizations. This project, from the point of view of quantitative indicators, attracted the attention of almost 95% of the followers of the account. Also presented in table 5. the two posts through which the activity was made visible, a video material was collected, 3 posts with images and 2 with text in which the theme of the project was explained and argued.

Table 5. Quantitative analysis of the posts within the project Faith, education and culture in the service of our local community - 500 years since the transition to the eternal ones of the Holy Voivode NeagoeBasarab

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	5,158
2	2	1	2	6,971

Source: Own determinations based on APIs.

At the qualitative level, the project was appreciated by more than 90 people, who liked the project's widespread efforts. As shown in the graph presented in figure 6., the reactions per post gathered in two comments with positive likes, determined a number of more than 70 distributions in other social groups.

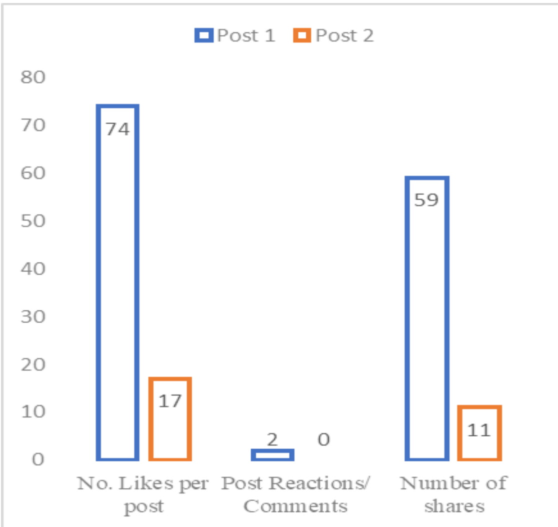

Fig. 6. Quantitative analysis of the posts within the project Faith, education and culture in the service of our local community - 500 years since the transition to the eternal ones of Saint Voivode Neagoe Basarab
Source: Own determinations based on APIs.

Culture and education are inseparable and yet complementary with multiple points of interaction. Culture paves the way for education, while education is responsible for flavoring cultural values in life. Therefore, both must be intertwined in various ways.

A sense of pride in our culture must manifest through all stages of an individual's growth. Primary education is where it all begins and the child begins to respect the importance of a value-based life as he too sees the things and events that happen and the behavior of others around him.

Another analyzed project refers to reading as a support pillar of education in the rural environment. This project analyzed through the quantitative indicators proposed and presented in Table 6, gathered more than 60% of the group's attention through a video post, 2 image posts and 1 text post [7].

Table 6.Quantitative analysis of posts from the National Reading Day project

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	4,906

Source: Own determinations based on APIs.

At a qualitative level, the project gathered a smaller number of appreciations, namely 16 registered in the databases queried. This, may be the cause emphasized primarily at the quantitative level, having only one post to disseminate the events. According to the data presented in the graph in Figure 7, however, the reaction of social media users was a positive one, marked by 2 comments and a share.

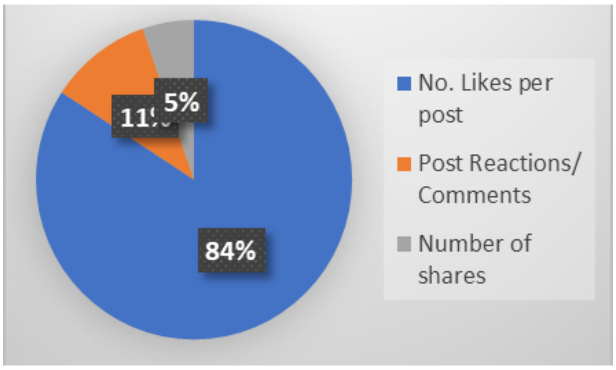

Fig. 7. Qualitative analysis of posts from the National Reading Day project
Source: Own determinations based on APIs.

The last project analyzed refers to the encouragement of reading in rural educational institutions. Thus, through the quantitative indicators, we observe that the project was disseminated through a single post that attracted the attention of over 60% of the group's users. The post, according to the data presented in Table 7, was distinguished by 2 sets of images and one set of text.

Table 7. Quantitative analysis of posts from the Whole School Reads project

Total posts	Posts			Number of post followers
	V	P	T	
1	0	2	1	4,809

Source: Own determinations based on APIs.

From a qualitative point of view, the post gathered 17 likes from followers with two reactions that had only positive words, and was distributed among 4 different groups according to the graph in Figure 8.

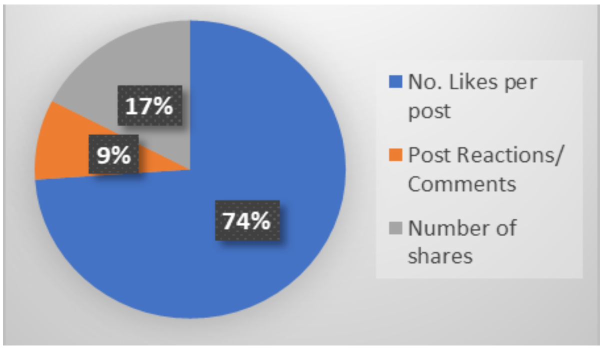

Fig. 8. Qualitative analysis of posts from the All School Reads project
Source: Own determinations based on APIs.

CONCLUSIONS

As Banciu et al. (2020) affirmed, the digitization of education actually brings a challenge for the entire education system, not just for distance education [2]. Compared to the data presented in the present research we can conclude:

-Both in the urban and rural areas, the pandemic period accentuated the distance from culture and traditions. However, the activities carried out with a limited audience through dissemination on social networks, attracted the attention of most of the users;

-Quantifying the success of dissemination on social networks can be done in many ways depending on the configuration of the APIs made available;

-Predominantly, from the analyzed data we can say that the posts that used more video images were more successful among the quantitative indicators;

-All posts were based on dissemination based on summary (text) to which images or videos were added. Using qualitative indicators, we can say that all posts recorded positive words and all were presented as (share) in other groups;

-As a degree of appreciation, at the rural level, the initiatives of joint culture, religion, education projects stand out. According to quantitative indicators, these projects attracted the attention of more than 95% of the account's followers, were qualitatively appreciated by the use of positive words and had the highest number of shares. One such initiative was the project Faith, education and culture in the service of our local community - 500 years since the passing to the eternal of the Holy Voivode Neagoe Basarab.

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THE USE OF LOCAL RAW MATERIALS FOR THE DEVELOPMENT OF HIGHER VALUE-ADDED CHAINS: THE LITHUANIAN CASE OF PEAS

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Abstract

The Lithuanian agricultural system survived paramount structural changes after the country had joined the EU. This paper investigates the case of peas. The study applies qualitative and quantitative methods in order to identify the potential of this raw material and map the most important solutions that allow to increase value added by introducing new products. Results suggest that in 2004 the harvested peas were mainly directed to domestic uses, while in 2020 farmers were mainly producing this crop for the export of dry peas. Indeed, the creation of the higher value-added products is a desired alternative for the locally produced raw material. The combination of literature and other relevant sources analysis and expert interviews allows us to identify food and feed directions as the most attractive ways to increase value added. However, experts suggest that the Lithuanian market imposes some restrictions on business development.

Key words: *agriculture, structural change, value added*

INTRODUCTION

The enlargement of the European Union (EU) fostered fundamental structural changes in agricultural systems of Member States. Although the most recent academic research focuses on different aspects of change, this paper pays attention to insufficiently explored nexus of transformations and value added.

The concept of value added could cover different aspects. According to [5], value added could be applied to measure the national (regional) development employing the criterion of the export structure. It is acknowledged that agriculture is classified as the low value added generating economic activity, while processed products are treated as the higher value-added one. The paper employs this aspect to investigate the situation of the selected raw material, namely peas, because the abovementioned measure is closely connected to other aspects of value added.

For example, the economic aspect of value added has the nexus with the national (regional) economic welfare of citizens [5]. This measure goes beyond business profits, because it pays regard to labour costs and taxes. In fact, the higher share of raw materials in export structure could be associated with lost opportunities to generate the higher economic welfare. In this context, new products from biological mass are obtained because of the greater focus on research and innovations [8], while the expansion of different value-added chains for the same raw material results in the creation of the higher value added.

Given that the Common Agricultural Policy (CAP) could contribute to the higher value-added products' appearance on the market, the important aspects of the EU budgetary added value referred to by [10] should be considered. Thus, public spendings must be linked to the benefits that arise when investments in new higher value-added chains allow us to increase the added value at the EU level.

This paper investigates the potential for new higher value-added products from peas in Lithuania and deals with the main barriers of innovative value-added chains establishment in the country.

To authors knowledge, in Lithuania, the academic research with this focus was not carried out. However, some fundamental academic research studies that contribute to the better understanding of the aforementioned topic were carried out by [1], [9], [16], and [18]. Indeed, the largest number of previous studies focus on the potential of peas for the developing of particular products and (or) the overcoming of specific problems (for example see [2], [3], [7], [11], [17], [19]).

MATERIALS AND METHODS

The methodological development framework combines couple directions that rely on different methods. The analysis of raw material's potential relies on data from Statistics Lithuania. The results are explained employing graphical visualization and comparative analysis methods.
The review of the academic literature and other reference material (e.g. reports, legislation, and etc.) allows us to identify main relevant drivers that encourage to use peas for the higher value-added products and highlight the most paramount directions for the value chains creation.
Finally, the main results of the semi-structured research interviews with 15 experts representing agricultural production (7), processing (3), and science (5) are provided. The research was carried out in March 2022 and focused on experts with the relevant competence. The interviews were used to verify main possible directions of the higher value-added products' creation, as well as for a better understanding of business barriers.

RESULTS AND DISCUSSIONS

Changes in the cultivation of peas and uses in value-added chains

This section identifies the potential of harvested peas that could be used to increase the domestic value added. First, it is important to note that the cultivation of peas did not play an important role in the Lithuanian agriculture before the accession to the EU. According to Fig. 1, in 2004, only 11.5 thou ha were sown by peas, while this crop represented 1.3% of the area sown by cereals. The role of leguminous crops in the structure of cereals was modest (3.4%) too. Nevertheless, peas accounted for 37.7% of the leguminous crops. However, the introduction of the CAP and other fundamental changes that took place on the Lithuanian market after the country had joined the EU made a significant influence on agriculture. The growth of cereals production, represented in Fig. 1, was led by a sudden shrinking of livestock population. The CAP support measures also introduced important changes in domestic structure of cereals.

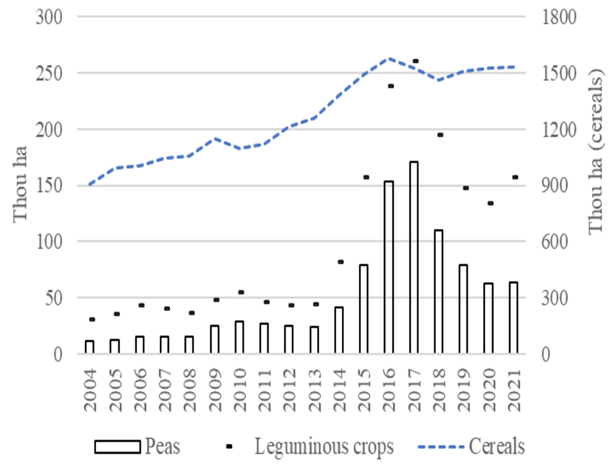

Fig. 1. Sown area of peas, leguminous crops, and cereals in 2004–2021
Source: Statistics Lithuania [12].

Coupled direct payments for the protein crops and the evolution of the direct payments scheme resulted in growing volumes of leguminous crops in Lithuania. Since 2014, the share of leguminous crops in the structure of cereals increased remarkably. Over the investigated period, the share of area sown with peas in leguminous crops fluctuated from 34.4% (in 2005 and 2006) to 65.6% (in 2017) and exceeded 50.0% in the structure of leguminous crops in 2009–2019. Experts link the later decline of areas sown with peas with the contraction of demand due to gradual consumption changes in main export markets. Other concerns are linked to the CAP regulations that make a remarkable impact on the agricultural output.
Fig. 2 shows the dynamics of harvested peas in 2004–2021. The results allow us stating that farmers do not generate a stable supply of peas. Indeed, this fact is critical for the functioning of domestic value-added chains,

and this circumstance must be taken into the consideration. The fluctuations of yields also do not allow to state that the progress in this area results in larger harvests over the period 2004–2021.

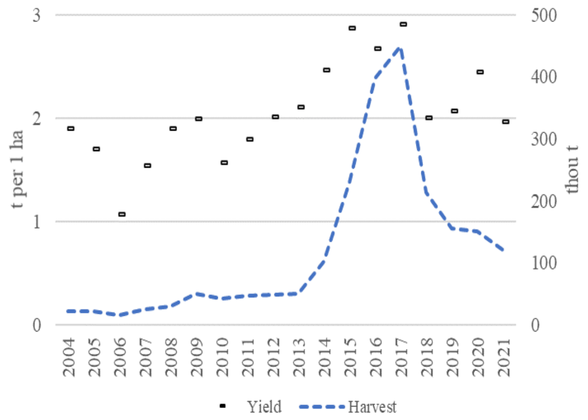

Fig. 2. Dynamics of harvests and yields per ha: the case of the Lithuanian peas
Source: Statistics Lithuania [13, 14].

As mentioned above, the sudden changes in supply rely heavily on dependence on foreign markets, because the consumption of peas in domestic value-added chains is low. Nonetheless, Table 1 reports about important structural changes in supply balance sheets over the period 2004–2020.

Table 1. Supply balance sheets for peas

	2004		2010		2015		2020	
	thou t	%	thou t	%	thou t	%	thou t	%
Initial stocks	17.2	41.2	17.2	28.5	48.2	16.7	107.0	39.1
Usable production	22.0	52.8	42.5	70.4	228.7	79.0	154.7	56.5
Imports	2.5	6.0	0.7	1.2	12.5	4.3	12.0	4.4
Total resources	41.7	100.0	60.4	100.0	289.4	100.0	273.7	100.0
Exports	3.7	8.9	16.8	27.8	174.2	60.2	148.6	54.3
Domestic uses, total	26.2	62.8	27.0	44.7	50.6	17.5	69.0	25.2
Final stocks	11.8	28.3	16.6	27.5	64.6	22.3	56.1	20.5
Total resources	41.7	100.0	60.4	100.0	289.4	100.0	273.7	100.0

Source: Statistics Lithuania [15] and own calculations on the basis of data from Statistics Lithuania.

In 2004, the cultivation of peas followed signals of the domestic market, i.e. 26.2 thou t were mainly used as seed, feed, and food, while the usable production accounted for 22.0 thou t. In 2020, 96.1% of usable production was exported, while in the previous period we observe the growing role of export. Indeed, the main feature of export was dried peas, i.e. an agricultural commodity that created low value added on the domestic market. In fact, these volumes of peas could be treated as a potential and used as a raw material for the higher value-added products that increase value added of the country.

According to Tables 1 and 2, the domestic market reacted to the overproduction of peas and domestic uses increased from 26.2 thou t in 2004 to 69.0 thou t in 2020. Nevertheless, in 2020, the domestic uses accounted for 44.6% of usable production, while the strong orientation towards export was evident.

Table 2. Changes in domestic uses of peas

	2004		2010		2015		2020	
	thou t	%	thou t	%	thou t	%	thou t	%
Domestic uses, total	26.2	100.0	27.0	100.0	50.6	100.0	69.0	100.0
Uses for seed	3.4	13.0	7.1	26.3	13.9	27.5	13.4	19.4
Uses for animal feed	13.4	51.1	10.6	39.3	17.5	34.6	38.8	56.2
Human consumption	8.7	33.2	8.9	33.0	10.1	20.0	10.6	15.4
Losses	0.7	2.7	0.4	1.5	9.1	18.0	6.2	9.0

Source: Statistics Lithuania [15] and own calculations on the basis of data from Statistics Lithuania.

Supply balance sheets do not identify significant changes in dietary habits during the period 2004–2020. The indicator of human consumption increased from 8.7 to 10.6 thou t (Table 2). The growth of uses for seed goes in lines with the enlargement of the sown area. However, fundamental changes are observed in uses for animal feed, because this indicator has almost tripled over the investigated period. The increase in losses also shows undesired trend, because those raw materials could be used as a potential to create higher value-added products.

The main directions of the increase in value added

Main drivers behind the change. This section provides the results of academic literature and other relevant documents analysis combined with results of experts' interviews to identify the alternative uses of peas that could result in the higher value added.

Literature review and interviews with experts allow us to identify several important at the EU level added values that ground the development of the new value-added chains in Lithuania. First, the current CAP support scheme could be treated as an important factor contributing to the presence of leguminous crops in national agriculture. The importance of peas is linked to the management of environmental challenges. According to The legumes expert forum [18], peas increase soil fertility and allow to reduce dependence on synthetic fertilisers and chemical weed control, while the aforementioned benefits reduce the pollution from agricultural systems and enhance agricultural biodiversity.

Multiple academic studies link peas and climate change mitigation challenges. The most recent academic paper [6] argues that peas lose less important nutritional components under the scenario of growing concentration of atmospheric carbon dioxide than widely consumed wheat. This fact could have an impact on the future consumption and dietary changes that deal with health issues.

Another climate change mitigation challenge is related to the phenomenon of flexitarianism, which is promoted in the EU to reduce meat consumption. As the consumption of meat products has a significant impact on the increase in greenhouse gas emissions, people are encouraged to become semi-vegetarians that focus their diets on plant foods and have the occasional inclusion of meat into their diets. In this context, peas become an alternative that allows us to change animal protein.

Thus, the spread of vegetarianism, veganism, and flexitarianism creates an attractive niche for new products from peas that supplement dietary needs by plant protein. Academic research underlines the importance of functional ingredients from peas [1] that could be used in food, animal feed, and pet food. In addition to the traditional usage, peas as a raw material become popular producing meat substitutes, confectionary and baked goods, desserts, etc. [1, 11]. Peas could be successfully used in meat products to improve the texture, enrich the fiber, and obtain other important properties [1, 19]. Academic studies show that even by-products from processing can be successfully used to obtain food, feed, and other products [16]. Indeed, the research still identifies that the substitution of meat by legumes faces serious challenges [9], because people prefer meat products.

Another paramount direction of new value chains' development is the use of peas and pea processing waste in animal feed. In 2018, "A European strategy for the promotion of protein crops" [4] declared the intention to reduce the dependence of the EU livestock sector on imported proteins from the third countries. The current plant protein deficit is linked with important problems, including the emerging demand of feed proteins on the global market, especially in China. These changes could have an impact on the EU food security and the desire to facilitate GMO-free feed production in order to have non-GMO products in the EU. The use of local leguminous crops also contributes to the climate change mitigation. Although the conducted research shows that during the investigated period some progress was achieved in Lithuania to increase use of peas for animal feed, the further steps are necessary, because the country remains dependant on imported cheap proteins.

Academic research demonstrates that local peas could be used as a raw material for three main market segments, namely GMO-free feed, organic feed, and conventional feed [1]. Those market segments will empower premium products for costumers (for example, organic or GMA-free meat, eggs, dairy products). A wide range of feed products could be received due to different levels of raw material processing. Indeed, the digestibility and safe norms for animal health, including maximum incorporation norms for peas, remains an important research question that attracts the attention of scientists around the world [3, 7, 17]. Another research direction deals with innovative technologies that improve digestibility of peas [2, 16].

Interviews with experts. To summarize, experts also argue that new products that represent food and feed chains are the most attractive development directions to increase value added. However, the low funding for science and business collaboration projects is mentioned among the most important problems that make the development of innovative value-added chains rare and force local businesses to adapt innovations that have already been created in other countries. In fact, even those projects require good cooperation of business and academic society and the relevant funding that is not provided. Thus, significant attempts must be taken to improve the current situation.

Indeed, the most important challenge is named as finding markets for the higher value-added products, while the markets for less processed products are available. Table 2 demonstrates that changes in human consumption are very slow, and it puts serious limitations on the demand for new food products on the domestic market. Some progress could be achieved investing in marketing and educational projects that aim at changing dietary habits. Since the switch from animal to plant protein use brings added value at the EU level, these measures could be lunched as individual programs with the corresponding funding.

Experts also stress the barriers that prevent local producers from access to foreign markets and suggest directing the value added into business-to-business segment as the most realistic viable solutions. Proteins from peas, pea concentrate, and pea isolate were mentioned by many experts as possible business development directions.

Another important direction of the establishment of new value-added chains is feed manufacturing. Experts mentioned three main problems that must be overcome in order to develop this direction successfully. First of all, this feed must be competitive with the current alternatives available on the market. Experts also mentioned that ingredients from peas could be linked with some limitations, because this crop has different impact on animal health, while ruminants are proposed as the most promising feed manufacturing development niche. The third problem deals with the livestock sector shrinking in Lithuania that introduces the decline in demand for these products on the domestic market and encourages to consider business investments that propose competitive products for foreign markets.

It should be noted that the support for the new value-added products is mentioned as a very important factor that could accelerate the payback period and allow to enter a new market with lower prices. This issue is mentioned as critical for both food and feed directions.

CONCLUSIONS

Over the period 2004–2021, in Lithuania the cultivated area and the volumes of harvested peas increased significantly. This fact could be linked to the availability of excessive raw material that was not common in Lithuania before the accession to the EU. Indeed, the analysis of national supply balance sheets shows that the country survived a remarkable switch from domestic uses of peas to export during the investigated period. This transformation supposes losses of value added in the country. The dependence on demand from foreign markets results in sharp fluctuations of sown areas and the relevant changes in rotations.

The review of academic research and other relevant material shows that the most attractive niches for the development of new higher value-added products cover food and feed directions. These directions contribute to the creation of added value at the EU level, because this crop contributes to climate change mitigation, reduces dependence on synthetic fertilisers and chemical weed control, allows to develop the sustainable and secure food system in the EU. Interviews with experts confirm the attractiveness of these niches, however, introduce some limitations on the wide list of available options. Experts stress that the domestic market for food products is limited and suggest business-to-business models and the development of functional ingredients as a viable alternative. Business projects introducing new feed products also must offer competitive prices that could cover both domestic and foreign markets.

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ECONOMIC ANALYSIS OF CUT FLOWER PRODUCTION (CARNATION, GERBERA AND LISIANTHUS) IN TURKEY: THE CASE OF ANTALYA PROVINCE

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Abstract

This research aims to determine the cost and profitability analysis of farmers' greenhouse cut flower (carnation, gerbera and lisianthus) production in Antalya. In 2018, the cut flower production in Antalya province accounted for about 56.04% of Turkey's cut flower production. Snowball sampling methods were used to select the cut flower growers and the sample size was calculated as 53 farmers. The data obtained from the enterprises' cut flower production was obtained by face-to-face interviews with the farmers using the producer questionnaire developed by these researchers. The data for the study was obtained in 2018. According to the study's conclusions, the most important cost factor in the greenhouse cut flower production process in the enterprises interviewed was the variable cost. The variable cost share of the total production cost in carnation production was 56.96%, 59.44% in gerbera production, and 64.03 in lisianthus production. The fixed cost percentage was 43.04%, 40.56% and 35.97%, respectively. As for cost items, the most important elements were permanent labour, fertiliser, seedlings, pesticide and land rent. The relative profit value, which better measures the return of production activities, in greenhouse cut flower production was calculated as 1.47 in carnation enterprises, 1.60 in gerbera enterprises and 1.26 in lisianthus enterprises.

Key words: *carnation, gerbera, lisianthus, cut flower, economic analysis*

INTRODUCTION

Ornamental plants are examined in four subgroups. These are cut flowers, indoor ornamental plants, outdoor ornamental plants, and natural flower bulbs [11].

Cut flowers are more preferred by farmers and consumers than other ornamental plants. Therefore, the demand for cut flower production in Turkey is high [12].

The increase in the level of economic development of countries, the development in the purchasing power of consumers, the increase in the population living in cities and important days (wedding anniversary, mother's day, valentine's day, etc.) increase the demand for luxury goods. This demand also increases the cut flower production [12].

In 2020, cut flowers and potted plants were produced on an area of approximately 750,000 hectares in the world. India ranks first in cut flowers and potted plants production with a share of 41.78% (313,000 ha). India were followed by China with a share of 24.64% (184,586 ha). China were followed by USA of 3.76%, Japan of 2.42%, Brazil of 2.08%, Mexican of 2.00%, Italy of 1.70%, Thailand of 1.64%, South Africa of 1.53%, Ecuador of 1.24%, and Colombia of 1.02% respectively (Fig 1).

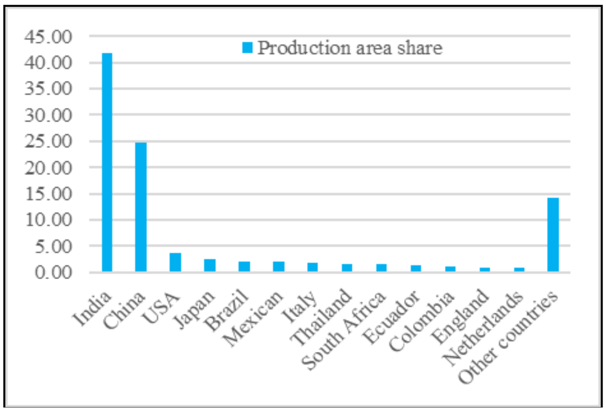

Fig. 1. The share of countries in cut flower and potted plants production area in the world (%)

Source: [3].

In terms of the production quantity of cut flowers in Turkey in 2021, the share of carnation was 56.98%, the share of gerbera was 11.32%, and the share of lisianthus was 1.91%. In terms of production area, the share of carnation was 38.72%, the share of gerbera was 9.24%, and the share of lisianthus was 2.30% (Fig 2).

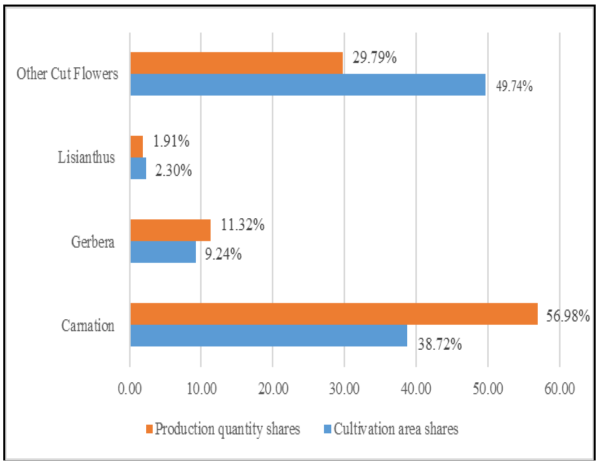

Fig. 2. The share of cut flowers in terms of production quantity and production area in Turkey (%)
Source: [22].

The Mediterranean Region including the province of Antalya, ranks first in cut flower production due to the high average temperature, fertile soil, and proximity to the target market. In addition, due to climatic factors, the greenhouse heating cost of this region is lower than other regions [17].

Cut flower production in greenhouses is common in this region, cut flower production is made for high quality and export-oriented [15].

While the carnation production area in Antalya in 2011 met 55.59% of the production area in Turkey, its share decreased to 51.25% in 2021. While the gerbera production area in Antalya in 2011 met 74.24% of the production area in Turkey, its share increased to 77.17% in 2021. While the lisianthus production area in Antalya in 2011 met 26.83% of the production area in Turkey, its share increased to 38.80% in 2021 (Fig. 3).

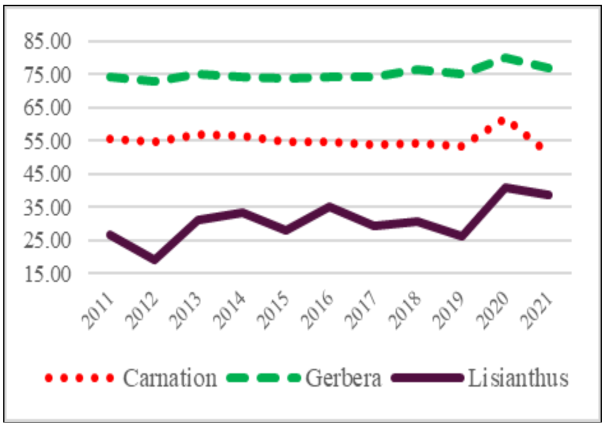

Fig. 3. The share of Antalya province cut flower (carnation, gerbera and lisianthus) production area in Turkey (%)
Source: [22].

While Antalya's carnation production was approximately 49.97% of the total carnation production in Turkey in 2011, its share decreased to 48.07% in 2021. While the gerbera production in Antalya in 2011 met 74.99% of the total production in Turkey, its share increased to 82.25% in 2021. While the lisianthus production in Antalya in 2011 accounted for 33.52% of the total production in Turkey, its share increased to 48.30% in 2021 (Fig. 4).

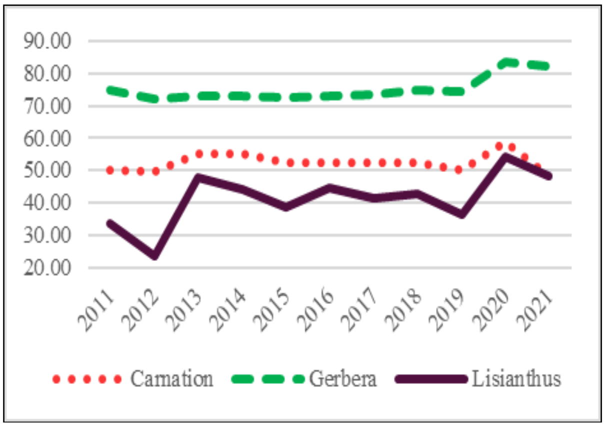

Fig. 4. The share of Antalya province cut flower (carnation, gerbera and lisianthus) production in Turkey (%)
Source: [22].

As a result of the literature review, it was determined that there are many studies on the technical structure [6], [9], [19] and foreign trade [10], [12], [20], [21] of cut flower production, but there are fewer studies on its economic analysis [7], [14].

This study aimed to analyse the technical applications, costs, and profitability of enterprises producing cut flowers in the greenhouses of Antalya.

MATERIALS AND METHODS

The study's primary material was comprised of original data obtained via a face-to-face survey method from 53 cut flower production enterprises in the Antalya province. Since cut flower producers are intense in Altinova Region of Antalya province, survey interviews were conducted in this region.

Survey data belongs to the 2018 production period. In the 2018 production year when the data were collected, Antalya province has 57.58% cut flower production area and 56.04% cut flower production in Turkey [22]. For this reason, these districts were chosen as the research area. In order to calculate the number of farmers to be interviewed in the research, a list of cut flower growers was requested from the Antalya Province Farmer Registration System, but no record was found. For this reason, snowball sampling methods were used in the selection of the sample and the sample size was calculated as 53 farmers.

The average cut flower area of the enterprises was calculated as 9.04 decares for carnation enterprises, 4.00 decares for gerbera enterprises and 2.46 decares for lisianthus enterprises (Table 1).

In calculating the cost and profitability of the enterprises, the calculations were made after the answers were received through face-to-face surveys with the farmers. Single product budget analysis was used in the cut flower cost analysis.

The variable cost consisted of fertiliser, seedlings, pesticide, machine rental, temporary labour, electricity (for irrigation), other variable costs, and the interest in working capital. Permanent-family labour, land rent, establishment capital interest, establishment depreciation value and general administration expenses made up the fixed cost.

The gross production value was calculated by multiplying the cut flower production of the enterprises with the sales price. The daily wage paid to the wage labourer in the region was taken as a precedent in calculating the enterprise's daily wages for the enterprise owner and his family members. 3% of the total variable cost was the general administrative expenses [1] [13].

The gross profit was calculated by subtracting the variable costs from the gross production value, and the net profit was calculated by subtracting the production costs [4] [16].

The relative profit was calculated by dividing the gross production value by the production cost [13]. The exchange rate for 2018 was 1 US dollar = 4.82 Turkish Lira (TRY).

Table 1. Sample size

Cut flower type	Cut flower production area (decare)*	Number of enterprises**	Percent
Carnation	9.04	25	47.17
Gerbera	4.00	32	60.38
Lisianthus	2.46	11	20.75

*1 decares = 0.1 hectares **In some enterprises, cut flower types were produced together
Source: Own calculation.

RESULTS AND DISCUSSIONS

Since greenhouse soils' physical and chemical properties are very different from each other, fertilization applied without soil analysis causes various problems in cut flower production [5]. For this reason, the application of soil analysis in greenhouse soils will prevent problems in cut flower production. The soil analysis status of the enterprises within the scope of the research was examined, and it was determined that 16.98% of the enterprises applied soil analysis. It was determined that 88.68% of the enterprises applied foliar fertiliser and 60.38% applied animal manure (Table 2).

In the interviewed enterprises, it was determined that the enterprises that applied soil analysis had a low rate and that the enterprises that made fertilisation had a high

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rate (Table 2). This situation showed that cut flower producing enterprises had fertilization applications without soil analysis.

Non-operating agricultural income is the income that the capital and labour force of the enterprise are obtained for agricultural purposes outside the enterprise [18]. In other words, it is the income obtained by the enterprises from the agricultural sector except that their own agricultural income. The proportion of cut flower enterprises with non-operating agricultural income was 7.55%, and the proportion of cut flower enterprises with non-agricultural income was 41.51% (Table 2). It was determined that almost half of the enterprises interviewed had non-agricultural incomes. The rate of enterprises producing cut flowers every year was determined at 83.02% (Table 2). Most of the enterprises continue their cut flower production regularly. This showed that farmers who regularly produce cut flowers every year are more experienced.

Table 2. Technical information about cut flower production of enterprises

Indicators	Answers received from enterprises			
	Applying		Not applying	
	N	%	N	%
Soil analysis	9	16.98	44	83.02
Foliar fertiliser	47	88.68	6	11.32
Animal manure	32	60.38	21	39.62
Non-operating agricultural income	4	7.55	49	92.45
Non-agricultural income	22	41.51	31	58.49
Cut flower production every year	44	83.02	9	16.98

Source: Own calculation.

The average production cost was calculated as 38,404.90 TRY in carnation production, 32,095.11 TRY in gerbera production, and 33,038.84 TRY in lisianthus production. The most important cost factor in the greenhouse cut flower production process in the enterprises interviewed was the variable cost. The variable cost share of the total production cost in carnation production was 56.96%, 59.44% in gerbera production, and 64.03 in lisianthus production. The share of fixed costs was 43.04%, 40.56% and 35.97%, respectively. As for cost items, the most important elements were permanent labour, fertiliser, seedlings, pesticide and land rent (Table 3).

Permanent labour costs had the most important share with 24.66% among the factors that constituted the production costs in carnation production. Permanent labour costs were calculated at 9,470.48 TRY per decare in carnation producing enterprises. Permanent labour costs were followed by fertiliser costs with a 13.30% share and 5,107.64 TRY per decare. The seedling cost was calculated at 661.55 TRY per decare in the average of enterprises. The share of seedling costs in production costs was 12.14%. The seedling cost was followed by land rent with a 9.06% share and 3,478.22 TRY per decare. Land rent was followed by machine rental cost of 8.10%, pesticide costs of 7.84%, the temporary labour cost of 5.00%, establishment capital interest of 4.82%, electricity cost (for irrigation) of 4.41%, other variable costs of 3.98%, establishment depreciation value of 2.79%, interest in working capital of 2.19%, and general administration expenses of 1.71%, respectively (Table 3).

Permanent labour costs in gerbera producing enterprises were calculated at 7,472.44 TRY per decare. Its share of the total production cost was 23.28%. Permanent labour costs were followed by seedling costs with a 14.03% share and 4,504.40 TRY per decare. Fertilisation costs were calculated as 4,455.42 TRY per decare in gerbera producing enterprises. The share of fertiliser costs in production costs was 13.88%. Fertiliser cost was followed by pesticide cost with an 11.84% share and 3,800.30 TRY per decare. Pesticide costs were followed by land rent of 9.73%, machine rental cost of 5.80%, the temporary labour cost of 4.87%, electricity cost of 3.66%, establishment capital interest of 3.43%, other variable costs of 3.07%, establishment depreciation value of 2.34%, interest in working capital of 2.29%, and general administration expenses of 1.78%, respectively (Table 3).

In enterprises producing lisianthus, the permanent labour cost per decare was calculated as 7,650.41 TRY and seedling cost per decare was calculated as 7,643.38 TRY. Their respective percentages of the total production cost were 23.16% and 23.13%. Permanent labour and seedling costs followed by fertiliser costs with a 12.86% share and 4,250.37 TRY per decare. Land rent was calculated at 2,892.56 TRY per decare in gerbera producing enterprises. The share of land rent in production costs was 8.76%. The cost of land rent was followed by the cost of pesticides, which had an 8.00% share and a cost of 2,642.27 TRY per decare. Machine rental costs of 6.65% followed by pesticide costs, temporary labour costs of 5.09%, electricity costs of 2.98%, other variable costs of 2.86%, interest in working capital of 2.46%, general administration expenses of 1.93%, establishment depreciation value of 1.13%, and establishment capital interest of 1.00%, respectively (Table 3).

Table 3. Cut flower production costs per unit area in enterprises

Production costs	**Carnation**	**Gerbera**	**Lisianthus**
	Cost (TRY per decare)		
Fertilisation cost	5,107.64	4,455.42	4,250.37
Seedling cost	4,661.55	4,504.40	7,643.38
Pesticide cost	3,011.12	3,800.30	2,642.27
Machine rental cost	3,112.45	1,862.11	2,198.17
Temporary labour cost	1,920.25	1,560.35	1,680.33
Electricity cost (for irrigation)	1,692.38	1,175.36	983.36
Other variable costs	1,527.44	984.84	944.28
Working capital interest	841.32	733.71	813.69
Total variable cost (1)	*21,874.15*	*19,076.49*	*21,155.85*
Permanent labour cost	9,470.48	7,472.44	7,650.41
Land rent	3,478.22	3,122.33	2,892.56
Establishment capital interest	1,852.52	1,100.43	330.89
Establishment depreciation value	1,073.31	751.13	374.45
General administration expenses	656.22	572.29	634.68
Total fixed cost (2)	*16,530.75*	*13,018.62*	*11,882.99*
Total production costs (1+2)	38,404.90	32,095.11	33,038.84
	The share in the production costs (%)		
Fertilisation cost	13.30	13.88	12.86
Seedling cost	12.14	14.03	23.13
Pesticide cost	7.84	11.84	8.00
Machine rental cost	8.10	5.80	6.65
Temporary labour cost	5.00	4.87	5.09
Electricity cost (for irrigation)	4.41	3.66	2.98
Other variable costs	3.98	3.07	2.86
Working capital interest	2.19	2.29	2.46
Total variable cost (1)	*56.96*	*59.44*	*64.03*
Permanent labour cost	24.66	23.28	23.16
Land rent	9.06	9.73	8.76
Establishment capital interest	4.82	3.43	1.00
Establishment depreciation value	2.79	2.34	1.13
General administration expenses	1.71	1.78	1.92
Total fixed cost (2)	*43.04*	*40.56*	*35.97*
Total production costs (1+2)	100.00	100.00	100.00

Source: Own calculation.

In another study [17] carnation production in Antalya province in 2018, the share of variable cost per decare was 52.33% and the share of the fixed cost was 47.67%. Permanent labour costs (21.62%), pesticide costs (14.10%), fertilisation costs (13.12%), and seedling costs (12.14%) were found to be the essential costs.

In another study [8] conducted on the production of ornamental plants in Samsun, the share of variable costs per decare was

36.82%, while the share of fixed costs was 63.18% for carnation production.

In greenhouse cut flower production, the gross production value per decare was 56,463.76 TRY in carnation enterprises, 51,265.63 TRY in gerbera enterprises and 41,614.32 TRY in lisianthus enterprises (Table 4). Gross profit was found by subtracting the variable cost from the gross production value [2] [13]. The gross profit per decare in greenhouse cut flower production was calculated at 34,589.61 TRY in carnation enterprises, 32,189.14 TRY in gerbera enterprises and 20,458.47 TRY in lisianthus enterprises (Table 4).

The net profit was determined by subtracting the production cost for greenhouse cut flower production from the gross production value [13]. The average net profit of the carnation enterprises was calculated at 18,058.86 TRY per decare. Net profit per decare in lisianthus enterprises was at the lowest level with 8,575.48 TRY and gerbera enterprises had the highest value with 19,170.52 TRY (Table 4).

The cut flower yield per decare was 143,200 branches in carnation enterprises, 106,250 branches in gerbera enterprises and 72,600 branches in lisianthus enterprises (Table 4).

The cost of one branch of cut flowers was 0.27 TRY in carnation enterprises, 0.30 TRY in gerbera enterprises and 0.46 TRY in lisianthus enterprises (Table 4).

The selling price of one branch of cut flowers was 0.39 TRY in carnation enterprises, 0.48 TRY in gerbera enterprises and 0.57 TRY in lisianthus enterprises (Table 4).

The net profit of one branch of cut flowers was calculated at 0.12 TRY in carnation enterprises, 0.18 TRY in gerbera enterprises and 0.11 TRY in lisianthus enterprises (Table 4).

The relative profit was found to be the ratio of the gross value of production to the cost of production [13]. The relative profit in greenhouse cut flower production was calculated as 1.47 in carnation enterprises, 1.60 in gerbera enterprises and 1.26 in lisianthus enterprises (Table 4). The relative profit value calculated for the 2018 production season indicated that the greenhouse cut flower production activity was profitable. A gross production value of 147 TRY was obtained for each 100 TRY production cost in carnation production. Therefore, a profit of 47 TRY was obtained for every 100 TRY production costs. For every 100 TRY of production cost, 60 TRY profit was obtained in gerbera production and 26 TRY of profit was obtained in lisianthus production.

Another study [17] calculated the cost of carnation production per decare at 27,019 TRY, with 129,182 TRY as the yield of carnation per decare, 0.203 TRY per branch of the selling price. According to this study, the cost of decare was high in our study. The reason for the difference in production costs per decare in TRY is that the dollar exchange rate was low in 2017 when the study was conducted. The exchange rate for 2017 was 1 US dollar = 3.64 Turkish Lira. In 2018, the exchange rate increased by about 32%.

Another study [7] calculated the gross production value per decare was found to be 77,164.87 TRY in carnation enterprises, 40,941.18 TRY in gerbera enterprises and 56,056.06 TRY in lisianthus enterprises.

Table 4. Cost and profitability in cut flower production

Costs and profit	Carnation	Gerbera	Lisianthus
1. Total GPV per decares (TRY) (6x8)	56,463.76	51,265.63	41,614.32
2. Variable cost per decares (TRY)	21,874.15	19,076.49	21,155.85
3. Gross profit per decares (TRY) (1-2)	34,589.61	32,189.14	20,458.47
4. Total production costs per decares (TRY)	38,404.90	32,095.11	33,038.84
5. Net profit per decares (TRY) (1-4)	18,058.86	19,170.52	8,575.48
6. Yield (branch/decares)	143,200	106,250	72,600
7. Cut flower cost (TRY/branch) (4/6)	0.27	0.30	0.46
8. Cut flower selling price (TRY/branch)	0.39	0.48	0.57
9. Net profit (TRY/branch) (8-7)	0.12	0.18	0.11
10. Relative profit (1/4)	1.47	1.60	1.26

Source: Own calculation.

The gross profit per decare was calculated as 19,560.81 TRY in carnation enterprises, 3,373.19 TRY in gerbera enterprises and 9,689.39 TRY in lisianthus enterprises. The selling price of one branch was calculated as 0.46 TRY in carnation enterprises, 0.49 TRY in gerbera enterprises and 0.20 TRY in lisianthus enterprises.

CONCLUSIONS

The highest profits in cut flower types were obtained in gerbera enterprises. Carnation and lisianthus enterprises followed. Although it varies according to the cut flower types; permanent labour, fertiliser, pesticide, seedling and land rent constituted the highest expense group. The product with the highest total cost per decare was carnation, and the product with the lowest was gerbera.

As a result, the factors affecting the profitability of the enterprises were determined as the size of the enterprise, the type of cut flower produced and the level of input used.

There is a need for policies to reduce the input costs of enterprises producing cut flowers. For this reason, these issues should be taken into account when determining the policies for cut flower cultivation. The decrease in input costs will increase the profitability of cut flower producing enterprises.

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REALIZATION OF CROATIAN AGRICULTURAL POLICY GOALS: SELF-SUFFICIENCY AND AGRICULTURAL INCOME

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Abstract

The aim of this research is to determine the achievement of Croatian agricultural policy goals (AP) in the area of self-sufficiency and agricultural income. Previous studies do not provide specific quantitative estimates of the achievement of Croatian agricultural policy goals. Therefore, in this research self-sufficiency is considered achieved if 6 out of 11 selected products have an average self-sufficiency rate above 100%. Income, as AP goal, is considered achieved when agricultural income is lower than income from non-agricultural activities by up to 30%. In the analyzed period (from 1997 to 2020), the goal of self-sufficiency was not achieved. Considering that the income from agricultural activity is usually 30% lower than the income from non-agricultural activity, it can be concluded that the income goal has been achieved. Looking only at the statistics, without conducting empirical research, one can conclude that the Croatian agricultural policy is indeed "the most successful agricultural policy in the world". On the other hand, the same agricultural policy has not resulted in a competitive agricultural sector, developed rural areas, or sufficient production to meet the needs of the local population.

Key words: *agricultural policy, goals, self-sufficiency, agricultural income*

INTRODUCTION

Agriculture in Croatia can be described as the basic and traditionally the most represented branch of the economy. Despite the favorable natural conditions and the declared attitude towards agriculture as the backbone of the Croatian economy, the Croatian agricultural sector has not managed to achieve significant production and economic results since independence in the early 1990s.
There are several reasons for the poor socioeconomic situation of Croatian agriculture: the transition to a market economy, liberalization and war devastation in the early 1990s, weak institutional support and insufficient efficiency of administrative services, lack of business and trade cooperatives and farmers' organizations [8, 10]. The recovery of the national economy in the 2000s led to an improvement in agriculture, but still there are very few vital and market-oriented family farms that can withstand import competition [7, 8].
The results of recent research on the state of Croatian agriculture still do not give cause for greater optimism. The total agricultural production of the Republic of Croatia has increased by 2.6% in the period after EU accession compared to the analyzed period before accession [10]. Croatian agriculture contributes less than 3% to the GDP of the Republic of Croatia. The structure of agricultural production is dominated by crop production (about 65%), while livestock production participates with about 35%.
Self-sufficiency as an agricultural policy goal is regularly emphasized in Croatian public debates. Self-sufficiency as a means of ensuring food security within the framework of the European Common Market and liberal economics has no particular justification at the national level and often conflicts with the goal of competitive production. In recent

research, self-sufficiency is associated with the challenges of sustainable development, environmental protection and climate change [1, 25, 26]. In the last two years, due to the COVID -19 and the Ukraine crisis, the issue of self-sufficiency, i.e. the ability of the state to meet the needs of the population through its own production, has returned to the focus of decision makers. The forecast for the period 2021-2031 foresees a slight decrease in total Utilized Agricultural Area (UAA), an increase in the value of agricultural production by 0.7% per year, and stable agricultural income per worker. In addition, the EU economy is expected to return to pre COVID -19 production levels in 2023, but [4] emphasizes uncertainties due to the rise in energy prices (oil) and conflicting forecasts for the USD/EUR exchange rate [4]. In light of the Ukraine crisis, food security becomes an EU priority, with a focus on maintaining and, where necessary, increasing food production by European farmers [5]. The focus on food security goes so far that the European Parliament calls on the European Commission to analyze the objectives set out in the Farm to Fork and the "Biodiversity" strategy, and even to suspend any new legislative initiatives that would lead to a reduction in agricultural production.

The issue of agricultural income as a fundamental agricultural policy goal in developed economies has been researched since the middle of the last century, when the methodology for its measurement was discussed [12]. In the last twenty years, the focus of research has been on the impact of diversification on farmers' incomes [11, 24].

The influence of the international and national contexts on Croatian agricultural policy analyses [15]. According to [15], both contexts have an equal influence on policy making. In domestic policy debates, self-sufficiency is often highlighted as one of the most important agricultural policy goals, while in the international context, the most important agricultural policy goal is to ensure a stable agricultural income. Considering that [17] points out that membership success depends on the initial agricultural structure, the evaluation of the goals of AP is extremely important.

The aim of this research is to determine the achievement of the goals of the Croatian agricultural policy (AP) in the field of self-sufficiency and agricultural income. In her research [14], she analyzes the development documents of Croatian agriculture in the period 1995-2013 and classifies almost 100 goals into four groups: self-sufficiency, income, competitiveness and rural development. The author warns that the policy goals were formulated in a general way, with numerous overlaps and without indicators that would assess their achievement in a simple, quantitative way and with implementation deadlines [14].

MATERIALS AND METHODS

There is no systematic and official evaluation of Croatian agricultural policy. In addition, previous studies do not provide specific quantitative assessments of the achievement of Croatian agricultural policy goals. Due to the methodological limitations explained below, self-sufficiency is observed for only 11 products. Self-sufficiency as a policy goal is considered to be achieved when six products have an average self-sufficiency level above 100% in the observed period. In developed countries, income from agriculture is 30% lower than income from non-agricultural activities. Therefore, in this study, agricultural income is considered to be achieved (as a policy goal) when agricultural income is up to 30% lower than income from non-agricultural activities [14].

This research is based on [14] and supplements it with more recent data. The research period is from 1997 to 2020, but the research periods are not identical for the policy goals analyzed, as the statistics do not provide comparable indicators. For example, in research [16:49], self-sufficiency data come from 10 different sources, resulting in different coverage of agricultural products. In this research, the average self-sufficiency rate (%) is reported for wheat, corn, sugar, meat (pork, beef, and poultry), eggs, oilseeds (soybean grains, sunflower grains, and rapeseed grains), and wine. Data on self-sufficiency in agricultural products for the entire research period are available only for wheat, corn, and sugar. Data for meat and eggs are available for 1997-2012. Data for oilseeds are available for 2010-2020. Data for wine are available for 2000-2020. Average self-sufficiency rates for meat and eggs were calculated using internal data from the Ministry of Agriculture, while average self-sufficiency rates for other products were calculated using official data from the Central Bureau of Statistics (CBS). Unfortunately, the data for fruits and vegetables or milk are not available in the official statistics. In her research, [14] finds most of the data for various products in the annual reports of the Ministry of Agriculture and supplements them with internal data of the Ministry and data published in various scientific papers. Since her research ends in 2012, the most recent data on self-sufficiency rates were found in the CBS database, which unfortunately covers only 11 of the previously mentioned products.

The CBS does not collect data on family farm income. Instead, the CBS provides data on average monthly gross and net earnings per person employed in legal entities in agricultural and nonagricultural activities. For agricultural income, the research period is 2001-2020. For ease of reference, data for the observed period are presented as a five-year average (2001-2005, 2006-2010, 2011-2015, 2016-2020).

The harmonization of national statistics with Eurostat in 2005 has caused an additional problem. For example, in 2005, the long-standing method of collecting data for family farms through assessments by agricultural experts based on cadastral data was abandoned and the method of interviewing a selected stratified sample was introduced.

Also, for the same reason, the data on entrepreneurial income are now collected through the Economic Accounts for Agriculture. Net entrepreneurial income equals the net operating surplus/net mixed income less paid rents and interest plus received interest that refers exclusively to agricultural production [2].

For ease of reference, data for the observed period are presented as a five-year average (2001-2005, 2006-2010, 2011-2015, 2016-2020. Since 2014, the net farm income can be monitored through the Farm Accountancy Data System (FADN).

In addition to the CBS, data on agricultural income were taken from Eurostat. In this paper, we used the index of real income of factors in agriculture per annual work unit and net entrepreneurial income of agriculture for the period 2005-2020. The year 2010 was taken as the base index.

RESULTS AND DISCUSSIONS

Self-sufficiency

In the period prior to EU accession (2005-2013), Croatia attempted to increase agricultural productivity through various operational programs, change/improve production systems in livestock (pig farming), and renovate and replant vineyards, olive groves, and orchards. The expected goal of these programs was officially not to increase self-sufficiency, but to prepare Croatian agriculture for EU membership. For example, EU Member States were not allowed to plant new vineyards during this period. The intention of Croatian policy makers to use the pre-accession period to improve viticulture was therefore understandable and justified. Ultimately, an increase in production should also lead to an increase in self-sufficiency.

Although the issue of self-sufficiency is a regular topic in agricultural policy debates, since 2010 the CBS has provided data on self-sufficiency in cereals (wheat, rye, and pork, barley, oat mixtures, corn, triticale, and other cereals), oilseeds (soybean grains, sunflower grains, and rapeseed grains), rice (raw, hulled, and rolled), sugar beets, and sugar and wine. Data are available for cereals, oilseeds, rice, and sugar for the period 2010-2020, and for wine for the period 2000-2020. Data for earlier periods and some other products can be found in the Annual Reports on the State of Agriculture [18, 19, 20, 21, 22], scientific papers and publications [6, 7, 13, 16, 27]. The average self-sufficiency of selected products is shown in Table 1.

Table 1. Self-sufficiency of basic and processed agricultural products (%)

Product			
Average 1997-2020		Average 1997-2012	
Wheat	122.26	Pig meat	75.48
Corn	113.68	Beef meat	72.36
Sugar	98.83	Poultry meat	95.87
		Eggs	98.11
Average 2010-2020		Average 2000-2020	
Soybean grain	389.2	Wine	91.91
Sunflower grain	207.63		
Rapeseed grain	238.56		

Source: Own calculation on the basis of data from [2, 14].

In the period from independence (1991) to 1999, Croatia was self-sufficient only in the production of corn, wine and eggs, while wheat and potatoes were close to self-sufficiency [27]. In the production of animal products (meat, milk, and eggs), self-sufficiency was not achieved and a significant part of domestic demand is covered by imports [10, 16]. On average, during 1997-2020, self-sufficiency was achieved only for wheat, corn, and oilseeds, while for poultry meat, eggs, and sugar, self-sufficiency exceeded 95%. Research results [14] indicate that the self-sufficiency level decreased in all other observed products during the period 2011-2015, except for wheat, corn and sugar. Therefore, we can conclude that the policy goal of self-sufficiency was not achieved in the period studied.

Agricultural income

Securing a viable agricultural income is considered the most important goal of agricultural policy in countries. For the purposes of this paper, we measure it by the level of average monthly net income in legal entities in the agriculture, forestry, and fishing sector (Table 2). In the period from 2000 to 2020, this salary was 10-15% lower than the average net salary [16:52]. Except for 2012, 2013 and 2014, entrepreneurial income is higher than the average monthly net wage in agricultural and non-agricultural activities. According to the FADN data for only four years (2014-2017), net monthly business income was higher than wages in agricultural activities and entrepreneurial income in 2014 and 2017 [14].

Table 2. Average monthly net earnings in agricultural and non-agricultural activities (2001-2020) and entrepreneurial income (2006-2020) HRK

Period	Agriculture, employees in legal entities	Industry and service activities	Ratio of agricultural to non-agricultural income%	Entrepreneurial income
2001-2005	3,339.8	3,897.1	85.7	
2006-2010	4,526.2	4,954.5	91.36	6,318.2
2011-2015	5,000.8	5,405.6	92.52	5,294.8
2016-2020	5,550.8	5,920	93.76	7,379.014

Source: Own calculation on the basis of data from [2, 14].

However, national statistics do not provide information on the wages/salaries of the self-employed in agriculture, who make up the majority of the labor force. Consequently, wages and entrepreneurial income in agriculture are not a reliable indicator of the annual income of agricultural workers. Results of an empirical study conducted in 2009 [23] indicate that wages and salaries in agriculture are 40% below the average wage and that GDP per worker in agriculture (at current prices) grows more slowly than GDP per worker in the national economy.

Eurostat provides data on agricultural income in the form of indices (of the real income of factors in agriculture per annual work unit (AWU); of real net agricultural entrepreneurial income, per unpaid annual work unit (AWU), and net entrepreneurial income of agriculture). According to Eurostat, in the period 2005-2020, the index of real income of factors in agriculture has been growing steadily since 2015 (Table 3). In

2020, agricultural income is more than 40% higher than in 2010, which can be explained by the prediction [4] that the value of agricultural production will increase in the next decade. Net entrepreneurial income follows a similar pattern to agricultural income, and is 27% higher in 2020 than in 2010 (Table 3).

Table 3. Average monthly net earnings in agricultural and non-agricultural activities, 2010=100

Year	Index of the real income of factors in agriculture per annual work unit	Net entrepreneurial income of agriculture
2005	82.85	92.41
2006	96.43	109.24
2007	99.63	105.57
2008	114.62	120.53
2009	109.35	112.80
2010	100.00	100.00
2011	95.45	93.85
2012	81.72	78.08
2013	90.45	83.81
2014	78.26	69.14
2015	105.73	96.33
2016	117.60	104.40
2017	117.74	104.09
2018	125.20	111.05
2019	131.84	119.46
2020	143.96	126.72

Source: [3].

One-third of rural households earn income from nonagricultural activities. According to the 2009 results [23], income from non-agricultural activities predominates in most agricultural households (agricultural household incomes are lower than the national average and vary by household type and region, and are higher in peri-urban areas). Very small farms depend on agriculture, which is a complementary activity, and larger farms earn four times more income. Comparing farmers' incomes with those of non-farmers shows a high degree of inequality, which should be a signal to policymakers when choosing income support measures. This refers primarily to farmers who, in addition to small, fragmented, and technologically outdated farms, lack sufficient knowledge to apply new concepts and management tools [16:52-53].

Harmonization of domestic statistics with EUROSTAT in 2005 led to the collection of agricultural accounts data. Entrepreneurial income from agriculture increases until 2008, when it reaches its highest level, and then starts to decrease until 2014. In the period 2015-2020, entrepreneurial income increases again. There was also registered an increase in the income as well as its convergence with the non-agricultural income (Table 2) [14]. Income from agricultural activities recorded higher growth than income from non-agricultural activities and services on an annual basis.

According to the statistical data, the average monthly net earnings of legal persons in agriculture, forestry and fishing were only 10-15% lower than the average monthly net earnings in non-agricultural activities. Therefore, it can be concluded that the income as agricultural policy goal has been achieved.

CONCLUSIONS

Although recent international literature deals mainly with agricultural, environmental, and climate change issues, research in Croatia is thematically related to problems that the international scientific community dealt with fifteen years ago. However, such research is also important because, in the absence of official evaluations of agricultural policy, it reveals much about the Croatian agricultural sector.

A detailed analysis of the achievement of agricultural policy goals, in this paper self-sufficiency and agricultural income, prevents the lack of consistent statistics in the long run. This is most evident in the case of agricultural income. The results of the only empirical study from 2009 (farmers' income is about 40% lower than non-agricultural income) are contradicted by official statistics. Looking only at the statistics, without conducting empirical research, one can conclude that the Croatian agricultural policy is indeed "the most successful agricultural policy in the world". On the other hand, the same agricultural policy has not resulted in a competitive agricultural sector, developed rural areas or sufficient production to meet the needs of the local population.

The analysis of the degree of self-sufficiency in the observed period allows us to draw conclusions about competitiveness and agricultural income. For example, a high degree of self-sufficiency in livestock, fruit or vegetable production also means a higher income for farmers, since these are products whose prices are higher than those of crops. In addition, it is difficult to expect exports of products and thus higher competitiveness if not enough is produced to meet the needs of the local population.

This study has shown that the self-sufficiency of agricultural production is not systematically monitored statistically, making it difficult to compare and evaluate data. According to the available data, the self-sufficiency level is reached in the production of wheat, corn, sugar, soybean grains, sunflower grains and oilseed rape. Close to the self-sufficiency level is the production of eggs and poultry meat.

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THE EFFECTS OF NATURAL PESTICIDES USAGE AND NATURAL ENEMIES ON SEVERAL CORN VARIETIES AGAINST *SPODOPTERA FRUGIPERDA*

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Abstract

The attack of "Spodoptera frugiperda" on maize has the potential to disrupt the availability of maize production in Indonesia, particularly in North Sulawesi, where it spread to additional districts of corn planting centers. Observations were made on nine maize varieties (Manado Kuning, Bissi 2, Pertiwi 3, JH 37, Bissi 18, Pioner P 37, Twinn 20, Bissi 228, and Nasa 29) and on the types and populations of pests and natural enemies on farms, which were sprayed with biopesticides, to determine the resistance, the number of eggs laid and the egg laying period; and logs the types of "S. frugiperda" egg parasitoid. The results showed that the Manado Kuning, Pioner P 37 and Nasa 29 corn varieties were the three most abundant varieties in terms of the number of egg groups laid by "S. frugiperda", where each had five. The Bissi 2 and Pertiwi 3 maize varieties had the least with only one egg group each. The earliest time for oviposition occurred at five days of age on the Pioner P 37, Bissi 228, and Nasa 29 varieties, while the latest time occurred on the Bissi 2 variety at 17 days of age. It was determined that the Bissi 2 variety may become the main plant choice, while the Pioner P 37 and Nasa 29 can be used as bait plants. The type of parasitoids obtained were "Telenomus sp." and "Trichogramma sp.", where "Telenomus sp." was obtained more than "Trichogramma sp." Both can be used as a natural insecticide.

Key words: *corn, fall armyworm, oviposition, varieties, parasitoids*

INTRODUCTION

Corn (*Zea mays* L.) is a type of food plant from the grass family which is classified as a grain crop. In Indonesia, this type of zea plant can be used as a staple food substitute for rice and various kinds of processed foods. Corn is the second food need after rice. To support the need for corn as food, and a staple for the animal feed industry, it is necessary to guarantee the availability of good quality corn, because corn is one of the plant commodities that has an important role in fulfilling human food needs, besides that it is widely used as a basic ingredient for making animal feed, parts of the corn plant can also be used as animal feed such as leaves, stems, husks and cob; so it is an opportunity to develop maize cultivation so that maize production increases. Corn is a seasonal product that is easily damaged, for that it is necessary to apply the right post-harvest technology so that the corn commodity remains available throughout the year, is not easily damaged and is more resistant to storage [20]. Corn has a large production potential and the prospect of its use is also good as a food and feed ingredient. In its marketing activities, there are still some obstacles, namely the availability of products throughout the year and quality that meets the requirements [21]. Therefore, post-harvest handling is important so that the corn does not become damaged and lost. To get quality corn, proper harvest and post-harvest handling is very necessary considering the main problems often faced by farmers are the high yield loss at harvest and post-harvest handling that has not been optimal.

Corn plants grow in the lowlands to high up to 1,200 meters above the sea level, require clay soil media, sandy loam, volcanic soil, fertile, loose, rich in organic matter, requires at least 8 hours of sunlight per day, air temperature 20-33^0 Celsius, rainfall medium, soil pH 5.5-7 with good drainage.

Pests and Diseases of Corn Plants

One of the obstacles in cultivating corn is the presence of pests or plant-disturbing organisms, which interfere with corn productivity, namely armyworm (*Spodoptera frugiperda*) or Grayak caterpillar. The part of the corn plant that is attacked by this pest is the young stem, the stem will break and eventually the corn plant will die. *Agrotis sp*. attacks at night and during the day. This caterpillar control can be done by spraying using the appropriate insecticide and using the recommended dose.

According to Nonci *et al.* (2019) [13], the symptoms of *S. frugiperda* attack can be seen on the young leaves that are still curled with bite holes and dirt. The presence of fall armyworm (FAW) eggs on the leaves and sometimes on the stems, as well as FAW larvae which are characterized by an inverted Y on the head and four dots forming a square on the penultimate segment.

The attack of *Spodoptera frugiperda* (Smith: *Lepidoptera*, *Noctuidae*) on maize has become an important issue because it has the potential to disrupt the availability of maize or maize production in Indonesia. Since April 2019, *S. frugiperda* has been declared or published as a new pest in Indonesia [6], and it attacked maize plantations in West Sumatra Province. It has since quickly attacked and damaged many maize crops in other Indonesian regions, including the North Sulawesi Province.

The corn armyworm *S. frugiperda* is an invasive insect that has become a pest on maize in Indonesia. This insect comes from America and has spread in various countries. In early 2019, this pest was found in corn plants in the Sumatra area [6]. This pest attacks the growing point of the plant which can result in the failure of the formation of young shoots/leaves of plants. *S. frugiperda* larvae have high feeding ability. Larvae will enter the plant and actively feed there, so if the population is still small it will be difficult to detect. Imago is a strong aviator and has a high cruising range [2]. *S. frugiperda* is polyphagous, some of its main hosts are food crops from the Graminae group such as corn, rice, wheat, sorghum, and sugar cane, so the existence and development of its population needs to be watched out for. The losses caused by this pest attack on maize in African and European countries are between 8.3 to 20.6 million tons per year with an economic loss value of between US$ 2.5-6.2 billion per year [5].

The larval species of the Lepidoptera group, namely *S. frugiperda* on sweet hybrid maize in Petir Village, Dramaga District, Bogor Regency. Damage to corn plants caused by *S. frugiperda* was about 60%. The growth phase of the attacked corn plants starts at a young age (vegetative) to the flowering phase (generative). *S. frugiperda* larvae were found on the shoots of plants. Infected plant shoots when the leaves have not fully opened (buds) appear hollow and there is a lot of larval faeces. If the leaves are open, you will see a lot of damaged leaf parts, with holes from the larvae. The larvae usually settle on plant shoots [8].

The emergence of *S. frugiperda* has become a topic of discussion for many parties, from the scientific community to corn farmers. This pest causes severe anxiety because it damages corn plants, especially if the attack occurs at an early age (< 2 weeks) because it causes the death of the corn plants. It also spreads very quickly. According to Meilin, *et al.* (2020) [11], the attack percentage of *S. frugiperda* reaches 93.45% during the vegetative phase of maize. Particularly in North Sulawesi, the attack percentage of *S. frugiperda* in the region reached around 30% to 70%, with a low to severe intensity [10]. As a result, it greatly depressed the psychological condition of corn farmers; moreover, the information on approaches to control and prevent these pests is still very limited.

In North Sulawesi Province, the presence of *S. frugiperda* was found at the end of July 2019, three months after the pest attacked West Sumatran corn plants. The pest attack started on sweet corn plants (*Zea mays* var. saccharata) in Tomohon City; then, in the short time until October 2019, it spread to various corn planting centers in North Sulawesi Province, although in this early period (July – October 2019), attacks occurred in spots and the infestation did not spread evenly. Next, with the expansion of corn planting in November 2019, *S. frugiperda* attacks expanded with a relatively high population and attack rate. The attack pattern was no longer in the form of spots but occurred evenly in one planting area, which resulted in a severe level of damage and even caused the death of corn plants.

It was difficult to control this pest in many places because various control techniques showed low success rates. In addition, the use of synthetic pesticides (insecticides) was not successful, even though treatments were repeated at intervals from 2-3 days. This situation continued until June 2020 because no registered insecticides effectively controlled *S. frugiperda*, so various insecticides were used by trial and error. This situation was a big problem for corn farmers until several registered insecticides were found to have a satisfactory efficacy for *S. frugiperda*. However, the use of insecticides in pest management is not recommended because of their adverse side effects. In addition to the basic consequences, such as environmental pollution and contamination of corn products with hazardous materials, eventually, pests become resistant to pesticides; in addition, the choice of other insecticides with active ingredients and different ways of working will be very limited.

For this reason, it is imperative to develop environmentally friendly pest control approaches so that the use of pesticides may be avoided. Controlling pests by optimizing the management of plant cultivation and the use of natural enemies needs to be carried out and developed [18].

Entomopathogenic fungi have the potential to be used as one of the biological agents for pest control in food crops. The results indicated that *M. rileyi* was easily propagated in bulk on agar medium and had high virulence against *S. frugiperda* [8].

The oviposition (eggs laying) by adult *S. frugiperda* insects begins to occur as soon as corn plants appear on the soil surface. The younger a corn plant is infested, the greater the chance of damage with a high attack intensity. Nonci *et al.* (2019) [13], states that infestations that occur in corn plants when the young leaves are still rolling cause a production loss of 15-73% if around 55-100% of the plant population is being attacked. Furthermore, the same research states that losses due to *S. frugiperda* attacks varied and depended on the age of the affected corn plants. In addition, the yield loss also depends on the variety and plant cultivation techniques used.

The information above is very important in terms of efforts to implement agricultural controls. It is important to test the preference of maize varieties to see their resistance and susceptibility. Resistant varieties can be the best choice when selecting varieties to be planted, while susceptible varieties can be considered as bait plants.

S. frugiperda are transboundary destroyers with the ability to fly up to 100 km in one night, which allows a rapid increase in the population in new areas because of the lack of natural enemies [13]. However, biodiversity due to the presence of rich varieties of parasitoids, entomopathogenic fungi, and local predators has the ability to become an effective natural enemy for *S. frugiperda* pests. To obtain information about the possibility of local egg parasitoids capable of parasitizing *S. frugiperda* eggs, it is necessary to collect egg groups in preference tests to further maintain and inventory their species.

Corn pests are known to attack in all phases of plant growth, both vegetative and generative. The purpose of this study was to determine the types of pests and natural enemies on corn plants. This study aims to determine the population of pests and natural enemies in corn plants, and the benefits that can be taken are as information material about the composition of pests and natural enemies in corn planting areas, as a reference for environmentally friendly pest control for the community, especially farmers in suppressing corn pest populations. The results of the research that have been carried out show that there are five types of pests that have been found in the field, namely, grasshoppers, *Epilachna sp, Nezara viridula* and *Spodoptera litura.* Grasshoppers are pests that always appear during observation, while *Epilachna sp,* is a pest that rarely appears during observations. Natural enemies found during observations were *Oxyopes sp, Coccinella sp, Praying Mantis, Diplocodes sp.* The natural enemy that often appears when observing *Oxyopes sp,* while the natural enemy that rarely appears is the praying mantis. The largest pest population is grasshoppers for the largest natural enemy population is *Oxyopes sp.* [7].

Many natural enemies control the armyworm population in field. *Peribae orbata* (Tachinidae) is a larval parasite of caterpillars armyak in Laguna, Philippines. The role of the larval parasite important in the field, because in Sarawak, Kalimantan, parasitization levels can be reach 40%. Another parasite that has been identified is *Palexorista lucaqus* (Wlk), *Pseudogonia rufifrons, Apanteles sp., Chelonus sp.,* and *Cuphocera varia* and there are still some larval parasites others from the families *Braconidae* and *Icheumonidae*. *Telemonus sp*. and *Tetrastichus schoenobii* were found as egg parasites. In South Sulawesi, the fungus *Nomuraea rileyi* is found (Far.) Sanson and polyhidrosis nuclear virus attack larvae. This natural enemy mainly plays a role in suppressing the population so that no pest explosion and reduce population when it occurs explosion. However, due to the time lag and effectiveness low during the population explosion, the results are not satisfactory so that additional efforts such as pesticides are needed.

Armyworm (*Spodoptera sp.*), is a polyphagous pest. These pests, among others, attack corn plants. The leaves of the plant can be eaten up until only the bones remain. The distribution of armyworms starts from Southern Europe, Africa, India, China, Indonesia, Australia, Pacific countries to America. This caterpillar is found in Java, Indonesia up to an altitude of 1,800 m. The explosion of the armyworm population can suddenly appear and also quickly disappear. Often a population explosion lasts for only one generation, followed by a population decline in the next generation. From observations made every time there is a population explosion due to climate change, especially dry periods followed by high rainfall and humidity and accompanied by abundant food. Often a population explosion is preceded by unfavorable conditions for the development of parasites and predators. Eggs are laid in clusters on leaves and covered with light brown hairs. A female *Spodoptera sp.* lay about 1,500 eggs, each group there are 50-400 grains. The egg stage lasts 3-5 days. The ability to lay eggs is increased by the habit of cannibalism among female larvae. This cannibalism compensates for poor food quality and is an important factor in population dynamics. The young larvae, temporarily stay where the eggs are laid and attack in groups. During the day, the larvae hide in the soil and are active at night, except for *S. exempta* which is also active during the day. The color patterns of the larvae differ depending on their behavior. In crowded conditions, namely the gregarious phase, dark in color, the larvae are active. In the solitary phase, the color is lighter and passive. The larvae can reach a length of (4-4.5) cm. Larval stage obtained after 13-18 days. Pupae are formed in the soil with a stadium length of about 9 days. Development from egg to adult in *Spodoptera sp.* shorter, i.e. 29-31 days. Adult insects are short-lived, can mate several times and lay eggs for 2-6 days [7].

The use of resistant varieties to control pests is a cheap and easy way, it can also be combined with other ways, but have not found varieties that have high resistance to the main pests of corn. There are three ways that might be developed today in Indonesia, namely technical culture, biology, and insecticides. Research results from Balittan Maros, Indonesia, for several years show that corn planted earlier at the start of the rainy season will be less susceptible to pests, especially stem borers [4].

Pest and disease control can be done mechanically, technically and chemically. Mechanically is by catching pests that attack the plants or dispose of diseases parts of plants that are attacked by pests, or control of the technical culture between the air humidity regulation, the protective arrangement and the intensity of sunlight. Chemical control using insecticides and functionalities. Recommendation usage of insecticides and fungicides in the cultivation of medicinal plants are avoided, because the chemical residues can affect the medicinal compounds in the plant, so it is necessary to use biopesticide than chemical insecticides and fungicides.

In general, biopesticides are defined as a pesticide whose base material is derived from plants and microbes. With advances in the field of chemistry and the development of analytical tools, many chemical compounds derived from plants have been isolated and identified even synthesized. The content of plant compounds can show various kinds of biological activity on insects such as inhibition/rejection of feeding, spanking rejection activities, growth and development inhibitory activities, and death effect, therefore the bioactive can be used to control of plant pest organism (PPO). This study aimed to determine the effectiveness of various biological agents, consisting of biological and microbial pesticides as biopesticide, also obtain bait plants to protect the main crop from *S. frugiperda* attacks.

MATERIALS AND METHODS

Preference test

This research was conducted in Paniki Bawah Village, Mapanget District, Manado City between December 2020 to January 2021. The method, does not use a special design because it is carried out based on primary data, namely direct observation data at the research location, with observation intervals every two days, and the number of plants observed is 63 plants per plot. The condition of the research location is made to resemble the conditions in the field, to estimate the yield when planted by farmers. In this study, observations were made on the types and populations of pests and natural enemies on corn farms, which were sprayed with biopesticides. Each treatment plot measured 3 x 4 meters with a spacing of 80 x 20 cm. There were 3 rows of plants, and in each row, there were 21 plants; thus, there were 63 plants per plot. By taking a sample of 10%, 7 plants were used from the 63 total plants. The types of corn varieties used as treatments were Manado Kuning, Bissi 2, Pertiwi 3, JH 37, Bissi 18, Pioner P 37, Twinn 20, Bissi 228, and Nasa 29. The varieties chosen were based on the varieties used by farmers in addition to the varieties available in the corn planting location. Observation of egg laying (oviposition) started from day 3 after corn was planted until day 21 after corn was planted at an observation interval of 2 days. Based on the observation results, the number of egg groups laid and the oviposition period differed and depended on the type of corn plant. Furthermore, the eggs were collected and maintained in the laboratory.

The oviposition evaluations were stopped when the corn plants reached the age of 21 days. This was done in accordance with the goal of this research, which was to analyse *S. frugiperda* oviposition preferences and its most destructive impacts on relatively young corn plants during the early stage of their growth (0-21 days old). According to Maharani *et al.* (2019) [9], this pest attacks the growth point of plants, which results in the failure of the formation of young shoots/leaves and causes the death of corn plants. Mamahit *et al.* (2020)[10] stated that corn plants are very vulnerable to attacks by pests during an early age (0-21 days old). Beyond the first 21 days, corn plants can recover from pest attacks through normal cultivation processes.

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Parasitoid inventory

The identification process was then carried out at the Laboratory of Biological Agents (LBA), Kalasey, Manado. Each group of eggs found during observation was kept in a test tube until they hatched. The identification process of the parasitoids was carried out using a microscope to determine the type of parasitoid that emerged from each group of eggs. To support the results obtained in the laboratory, *S. frugiperda* eggs were also collected from several corn planting centers in several locations, including North Minahasa Regency, Minahasa Regency, Bolaang Mongondow Regency and Tomohon City.

RESULTS AND DISCUSSIONS

Number of eggs laid

The results of the observations on the number of eggs laid on the corn plants at 3 days of age (observation 1) until 21 days of age (observation 10) are presented in Table 1. The oviposition process began to occur at the age of 5 days (observation 2), and the final oviposition occurred when the plants were 17 days old (8th observation). The number of eggs laid varied from 5 groups of eggs to 1 group of eggs, and all maize varieties were laid by *S. frugiperda*.

Table 1.Data on the oviposition of *S. frugiperda*

Corn Variety	Total Replication	Mean Replication	Mean Treatment
Manado Kuning	5	1.67	0.17
Nasa 29	5	1.67	0.17
Pioner P 37	5	1.67	0.17
Bissi 228	4	1.33	0.13
Bissi 18	2	0.67	0.07
JH 37	2	0.67	0.07
Twinn 20	2	0.67	0.07
Bissi 2	1	0.33	0.03
Pertiwi 3	1	0.33	0.03

Source: Personal observation results.

Table 1 shows that the Manado Kuning, Nasa 29 and Pioner P 37, varieties experienced the most egg laying during the observation process, with five groups of eggs laid. Meanwhile, the other three varieties experienced egg laying between four and two groups (Bissi 224 with four egg groups, and Bissi 18, JH 37, and Twinn 20 each with two egg groups). The Bissi 2 and Pertiwi 3 varieties experienced the lowest egg laying number, with only one egg found on each.

The Bissi 228, Nasa 29, and Pioner P 37 varieties experienced the fastest egg laying by *S. frugiperda* due to the physical and chemical support of these maize varieties compared to the other six varieties. In addition, the speed at which the maize plants appeared on the soil surface and the physical growth speed of the maize were factors. The longest varieties chosen for laying eggs after appearing on the ground was Bissi 2, with a difference of about 12 days. The difference in egg laying time is quite long, indicating that Bissi 228, Nasa 29, and Pioner P 37 are preferred by *S. frugiperda*. The sooner *S. frugiperda* lays eggs on corn plants, the earlier the *S. frugiperda* larvae will attack it. The younger the corn plants are that are infested/attacked by *S. frugiperda* larvae, the more severe the damage to the corn plants will be.

Death can even occur because the larvae of *S. frugiperda* can reach and eat up to the growth point of corn plants. This is in accordance with the statement by Sharanabasappa et. al. (2018) [17] and CABI (2019)[2], which stated that *S. frugiperda* attacks growing points and can thwart young leaves and plant shoot formation.

That plants are chosen by insects because of their physical and chemical properties [15]. In addition, according to Borror *et al.* (1992)[1], insect eggs are generally laid in conditions where they get protection as young insects.

The choice of oviposition for all varieties may also be due to *S. frugiperda*, which has a wide variety of plant hosts. Clark *et al.* (2007) [3]

and Purwanto and Agustono (2010) [14], stated that *S. frugiperda* pests are polyphagous and found in many countries. However, there were differences in the level of preference; there were very liked, liked and disliked corn varieties, which could be seen from the different number of groups of eggs laid, as shown in Table 2.

Table 2. The preference level for oviposition of *S. frugiperda*

Preference level	Number of eggs	Varieties
Very liked	5 groups	Manado Kuning, Nasa 29, Pioner P 37
Liked	Groups of 2 – 4	Bissi 18. JH 37, Twinn 20, Bissi 228
Disliked	One group only	Bissi 2, Pertiwi 3

Source: Personal observation results.

As shown in Table 2, the Manado Kuning, Nasa 29 and Pioner P 37 varieties were the most favored varieties ("very liked" preference level) for the *S. frugiperda* egg laying process. They had five egg groups, while the Bissi 2 and Pertiwi 3 varieties were the least preferred varieties ("disliked" preference level) with only one group of eggs.

As the most preferred, the Manado Kuning, Pioner P 37 and Nasa 29 varieties seemed to have more attractive support for *S. frugiperda* to lay their eggs. This support involved the appearance of the plant, such as having an adequate leaf condition and nutrient content. The instincts of *S. frugiperda* adult females favored these factors because they guarantee the availability of food for larvae that will hatch. This was not the case for the Bissi 228, JH 37, Bissi 18, and Twinn 20 varieties; this was especially true for the Bissi 2 and Pertiwi 3 varieties, which only experienced one group of egg laying.

Each adult female insect of *S. frugiperda* will choose the type and condition of a plant that can ensure the health of newly hatched larvae because they must be provided with sufficient and suitable food for growth in the form of fresh young leaves. Mello da Silva *et al.* (2016) [12] and Sharanabasappa *et al.* (2018) [17] stated that early instar larvae of *S. frugiperda* usually live on young corn leaves, which was confirmed by the statement of Nonci *et al.* (2019) [13] that the favorite place for *S. frugiperda* larvae to live and grow is on the young leaves of corn.

Natural enemy type and population density

The results of the study on egg laying time by *S. frugiperda* are given in Table 3.

Table 3. Data on the oviposition time by *S. frugiperda*

Corn Variety	Plant age (days)									
	3	5	7	9	11	13	15	17	19	21
Manado Kuning	-	-	v***	v	v	-	-	-	-	-
Bissi 2	-	-	-	-	-	-	-	v	-	-
Pertiwi 3	-	-	v	-	-	-	-	-	-	-
JH 37	-	-	-	v	v	-	-	-	-	-
Bissi 18	-	-	-	v	v	-	-	-	-	-
Pioner P 37	-	V	v**	v	-	v	-	-	-	-
Twinn 20	-	-	v	v	-	-	-	-	-	-
Bissi 228	-	V	-	v***	-	-	-	-	-	-
Nasa 29	-	V	v**	v	v	-	-	-	-	-

Source: Personal observation results.

Table 3 shows that oviposition by *S. frugiperda* began at the age of 5 days and ended at the age of 17 days. There was no oviposition in all treatment varieties during the first observation (3 days old), while the earliest oviposition by *S. frugiperda* occurred at the age of 5 days for the Pioner P 37, Bissi 228, and Nasa 29 varieties. Then, at the age of 7 days, egg laying occurred on the varieties of Manado Kuning, Pertiwi 3, Pioner P 37, Twinn 20, and Nasa 29. At 9 days of age, egg laying occurred in seven of the nine varieties tested, namely, the Manado Kuning, JH 37, Bissi 18, Pioner P 37, Twin 20, Bissi 228 and

Nasa 29 varieties. At the age of 11 days, eggs were laid on the Manado Kuning, JH 37, Bissi 18, and Nasa 29 varieties. At the age of 13 days, egg laying only occurred on the Pioner P 37 variety, and at the age of 15 days, there was no egg laying on all varieties of maize tested. Meanwhile, at the age of 17 days, the oviposition occurred only on the Bissi 2 variety. At the ages of 19 and 21 days, the oviposition process ceased.

The Pioner P 37, Bissi 228 and Nasa 29 varieties had the earliest oviposition time by *S. frugiperda* compared to that for the other six varieties. Bissi 2 had the longest oviposition time, and the time difference between the earliest oviposition on the Pioner P 37, Bissi 228 and Nasa 29 varieties and the latest oviposition on the Bissi 2 variety was 12 days long. This considerable difference in oviposition indicates that the physical and chemical support of the Pioner P 37, Bissi 228 and Nasa 29 maize varieties were preferred by *S. frugiperda* compared to those for the Bissi 2 variety. Other differences in oviposition time may be due to the speed at which corn plants appear on the soil surface and the physical growth rate of corn after it appears on the soil surface. These factors are important because *S. frugiperda* will not lay eggs on corn that has not yet appeared on the soil surface. Differences in growth delay are possible if the time difference lasts only 1-2 days. This is because the seeds of each variety used as treatment may differ in several ways, such as the water content and depth at planting, so these two things may cause differences in the growth of each corn variety planted.

The data obtained on oviposition time for each variety are important because the sooner the oviposition of *S. frugiperda* on corn plants occurs, the earlier the *S. frugiperda* larvae will attack it. The younger the corn plant is when it is infested by *S. frugiperda* larvae the more severe the damage to the corn crop. Even death may occur because the *S. frugiperda* larvae can reach and eat up to the growth point of the corn plant. This is in accordance with the statement of Sharanabasappa et al. (2018) [17] and CABI (2019) [2] that S. frugiperda attacks growing points and can thwart young leaves and plant shoot formation.

Inventory of egg parasitoids

Parasitoids are insects that are smaller or at least the same size as their host, live on the host throughout their lifetime and slowly eat the host until the host dies. Depending on the stage of the insect it attacks, there are three types of parasitoids, namely, egg parasitoids, larval parasitoids and pupae [16]. Research on egg parasitoids was carried out to complement this study after a preference test was conducted. A total of 27 groups of eggs found during observations were collected and reared by putting each group of eggs into a measuring cup. Egg group maintenance was also carried out by taking samples of egg groups from several areas in addition to the research location, such as Manado City, Bolaang Mongondow Regency, North Minahasa Regency, Minahasa Regency, and Tomohon City. The maintenance and inventory process lasted for one month and started on the same day.

From the results of the egg parasitoids inventory, two parasitoids were obtained, namely, *Telenomus sp.* (Figure 1) and *Trichogramma sp.* (Figure 2).

Based on observation, *Telenomus sp.* had several distinctive physical characteristics, such as a black body colour, wings that were slightly larger than the forewings, angled antennae consisting of 10-11 segments, and a tarsi with 5 segments. *Telenomus sp.* is larger than *Trichogramma sp.*, which has the distinctive physical characteristics of a clear yellowish body colour, antennae consisting of 6 segments, and a tarsi with 3 segments. *Trichogramma sp.* also has hairy wing edges and short hairs at the tip of the antennae. The observation results are in accordance with the statement of [1].

The level of parasitizing was very different among the areas, with the highest level of 85% in Manado and the lowest level of 5% in Bolaang Mongondow Regency.

In the city of Manado, from the average number of 27 egg groups of *S. frugiperda*, there were 23 egg groups parasitized that consisted of 17 *Telenomus sp.* and 6 *Trichogramma sp.* parasitoids. In Minahasa Regency, from 26 groups of *S. frugiperda* eggs, 12 groups were parasitized that consisted of 9 *Telenomus sp.* and 3 *Trichogramma sp.* parasitoids.

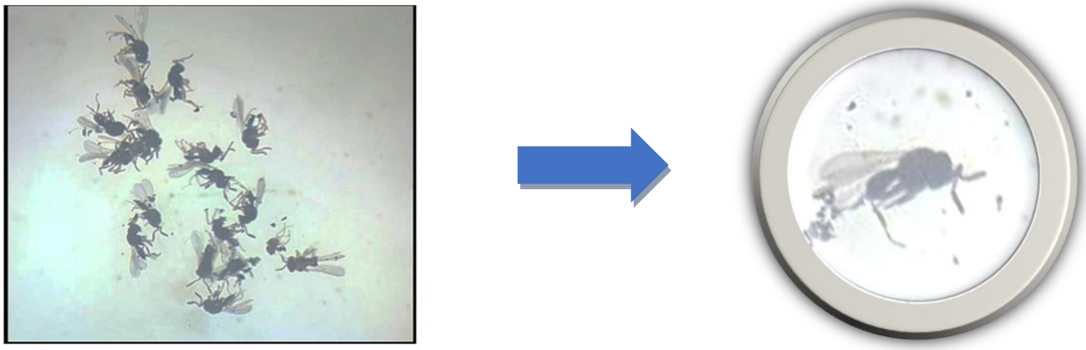

Fig. 1. Image of *Telenomus sp.*
Source: Personal observation results

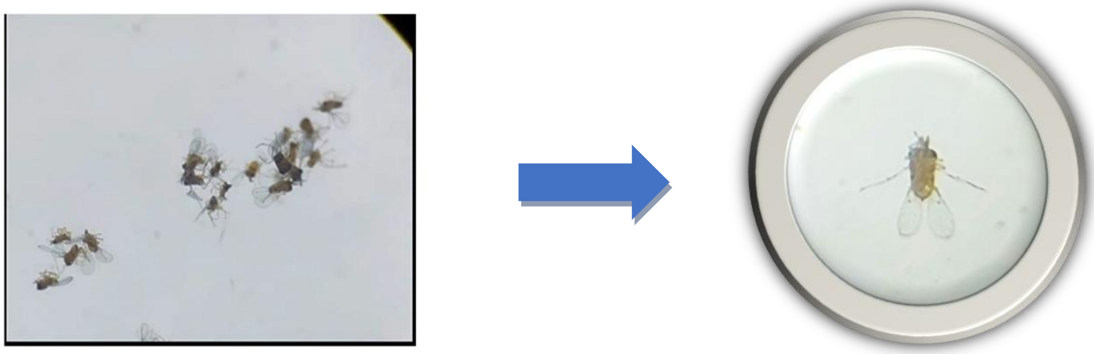

Fig. 2. Image of *Trichogramma sp.*
Source: Personal observation results

Table 4. Number of *S. frugiperda* egg groups, types of parasitoids, and parasite level

Region of Origin	No. of Egg Groups	Frugiperda Larvae	Type of parasitoid			Percentage of parasites
			a	b	c	
Manado	27	4	17	6	23	85%
Minahasa Regency	26	14	9	3	12	46%
North Minahasa Regency	59	48	7	4	11	19%
Tomohon	32	30	1	1	2	6%
Bolaang Mongondow	37	35	2	0	2	5%

Notes: a = *Telenomus sp.*
b = *Trichogramma sp.*
c = Sum
Source: Personal observation results.

Furthermore, from North Minahasa Regency, 59 groups of *S. frugiperda* eggs were obtained, and as many as 11 groups of eggs were parasitized that consisted of 7 *Telenomus sp.* and 4 *Trichogramma sp.* parasitoids. From Tomohon City, 32 groups of *S. frugiperda* eggs were obtained, but only two groups of eggs were parasitized and consisted of one *Telenomus* and one *Trichogramma*. From Bolaang Mongondow Regency, 37 groups of *S. frugiperda* eggs were obtained, and only two groups of eggs were parasitized, all of which consisted of *Telenomus sp.* and not *Trichogramma sp.*

These results are in accordance with Shylesha *et al.* (2018)[18], who reported finding a natural enemy complex of *S. frugiperda*, namely, the egg parasitoid *Telenomus sp.* (Hymenoptera: Platygastridae) and *Trichogramma sp.* (Hymenoptera: Trichogrammatidae).

The egg parasitoid type *Telenomus sp.* was found in five study areas that were the source of the egg group of *S. frugiperda*, while *Trichogramma sp.* was not found in Bolaang Mongondow Regency. This indicates that there were sufficient egg parasitoids naturally. According to Sembel (2010)[16], parasitoids are insects that are small or as large as the host that parasitize and kill the host. Its role is very dominant in suppressing the development of plant pest populations. A parasite attack can weaken the host and can eventually kill it because the parasitoid eats or sucks the body fluids of the host [19].

It is known that there are two types of parasitoids capable of parasitizing *S. frugiperda* eggs. This means that naturally, there are two types of parasitoids that play a role in controlling *S. frugiperda* populations by eating or making *S. frugiperda* eggs their hosts. These two types of parasitoids are effective natural enemies against *S. frugiperda* eggs [16].

CONCLUSIONS

Several conclusions based on the research of the preference of *S. frugiperda* on several maize varieties are:

(i)The Bissi 2 variety may become the main plant choice, because it only gets one group of eggs and has the longest oviposition period, while Pioner P 37 and Nasa 29, as the varieties with the most abundant number of egg groups laid and shortest oviposition period, can be used as bait plants.

(ii)The highest number of eggs laid by *S. frugiperda* was found on Manado Kuning, Pioner P 37 and Nasa 29 maize varieties, each with five groups of eggs, while the lowest number of eggs was found on Bissi 2 and Pertiwi 3 varieties, with only one egg group.

(iii)The earliest egg laying time by *S. frugiperda* occurred on Pioner P 37, Bissi 228, and Nasa 29 varieties at five days of age, while the latest oviposition occurred on Bissi 2 corn variety at 17 days of age.

(iv)The type of egg parasitoid found in the egg group of *S. frugiperda* was *Telenomus sp.* and *Trichogramma sp.*, and both can be used as parasitoids against *S. frugiperda*.

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SOCIO-ECONOMIC SECURITY OF RURAL TERRITORIES AND AGRICULTURE: A CASE STUDY OF UKRAINE

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Abstract

In this article we have studied the issues of ensuring the socio-economic security of the rural population of Ukraine. It is determined that an important role in this process is played by the state policy on financing the development of rural infrastructure. At the same time, it is proved that the key role in ensuring the socio-economic development of the rural population belongs to the system of agricultural production, which provides the rural population with jobs and in case of its effective activity contributes to increasing incomes. It is determined that in the system of social and economic security, in particular, food security, which is based on the effective functioning of the agricultural sector, is becoming important. In the article we study the dynamics of food production in some European countries and the EU, as well as the main trends in the financing of agricultural development programs through targeted government programs in Ukraine. The method of integrated assessment of the state of socio-economic security of the rural population is applied. Based on it, it is determined that the integral value of this indicator in Ukraine is within critical limits, which requires a set of measures aimed at improving the socio-economic development of rural areas.

Key words**:** *socio-economic security, rural areas, rural population, integrated security indicator*.

INTRODUCTION

The peculiarities of the transformation of the system of economic relations in Ukraine, as well as the reform associated with the administrative and budgetary decentralization of territorial communities, involve a general change in approaches to the sustainable development of rural areas. The reason for this is the aggravation of socio-economic problems in these territories, which negatively affects the overall socio-economic security of the state. The reasons for these problems are quite diverse: on the one hand, urbanization and the general reduction of the rural population, and on the other – socio-economic problems associated with insufficient efficiency of socio-economic potential of the village and insufficient budget funding for its development. As a result, rural areas of Ukraine are characterized by problems related to the need to ensure the development of social and communal infrastructure, general deterioration of human capital, socio-demographic disparities, as well as low efficiency of available resources, and deteriorating environmental conditions.

At the same time, effective reform and development of rural areas in Ukraine is a significant reserve for solving socio-economic distortions of rural security, an incentive for the development of the real sector of the agricultural economy, general stimulation of business activity in rural areas, and a means to improve infrastructure and quality of life.

Many authoritative researchers have studied the problems of ensuring the socio-economic security of the rural population. It is worth noting the research on solving the problem of

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ensuring the effectiveness of rural development, which is presented in the works of such researchers as O. Agres [1], O. Binert [4], Y. Chaliuk [6], A. Marcuta [20], A. Popescu [18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30], T. Shmatkovska [31, 32, 33, 34], I. Yakoviyk [44], Y. Yanyshyn [45] and others. In addition, a significant contribution to solving the problems of financing the socio-economic development of rural areas was made in the works O. Apostolyuk [2], I. Balaniuk [3], A. Boiar [5], M. Dziamulych [7, 8, 9, 10, 11, 12, 13, 14, 15], R. Sodoma [35, 36, 37, 38], O. Stashchuk [39, 40, 41], O. Yatsukh [46], I. Zhurakovska [47] and others.
However, with the growing intensity of economic globalization, threats to the socio-economic development of rural areas are changing, which requires the formation of new approaches to their assessment and finding solutions.

MATERIALS AND METHODS

Each component of the economic security of agriculture is characterized by an appropriate set of indicators (39 in total), which can be attributed to stimulants (S) (an increase which is desirable), or to stimulants (D) (decrease which is desirable).
To unambiguously assess the state of economic security of agriculture, an integrated index has been analytically determined, which will ensure the methodological unity of all indicators.
The study of methodological approaches to integrated assessment of the state of development or security has revealed a number of shortcomings that lead to distorted assessments, so modern advances in integrated assessment of the level of security are used, namely:
integral index form - multiplicative:

$$I_t = \prod_{i=1}^{n} Z_{i,t}^{a_i}; \ \sum a_i = 1; \ a_i \geq 0$$

where: I – integral index;
z – normalized indicator;
a – weighting factor.

Method of rationing – combined:

$$S: z_i = \frac{x_i}{k_{norm}}, \qquad D: z_i = \frac{k_{norm} - x_i}{k_{norm}}, \ k_{norm} > x_{max}$$

where:
x – indicator values;
k_{norm} – normalization factor.

Weighting factors – dynamic: based on the application of the method “Main components” and the method of “Sliding matrix” [21]:

$$C_i \times D_i = \begin{pmatrix} d_1c_{11} + d_2c_{12} + \cdots + d_jc_{1j} \\ d_1c_{21} + d_2c_{22} + \cdots + d_jc_{2j} \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. \\ d_1c_{j1} + d_2c_{j2} + \cdots + d_jc_{jj} \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ \dots \\ w_j \end{pmatrix},$$

$$a_i = \frac{w_i}{\sum w_i}$$

where:
C – matrix of absolute values of factor loads;
D – vector-matrix of variances;
a – weights coefficients;
c and d – elements of matrices C i D;
w – the resulting contribution of the i-th indicator to the integrated index.

An important step in integrated assessment is to determine the limits of the safe existence of the system, so it is not enough to simplify the representation of thresholds such as “no more”, and “no less”, which can lead to erroneous conclusions about maximizing integrated indices. Therefore, for each indicator you need to set a vector of threshold values: lower threshold, lower optimal, upper optimal, upper threshold, but for more in-depth research you need to consider both lower critical and upper critical. Determining the vector of threshold values makes it possible to identify safety/danger zones, pre-

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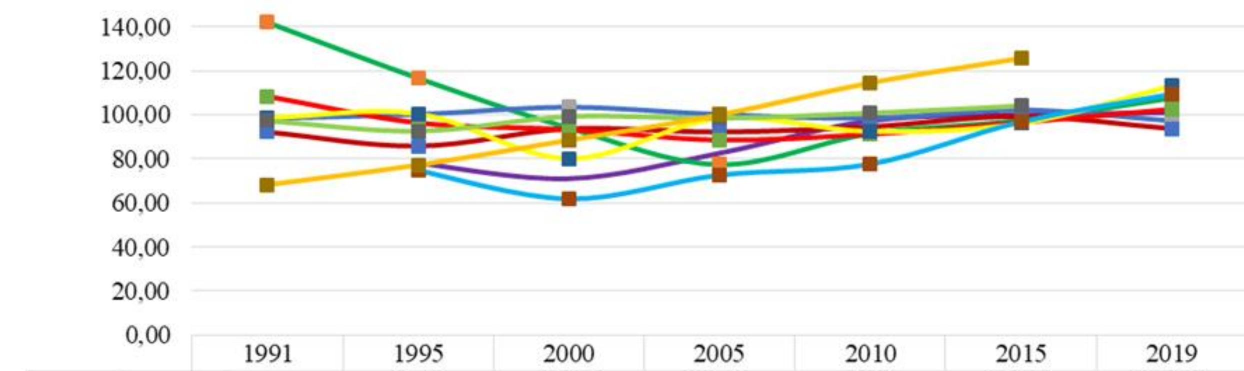
crisis, or crisis states by comparing them with the dynamics of the integrated index.
Thus, the definition of the vector of threshold values is closely related to the concept of dynamic stability of the economic system, or the mechanism of homeostasis, which leads to the conclusion: "Without knowledge of the safe existence of the system it is impossible" [20]. With this in mind, A. Kaczynski proposed the concept of "homeostatic plateau" of a dynamic system with upper and lower threshold values, which determines the existence for each system of a stable state of dynamic equilibrium [16].
There are a number of methods for determining the threshold vector, the most accessible of which is the "t-test method".

RESULTS AND DISCUSSIONS

One of the key elements in ensuring the economic security of rural areas is the availability of developed agricultural production. On the one hand, it contributes to increasing the level of employment of the rural population and reducing social tensions. On the other hand, the availability of products in rural areas provides additional revenues to the budgets of local communities, some of which will eventually be directed to their socio-economic development and infrastructure development, which will also positively affect the economic security of the region.
However, it is worth highlighting several separate areas of production in the agricultural sector, which not only contribute to the direct solution of economic problems of the rural population but also affect its self-sufficiency in the context of food security in general.
An important indicator in this aspect is the index of food production, which is recommended for analysis and calculated by the World Bank. In particular, it is necessary to assess the dynamics of this indicator over the past thirty years in terms of individual countries in Europe, the European Union, and the world as a whole (Fig. 1).



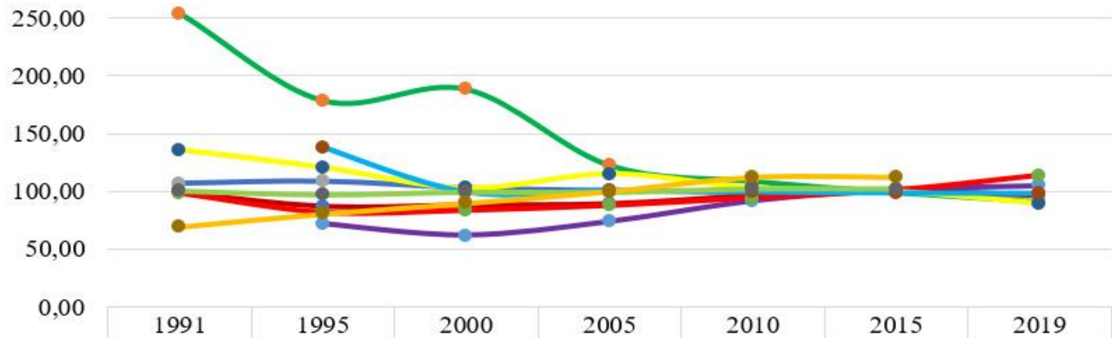
	1991	1995	2000	2005	2010	2015	2019
Belarus		78.10	70.99	82.60	97.24	99.95	100.97
Bulgaria	141.85	116.57	94.00	77.41	91.44	97.48	107.54
France	98.34	100.18	103.41	100.13	98.46	102.23	97.23
Germany	92.13	85.79	93.66	92.15	94.56	99.27	93.67
Poland	108.32	96.32	93.25	88.53	91.20	96.53	102.52
Romania	98.67	100.39	80.13	98.34	92.39	96.09	113.09
Ukraine		74.76	61.83	72.61	77.61	96.81	109.31
EU	97.21	92.60	99.17	98.42	100.76	104.04	
World	68.20	77.22	88.49	99.95	114.48	125.60	

Fig. 1. Index of food production, 1991-2019, %
Source: [43].

As you can see, during the analyzed period, the volume of food production on a global scale is associated mainly with global population growth. At the same time, in the European Union, such growth was less rapid and amounted to only 6.9 points. However, for some countries, such trends are not synchronous. In particular, while Ukraine and Romania have significantly increased production during this time, Western European countries such as Germany and France have generally remained unchanged. On the other hand, Bulgaria and Poland, which have joined the EU during this time, have reduced their production. Moreover, for Bulgaria, the fall of this index was the largest and amounted to 34.3 points.

According to the change in the dynamics of the food production index, the state of food security of the respective countries also changed. At the same time, the logical consequence was that these trends had a direct impact on the socio-economic situation of the rural population, which is directly involved in food production.

Trends in livestock production in the respective countries should also be considered separately based on the assessment of the dynamics of the livestock production index according to the World Bank (Fig. 2).



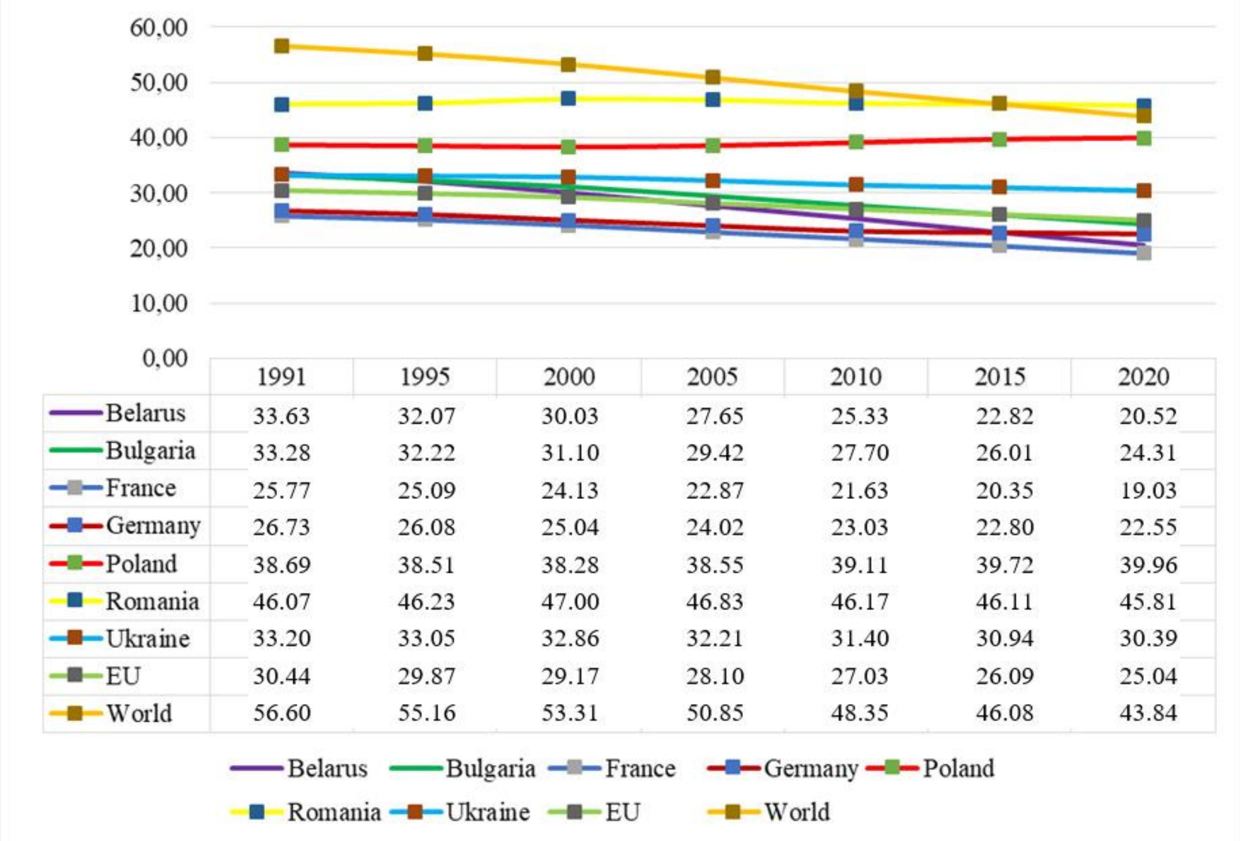
	1991	1995	2000	2005	2010	2015	2019
Belarus		72.24	62.21	73.99	92.07	101.82	105.13
Bulgaria	254.25	178.66	188.49	122.73	108.94	99.39	91.41
France	107.32	109.06	103.29	100.94	99.43	100.20	96.90
Germany	99.52	87.38	88.66	89.61	96.54	100.44	97.12
Poland	98.54	81.68	83.54	87.71	94.55	101.18	114.16
Romania	136.12	120.88	102.74	115.29	103.16	100.01	89.67
Ukraine		138.42	99.81	101.13	99.82	98.92	98.60
EU	100.68	97.27	99.62	99.51	102.59	102.59	
World	69.60	80.79	90.03	100.15	112.59	112.59	

Belarus, Bulgaria, France, Germany, Poland, Romania, Ukraine, EU, World

Fig. 2. Index of livestock production, 1991-2019, %
Source: [43].

As we can see from Fig. 2, the situation with the production of livestock products during the analyzed period was more problematic. At the same time, if world production grew, in the EU for thirty years the growth was only 1.91 points. In many European countries, there has been a significant decline in this index. The most significant reduction in production was in Bulgaria - a drop in the index by 162.84 points. This decrease was also noticeable in Ukraine and Romania, which showed a positive trend in the overall food production index. Conversely, significant growth in livestock production during the analyzed period was demonstrated by Poland and Belarus, although the latter achieved this growth due to significant direct government subsidies in this area, including direct lending by the Central Bank.

An important aspect in the analysis of the socio-economic security of the rural population is also the dynamics of its share of the total population. Of course, the processes of urbanization are inevitable on a global scale, but sharp fluctuations in this indicator indicate the presence of problems with the socio-economic situation in rural areas. Consider the dynamics of the share of the rural population in some European countries, the EU, and worldwide (Fig. 3).



	1991	1995	2000	2005	2010	2015	2020
Belarus	33.63	32.07	30.03	27.65	25.33	22.82	20.52
Bulgaria	33.28	32.22	31.10	29.42	27.70	26.01	24.31
France	25.77	25.09	24.13	22.87	21.63	20.35	19.03
Germany	26.73	26.08	25.04	24.02	23.03	22.80	22.55
Poland	38.69	38.51	38.28	38.55	39.11	39.72	39.96
Romania	46.07	46.23	47.00	46.83	46.17	46.11	45.81
Ukraine	33.20	33.05	32.86	32.21	31.40	30.94	30.39
EU	30.44	29.87	29.17	28.10	27.03	26.09	25.04
World	56.60	55.16	53.31	50.85	48.35	46.08	43.84

Fig. 3. The share of the rural population in the total population, 1991-2020, %
Source: [43].

As we can see, in the analyzed period, the processes of urbanization were indeed characteristic of all selected countries. At the same time, in the European Union, the share of the rural population decreased by 4.6%. At the same time, in Belarus and Bulgaria, such reductions were 13.11% and 8.97%, respectively, which is significantly higher than the average compared to other European countries. Based on this, we can conclude about the existing problems in ensuring the socio-economic security of the rural population of these countries. In Poland, on the other hand, the share of the rural population increased by 1.27%, which is uncharacteristic of global trends. At the same time, it indicates an increase in the level of economic security of the rural population, which has been ensured through significant investments in rural infrastructure over the past ten years.

At the national level, the assessment of the regulatory impact of the state on ensuring the socio-economic security of the rural population is determined not only by direct funding of rural communities and support for their infrastructural development.

Investment in agriculture and support programs for agricultural producers, which directly affect the level of employment and income of the rural population, are of key importance for the economic security of rural areas.

Therefore, to assess the effectiveness of such an impact on the agricultural sector in Ukraine, we estimate the planned and actual government expenditures to finance various agricultural support programs (Table 1).

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As you can see, during the analyzed period in the structure of the state budget expenditures on agricultural support programs, the largest share is occupied by expenditures on the financial support of agricultural producers.

Table 1. Structure of planned and actual expenditures of the state budget for financing programs of state support of the agricultural sector of the economy for 2017-2020,%

Name of the budget program	2017		2018		2019		2020	
	Plan	actually	plan	actually	plan	actually	plan	actually
Financial support of measures in the agro-industrial complex by reducing the cost of loans	5.51	5.87	6.21	6.31	8.75	9.86	0.00	0.00
Financial support of activities in the agro-industrial complex	1.10	1.13	0.12	0.07	0.10	0.04	0.12	0.00
Financial support for the development of farms	0.00	0.00	4.9	4.83	9.01	9.14	0.00	0.00
State support for the development of hop growing, the establishment of young orchards, vineyards, and berries, and their supervision	5.49	5.95	9.34	9.36	7.75	8.72	0.00	0.00
State support in the field of animal husbandry, storage, and processing of agricultural products, aquaculture (fish farming)	3.12	3.3	56.05	56.73	56.75	53.32	0.00	0.00
Financial support for agricultural producers	83.52	82.37	22.29	21.67	13.21	14.03	98.11	98.35
Providing loans to farms	1.19	1.29	1.01	1.01	4.35	4.89	1.65	1.65
Financial support of measures in the agro-industrial complex on the terms of financial leasing	0.07	0.08	0.09	0.02	0.09	0.00	0.12	0.00
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: [42].

At the same time, in 2017-2020, the share of these funds in the overall structure increased from 82.37% to 98.35% of the total expenditures. This indicates the state`s focus on targeted subsidies for large enterprises. At the same time, the program to support small farms is virtually non-existent, despite the fact that in 2019 it was allocated 9% of the total funding. As of 2020, the state was limited to preferential lending to farmers in the amount of 1.65% of all funds allocated to support the agricultural sector.

Thus, we can conclude that in the field of state regulation of agribusiness support the main attention is paid to large agricultural producers and agricultural holdings. From the point of view of ensuring the socio-economic security of the rural population, such an orientation is justified, as large enterprises have the opportunity to create a significant number of jobs, which will positively contribute to increasing the employment and income of the rural population. However, it should be noted that increasing the number of small farmers and financially stimulating the development of their farms will greatly contribute to the quality development of the middle class in rural areas, which will have a significant impact on the socio-economic security of the rural population.

Hence, using modern approaches to calculate the integrated index of economic security of agriculture, we obtain the dynamics of integrated indices of components of sustainable rural development! economy: the economic component and components of sustainable development (Fig. 4).

According to calculations, all components of the economic security of sustainable agricultural development are below the lower threshold value, which indicates a danger. Of the 39 indicators of sustainable development, 25 (almost 64%) pose a threat to the secure existence of economic security in agriculture and need immediate measures to improve them.

Integral convolution is carried out in stages by components simultaneously with the integral convolution of threshold values that define safety/danger zones, provided the choice of the principles of sustainable development (Table 2).

Fig. 4. Dynamics of integrated indices of economic security of sustainable development of agriculture
Source: [22].

Table 2. Vectors of threshold values of components of economic security of agriculture of Ukraine

Individual components	Lower threshold	Lower optimal	Upper optimum	Upper threshold
Economic	0.424062	0.566986	0.760337	0.978949
Social	0.353323	0.556334	0.719614	0.885245
Ecological	0.202794	0.432501	0.646858	0.921113
Economic security of agriculture	0.310711	0.513254	0.707008	0.929664

Source: own research.

The main reason for the low integrated level of industrial safety of agriculture in Ukraine is the presence of a number of indicators below or on the verge of the lower threshold, namely: economic component: structural development – low Gross value added of agriculture (face value) per capita, low level of production technology inflated intermediate consumption), low yields of cereals and legumes; on the structure of production – low level of production of fruits, berries, and grapes, meat and milk; by consumption structure – low level of consumption of grain, fruits, berries and grapes, meat and milk; on investment and financial development – low level of investment, critically low level of growth of foreign direct investment, the share of lending to agriculture.

Social component: below the lower threshold – depopulation rate (D); total mortality rate (number of deaths per 1,000 population), ppm (D); net reproduction rate per 1 woman (S); the number of hospitals in rural areas, per 10,000 rural population (S); the number of independent outpatient clinics and polyclinics per 10,000 rural population (S); on the border of the lower threshold – the share of the rural population (D); unemployment rate (D); coefficient of economic activity of the rural population (S); the number of medical and obstetric points per 10,000 rural population (S).

Ecological component: below the lower threshold - the level of the fertilized area with organic fertilizers, % (S); level of plowed territory, % (D); level of plowing of agricultural lands, % (D).

If we assume the growth of all threatening indicators for the period 2019-2022 by the maximum value observed in the previous period 2007-2018 for existing trends - the inertial scenario of development, we have that maintaining existing trends forever leaves the level of economic security in agriculture. critical zone with a high probability of further destruction of Ukraine`s economic system.

Thus, the calculations show that despite the important role of agricultural production in meeting the internal and external needs of the population of Ukraine, its level of economic security is invariably below or below the lower threshold, which symbolizes the danger that lies primarily in management. In particular, there are problems of inefficient management of agriculture and irrational use of productive resources, which directly affect the economic security and sustainable development of rural areas. In order to monitor the level of economic security of sustainable development of agriculture in Ukraine, the structure of its sustainable development is proposed, which includes social, environmental, economic (production: structural development, production structure, consumption structure, and investment-financial) components characterized by a set of indicators (39 in total), and certain vectors of threshold values of socio-ecological-economic “modernization” of agriculture, which allows identifying its current state in all the diversity of its aspects.

The identification of the state of economic security of agriculture in Ukraine using a modern methodology of integrated assessment indicates that all components of the relevant integrated indicator are below the lower threshold, which determines the same level of sustainable development and indicates a very poor agroeconomic policy in Ukraine.

CONCLUSIONS

Thus, we conclude that the socio-economic security of the rural population is from both global and regional factors of economic development. At the same time, the formation of economic security in rural areas should focus on stimulating the development of agriculture, which will have a direct impact on increasing the welfare and employment of the rural population of Ukraine. At the same time, there is an objective need to find methods to ensure dynamic growth and to form a mechanism for implementing measures to ensure the economic security of the rural population. In our opinion, an important role in this mechanism should be played by programs of state support for agricultural development, because it is through the economic mechanism is the direct distribution of funds among all participants in the production, which leads to increased welfare. The implementation of such measures should ensure the economic security of the agricultural sector in general and the rural population in particular. The key tasks to be ensured to ensure the effective functioning of the agricultural sector should be to fill the budgets of rural communities, increase the income of the rural population, improve the labour market, create a balanced market and social infrastructure in rural areas, and ensure proper environmental and man-made safety.

In addition, the calculations show that the most significant threat to the safe development of agriculture is the catastrophic situation in the social sphere, as 90% of

relevant indicators pose a threat to the economic security of agriculture in Ukraine. In total, among all 39 indicators used in the study, 25 (almost 64%) pose a threat to the secure existence of economic security in agriculture and need immediate measures to improve them.
Hence, given the current trends, the medium-term forecast of further changes in the level of economic security of agriculture indicates that the integrated index is in the critical zone, which is likely to destroy not only the agro-economic system but also slow down Ukraine`s economy.

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THE ISSUES OF THE SUBSTANTIATION OF PEER AGRICULTURAL LAND PLOTS EXCHANGE IN UKRAINE

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Abstract

The study is dedicated to the substantiation of peer land plots exchange in the course of land consolidation. The issue of the allowable difference of the values of land plots, considered to be peer, has been examined. The legally established 10 % allowable difference has been scrutinized. The evaluation of value difference ranges of land plots, considered to be peer, has been carried out. The formation of land plot value at peer exchange in Ukraine has been analysed. It has been revealed, that due to the vague definition of the allowable difference of land plot values and poorly elaborated evaluation, there arises an uncertainty of 1/110 (≈0.9%) to 13/220 (≈5.9%) of the land plot value. It complicates the voluntary involvement of landowners to land reallotment and potentially leads to disputing the peer land exchange in the court. With the example of an interspersed land plot within a land mass in Cherkasy Region, potential loss due to inaccurate demands to the valuation of land plots to be exchanged and poorly elaborated valuation methodology, has been calculated. An approach to the specification of the affordable land plot value range which excludes uncertainties has been suggested. The results can be used for the improvement of land reallotment modeling based on heuristic and optimization methods.

Key words*: *land exchange, land reallotment, peer land plots, land consolidation

INTRODUCTION

Land plot exchange is the key tool for both individual and comprehensive land consolidation [20, 17], and land reallotment [5, 8]. The advantages of the peer land exchange are manifold possibilities for the improvement of spatial land plot characteristics without the need for buying out the land plots or their shares, and minimal losses for landowners involved in the project [18]. It is of key importance in terms of compensation [9], especially at compulsory land consolidation, landtake for community needs [21], especially in cases the exchange is carried out by the court judgement, not by the mutual consent [7].
The key stage of exchange is (for example, in accordance with Land Exchange Decision Document) [2] the substantiation of the peerness of land plots to be exchanged [15], especially in case the exchange is carried out for the public benefit [4].
Fair exchange is the key incentive for land owners to get involved into the process of reallotment.
The poorly substantiated peerness of land plots to be exchanged can become a hurdle for land consolidation [16]. It is a precondition for suspicion to the project, and, as the result, social tension arises, and the implementation of reallotment measures is slow, especially, when there is a big number of land plot exchange options [10].
In the ideal case, the exchange can be considered peer provided the values of land plots to be exchanged are equal. Land plot reallotment modeling practices predefine the allowable 10% range of the land plot value difference [14]. In Ukraine, at land consolidation, land plots are considered to be peer when their normative monetary values are either equal or the difference of their values is no more than 10% [22, 23].
The working hypothesis is that the approach according to which the value difference of

peer land plots should be no more than 10%, does not set the value difference range conclusively. Further, it creates preconditions for disputing the exchange and finding it not peer.
The goal of this article is the issue of the substantiation of land plots as peer ones based on the calculation of the allowable difference of their value.

MATERIALS AND METHODS

Demetriou [6] suggests that the determination of value of land plots in the course of land consolidation can be carried out based on either market price or value, calculated considering a set of coefficients characterizing soil quality and productivity, expressed in numerical score.
In Ukraine, there is a methodology of exchange based on the land plot value calculated by normative monetary valuation [18], which is defined by the following formula for agricultural land:

$$V_i = S_i N K_{Pi} K_{Li} \frac{B_i}{B_{Mi}} \qquad (1)$$

V = the value of the land plot by normative monetary valuation;
S_i = the area of the land plot, square metres;
N = capitalized rental income from a unit of area (calculated by methodology [3], is equal to 27,520 UAH per ha ($96.61 /1,000 sq.m));
K_{Pi} = the coefficient of land plot designated use (K_{Pi}=1 for all agricultural land plots (including land plots occupied by field-protecting forest belts), excluding land plots for markets (K_{Pi} =2.5), for research and training (K_{Pi} =0.7), for the conservation and use of nature reserve fund areas, public hayfields and pastures (K_{Pi}=0.5), not owned or used land plots, including those occupied by agricultural facilities and farmsteads (K_{Pi} =0.1);
K_{Li} = the coefficient of the placement of the territorial community within the natural and agricultural region. Its value is preset by the methodology (0.276 to 1.593 for arable land; 0.156 to 3.266 for perennial plantings; 0.079 to 0.51 for hayfields; 0.035 to 0.325 for pastures);
B_i = the ball bonitet of the soil suitability group of a certain natural and agricultural area;
B_{Mi} = the mean ball bonitet of the soil of respective cultivated land of a certain natural and agricultural area.
The average value by normative monetary valuation ranges depending on the region of Ukraine from 33,646 UAH/1,000sq.m. ($125.14/1,000 sq.m.) to 21,411 UAH/1,000sq.m. ($79.63/1,000 sq.m.) (Fig. 1).

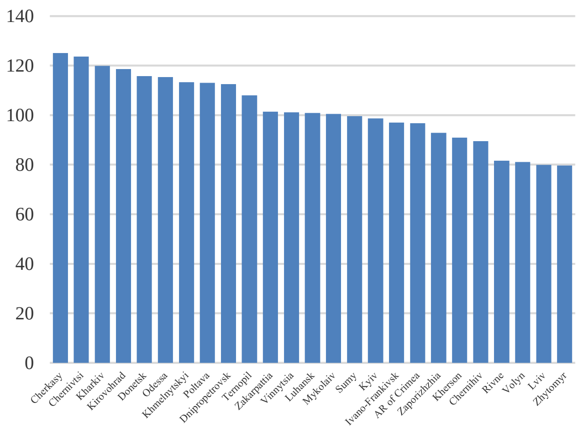

Fig. 1. Arable land normative monetary value by the region of Ukraine, $/1,000 sq.m.
Source: [19].

In the most widespread cases, land plot exchange is executed to spatially optimize land masses [11].

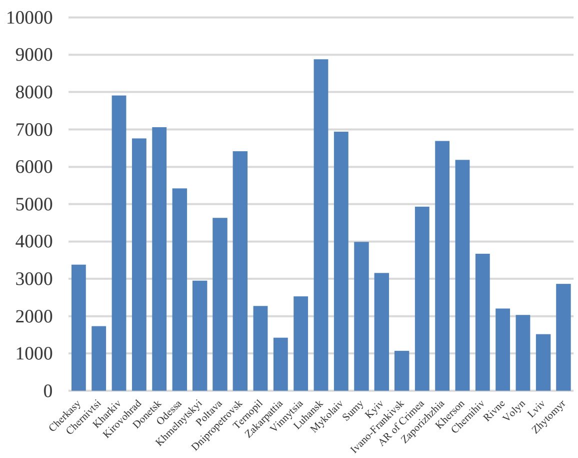

Fig. 2. Average normative monetary valuation of arable land plots (land shares) in the regions of Ukraine, $
Source: Own calculation based on [19].

Usually, strip farming arises within land masses formed with land shares, the demarcated afield. Normative monetary valuation of such land plots varies depending on the region from 28,695.70 UAH ($1,067.28) to 238,700.00UAH ($8,878.00) in average (Fig. 2).
According to formula (1), if land plots of the same type (e.g. arable land) are peerly exchanged within a territorial community, land plots will have the same value by normative monetary valuation in case:

$$S_i \times B_i = S_j \times B_j$$

where:
S = the area of the land plot;
B = the ball bonitet of the soil of the land plot.
Land plots are considered to be peer when the inequation is fulfilled:

$$S_i \times B_i - S_j \times B_j \le \pm\Delta$$

where:
Δ = the extreme acceptable value of the difference of land plot values by normative monetary valuation.
The effective legislation of Ukraine defines Δ to be equal to 10% without extra clarification, 10% from which land plot value (higher value, lower value, mean value) should be taken. Let us examine if such a vague formulation influences the range of the allowable value difference of land plots which are considered to be peer.
Generally, the demand on the difference of values of land plots, which are considered to be peer, is interpreted as follows. At the selection of a peer land plot, its possible value V_j is defined. In order to do it, we calculate 10 % from the value V_i of the initial land plot. Thus, the value of a peer land plot should be in the range of $0.9V_i$ to $1.1V_i$, i.e., is defined by inequality:

$$\frac{9}{10}V_i \le V_j \le \frac{11}{10}V_i \qquad (2)$$

Let us scrutinize the regulation on the value difference and assess if it is reasonable to apply formula (2) to all cases.

Let us address two land plots to be exchanged with values V_i and V_j . The value of a land plot is naturally higher than 0. Since there are no extra conditions, let us examine the case the values of land plots to be exchanged differ more than by 10%, irrespective of that, which land plot has less value. I.e.:

$$\begin{cases} \left|V_i - V_j\right| \le 0.1V_i \\ \left|V_i - V_j\right| \le 0.1V_j \end{cases} \Leftrightarrow \left[\begin{array}{l} \begin{cases} V_i \ge V_j \\ V_i \le \frac{11}{10}V_j \\ V_i \le \frac{10}{9}V_j \end{cases} \\ \begin{cases} V_i < V_j \\ V_i \le \frac{10}{11}V_j \\ V_i \le \frac{9}{10}V_j \end{cases} \end{array}\right. \Leftrightarrow \begin{cases} V_i \le \frac{11}{10}V_j \\ V_i \ge \frac{10}{11}V_j \end{cases} \qquad (3)$$

Then, the range of difference of peer land plots values, which complies with the inequality (3), is depicted in Fig. 3.

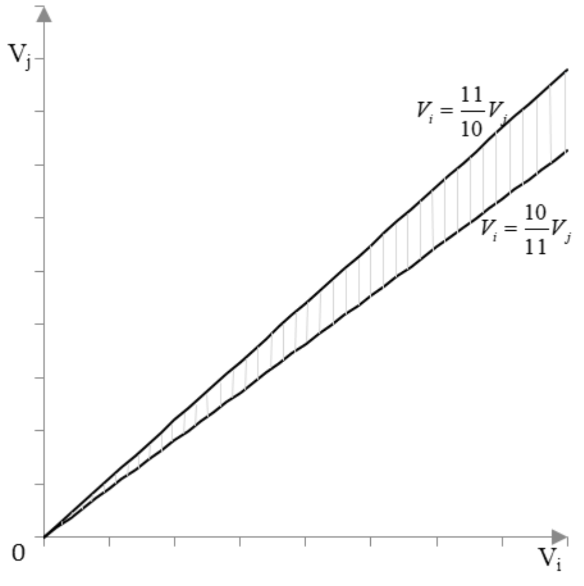

Fig.3. Range of difference of land plots values, which are considered to be peer
Source: Own calculation.

Generally, according to the inequality (3), for the given land plot with the value *Vj*, we can define the value *Vi* of a land plot, which can be considered to be peer:

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$$\frac{10}{11}V_j \leq V_i \leq \frac{11}{10}V_j \qquad (4)$$

As we can see from formula (2) and (4), the difference of extreme values of the land plot is 1/110 of the value of the land plot by normative monetary valuation.

RESULTS AND DISCUSSIONS

The calculations prove, the existing intepretation of the peerness of land plots causes an inaccuracy of 1/110 from the value of the land plot by normative monetary valuation. Thus, the selection of peer land plots according to the effective legislation can cause disputing the land plots exchange and finding it not peer. The inaccuracy for typical land plots across the regions of Ukraine is \$9.70 to \$80.81 (Fig. 2) (Fig. 4).

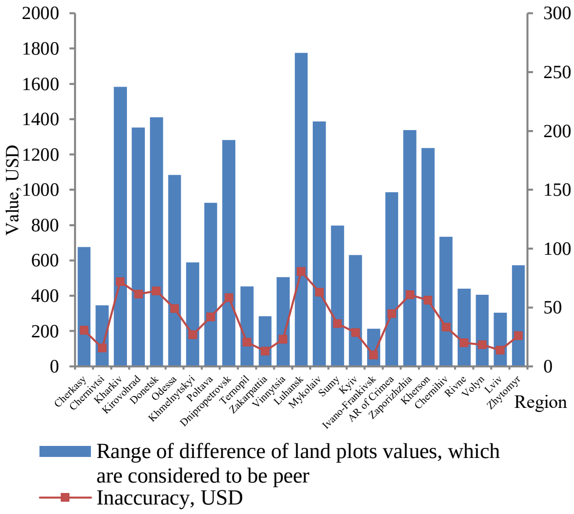

Fig. 4. Inaccuracy of range of difference of land plots values, which are considered to be peer
Source: Own calculation.

Let us examine an interspersed land plot with the area of 64,682 sq.m. in an agricultural land mass (Map 1 and 2) in Cherkasy Region, Ukraine.

Normative monetary value of such a land plot is 217,654.93 UAH (\$7,641.14).

According to general approach, in order to optimize the land mass [12], the exchange of the interspersed land plot with a peer land plot at the edge of the land mass is predefined. Let us calculate the value of a peer land plot for exchange.

Map 1. Interspersed land plot within a land mass
Source: space image from the Public Cadastral Map of Ukraine.

Map 2 . Interspersed land plot within a land mass
Source: The Public Cadastral Map of Ukraine.

In case we calculate the value of a peer land plot based on the value of the interspersed land plot, by normative monetary valuation it can be 195,889.44 UAH (\$6,877.03) to 239,420.42 UAH (\$8,405.24). Formula (4) proves, the minimal value of a land plot which can be considered as a peer one, is 197,868.12 UAH (\$6,946.49). In case the owner gets a land plot with the normative monetary value from 195,889.44 UAH to 197,868.12 UAH for their land plot, such exchange can be disputed and considered to be not peer. Thus, the landowner can lose 1,978.68 UAH ($69.46) by normative monetary valuation. Landowner's potential loss by market valuation is 3,592.20 UAH ($126.11), loss of area is 588 sq. m.

The application of normative monetary valuation is controversial per se [13], because the normative valuation does not take into consideration a number of other factors, important for land consolidation (land plot configuration, relief and placement within the land mass, distance to inhabited localities, and engineering and transport infrastructure) [1].

According to expert estimates, the market value of an irregular shape land plot other than rectangle or rectangular trapezoid or a land plot with complicated relief, is decreased by 5%. In case the land plot is exchanged with a land plot of the irregular shape or complicated relief, the landowner can lose as much as 39,155.01 UAH ($1,374.60) by market valuation, i.e., the inaccuracy is 13/220 of value.

CONCLUSIONS

The effectiveness of reallotment depends on the degree to which the peer land plot exchange is substantiated. The absence of clear regulations on the difference of values for land plots, which are considered to be peer, impedes the implementation of land tenure optimisation measures, especially, at the stage of peer exchange approval or exchange as the execution of court judgment.

It has been demonstrated, that the existing intepretation of the peerness of land plots causes an inaccuracy of 1/110 (≈0.9%) to 13/220 (≈5.9%) from the value of the land plot. It has been suggested to consider the exchange to be peer if land plots to be exchanged differ by 10% from the less value of those of land plots being exchanged. Based on the research, it is suggested to adjust the effective legislation of Ukraine. At exchange, it is reasonable to consider the value calculated by the expert monetary valuation, or relative value which considers the spatial characteristics of land plots, especially configuration and relief.

The results can be used to define the peerness of land plots by various valuations, especially, by relative value, and market value [6]. The results can be used at land reallotment modeling based on heuristic and optimizational approaches.

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THE IMPACT OF THE COVID-19 CRISIS ON THE BANKING SYSTEM IN ROMANIA

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Abstract

The banking sector is one of the most important sectors for the economy of a country, being the one that supports the functioning of the market and that contributes to the achievement of economic growth. In this paper, we proposed that, starting from the statistical data published in the databases regarding Romania, to characterize the functioning of the banking system during the Covid-19 pandemic. The data were processed and analyzed with the help of some statistical indicators used in the analysis of time series (absolute change with a fixed base, absolute change with a chain base, the dynamic index with a fixed base, the dynamic index with a mobile base and the rhythm of the dynamics) and stood at the basis for formulating conclusions regarding how the banking system in Romania faced the challenges of the 2018-2020 period. At the same time, the strengths and weaknesses that characterized the banking system were identified, so that in the future, measures can be taken to avoid the risks resulting from the emergence of economic, health, social, etc. crises.

Key words**:** *banking system, efficiency, Covid-19*

INTRODUCTION

The banking system is one of the pioneers of the functioning of the economy and therefore its functioning influences the economic policy, the way of doing business, the level of financing of investments, but also the way of lending to natural persons in order to satisfy their own needs.

The Covid-19 pandemic, as an event that triggered the last crisis of proportions of these years, influenced the entire economic, financial, social activity, etc.

Some sectors suffered more, such as tourism, transport, construction, etc. [3, 13], just as among the countries of the world, some were more affected than others, depending on the degree of spread of the virus [7, 8].

Regarding the banking system, although the Covid-19 crisis led to an erosion of bank assets as a result of payment delays that occurred both in the case of companies and in the case of natural persons who had contracted loans, this was not as strongly affected as other sectors of the economy [2, 11]. The risks and causes of their participation were in this case exogenous, they were due more to the health crisis than to a financial crisis [4], but they could have had serious influences on the performance of the financial sector [1, 6]. These risks were manifested on both sides, because non-performing loans led to a decrease in cash flows within the banks, to an increase in default rates, which leads to an increase in risk and requires the establishment of provisions by banking institutions, and on the other hand increases the risk of borrowers by increasing bank expenses.

However, the Covid-19 pandemic also caused a crisis in the banking system as a result of the fact that it had not fully recovered after the economic crisis that began in 2008 [12]. However, at this moment, the advantage was represented by the fact that it benefited from a higher capitalization and a higher liquidity compared to the previous crises [17]. However, the Covid-19 crisis has shown that there are still vulnerabilities in the banking system, and their anticipation can only be realized starting from an overall analysis of the causes and the effects produced. Choosing the right measures and solutions can contribute both to a better management of the existing situation in the banking system, but also to offering faster solutions to both companies and the population.

For many banks, the risk reduction measures that were applied during this period will constitute measures and practices that will be extended and continued with the aim of serving their clients effectively, with the aim of shaping culture and reputation [9]. Other authors consider that the mistakes made during periods of economic growth are visible only during crises, so these crises are a good moment to reflect on the way of developing and applying financial and monetary policies, in the choice and application of business strategies [2, 5].

Another important aspect that must be mentioned is that if in the crises that have affected the world economies over time banks were considered the causes of their outbreak, at this moment, of the Covid-19 crisis, the banks were considered to be the reason for overcoming it [10].

Romania, for its part, faced the inherent problems that accompanied the Covid-19 pandemic. The banking system, however, started from a stable position, doubled by a proactive policy, elements that allowed a better absorption of the problems faced by the banks' clients, a way of thinking about lending that had sustainable bases and the fact that there was an availability of funds resulting from an advanced savings system. At the same time, the Covid-19 pandemic led to an acceleration of digitization not only at the level of the banking system, but at the level of the entire society, which contributed not only to the efficiency of the activity, but also to the increase of transparency. Moreover, in the banking system, digitization allowed a better control of risk management [20].

The Romanian banking system went through a process of consolidation following some merger or acquisition processes and is currently made up of 34 credit institutions that hold assets of approximately 630 billion lei. Of these, approximately 71% are owned by institutions with foreign capital. The role of the banking system is to ensure the resources necessary for the functioning of the economy, but at the same time to protect the savings of natural and legal persons.

The statistical data show that in Romania the banking institutions have sufficient resources for lending, registering sufficient solvency for their operation, so that, at the moment, there are no worries about the functioning of the banking system.

MATERIALS AND METHODS

The research methodology assumed the use of time series analysis indicators, both absolute indicators and relative indicators. Starting from the level indicators that show the value of the characteristic at a certain moment in time (yi), and which are results from the primary statistical data, all the other analysis indicators of the time series were then calculated, analyzed and interpreted: the absolute change with fixed base, the absolute change with a chain base, the dynamics index with a fixed base, the dynamics index with a mobile base and the dynamics rhythm [19]. The analyzed period included the time period 2018-2021.

The absolute change with a fixed base allowed us, starting from the same comparison base, to determine the evolution of the phenomenon between different moments of time, according to the following relationship:

$$\Delta_i = y_i - y_1 \qquad (1)$$

where:

y_i – level index

y_1 – the value of the characteristic y at a moment in time.

The absolute change with the base in the chain allowed us to compare each phenomenon in relation to the previous year, using the following formula:

$$\Delta_{i/i-1} = y_i - y_{i-1} \qquad (2)$$

where:

y_i – level index

y_{i-1} – the value of the characteristic y at a moment in time.

The dynamics index with a fixed basis was used in the case of the terms of the time series compared with a single basis, being calculated as follows:

$$I_{i/1} = y_i/y_1 \tag{3}$$

The chain-based dynamics index allowed us to compare each term of the series with the previous term, being calculated as follows:

$$I_{i/i-1} = y_i/y_{i-1} \tag{4}$$

The pace of the dynamics allowed us to quantify the change relative to the value we used as the basis for comparisons, being calculated as follows:

$$R_{i/j} = \Delta_{i/j}/y_j \tag{5}$$

RESULTS AND DISCUSSIONS

In the banking system in Romania, out of the 34 existing banking institutions in 2021, 25 ended their activity with a profit, and 9 registered losses. Compared to the previous period, there is a decrease in the banking institutions that recorded losses. Because if in 2018 their number was 14, in 2019 their number was 10, and in 2020 it was 12. The ratio of own funds or the Solvency indicator also shows that it increased from 19.84% in 2018 to 24.62% in 2021 this is due to the increase in net asset values.

These assets increased in 2021 by 33% compared to 2018 (Figure 1).

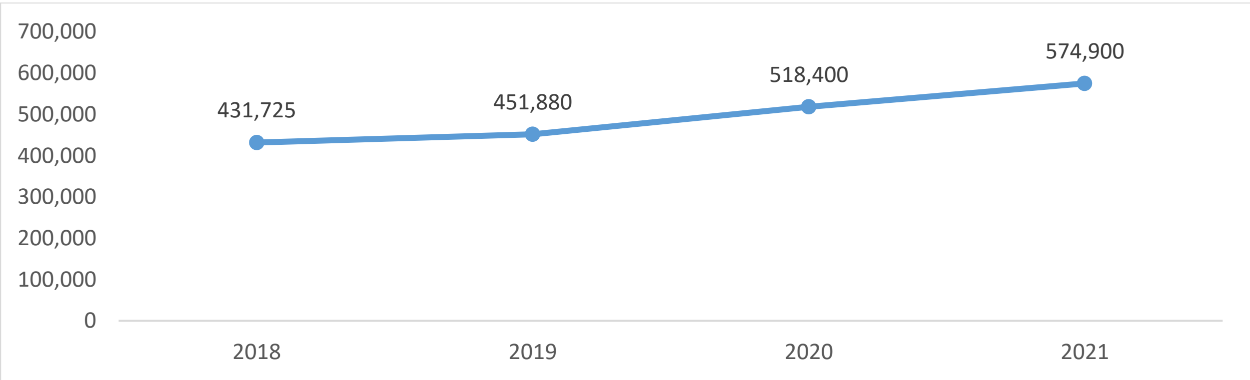

Fig. 1. Evolution of net banking assets
Source: own processing [14, 15, 16].

At the same time, there is also an increase in the net result obtained by the banking institutions. In 2018, it amounted to 1.767 million lei, the increase in 2021 being approximately 7%, the absolute amount being 1.887 million lei.

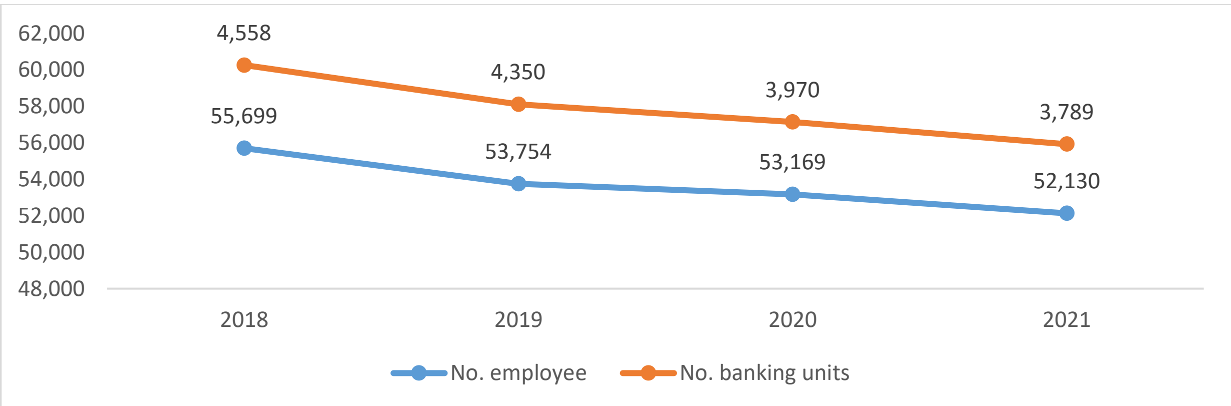

Fig. 2. Situation of the number of employees and banking units (2018-2021)
Source: own processing [14, 15, 16].

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Regarding the number of existing banking units in Romania, there is a decrease in their number, due to the computerization of the banking system and accentuated by the Covid-19 pandemic. If in 2018 the number of banking units was 4,558, in 2021 their number was 3,789. At the same time, there was a 6% decrease in the number of employees in the banking system (Figure 2).

As we show above, the reason for ensuring the cash flow necessary to finance the activity in the period 2018-2021 was represented by the high degree of savings. Statistical data prove this, given that during the analyzed period the ratio between loans and deposits was between 66 and 75%. The highest degree of savings was recorded in 2018, decreasing from one year to the next (74.8% in 2019, 71% in 2020 and 66% in 2021). The health crisis led to the reduction of jobs and the decrease of incomes [13, 18], which was also reflected on the level of savings.

Analyzing the loans and deposits of non-banking customers, we notice that in the period 2018-2021 they increased. In 2018, the increase in the total value of loans granted increased by 7% compared to 2018, while the value of deposits increased by 8%. In 2020, compared to the previous year, the value of loans increased by 8%, and the value of deposits by 23% as a result of the increase in the degree of responsibility, but also of concern about the consequences of the health crisis and the worsening of the economic crisis. The decrease in purchasing power, the increase in inflation caused the value of deposits to increase by 6% in 2021, while the value of loans increased by 7% (Table 1).

Table 1. The situation of loans and deposits to non-banking customers, 2018-2021 (Millions lei)

Indicator	***2018***	***2019***	***2020***	***2021***
Loans of non-banking customers	248,811	265,842	286,002	305,694
Deposits of non-banking customers	330,246	355,396	436,687	460,536

Source: own processing [14, 15, 16].

Regarding the efficiency of the banking activity, it is noted that they had a supra-unitary ratio of revenues and operational expenses. The 2019-2020 period actually brought a decrease in this ratio, which was due to the fiscal measures taken by the Romanian state in accordance with the European rules regarding the postponement of instalments related to credits borrowed by both individuals and legal entities. After the 11% decrease in 2019 and 10% in 2020 compared to 2018 in the revenue/operational expenses ratio, we note that the return in 2021 is close to the situation in 2018 (Figure 3).

It can thus be observed the dependence between the amount of interest and commissions collected by banks concomitant with the increase in the value of the loans granted. At the same time, the cost savings made by banks on the basis of digitization, which led to the replacement of employees in the banking system, to the decrease in the number of banking units, led to an increase in the operational profit recorded by banks.

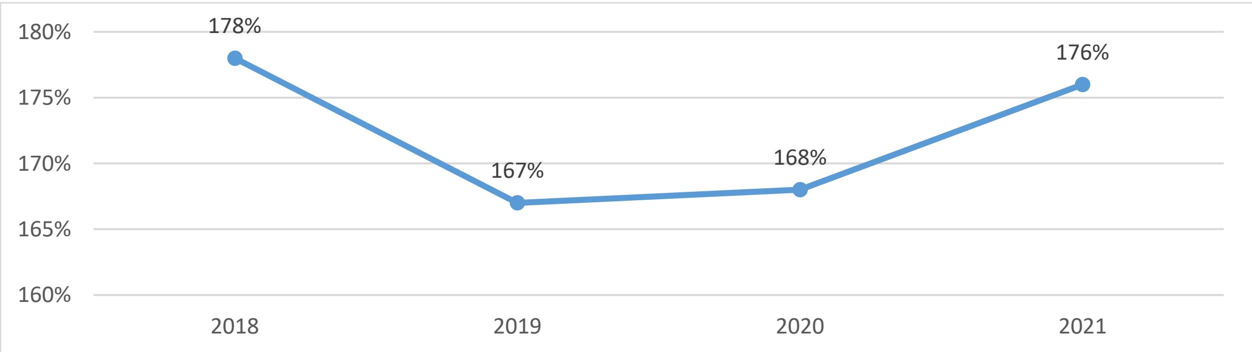

Fig. 3. The ratio between revenues and operating expenses
Source: own processing [14, 15, 16].

As a result of these measures, the rate of deferred payment of non-performing loans decreased. According to ABE data, this rate recorded the value of 6.16% in 2018, but it decreased reaching 4.9% in 2019 and 3.94% in 2020 and 2021. This is also due to the increase in the responsibility of borrowers, but also to the strengthening of financial discipline, because the Covid-19 meant an increase in responsibility on all levels, a moment of reset for many activities, but also for the way of managing business, thinking, etc.

Another fact that should be noted is the way in which the situation of appealing to new consumer loans and mortgage loans has evolved among the population, because after their value decreased in 2020, it is noted that in 2021 they recorded the most great value from the last 15 years. This was influenced by the desire to relocate following the outbreak of the Covid-19 pandemic (for mortgage loans), but also the decrease in income and the need for financing (consumer loans) (Figure 4).

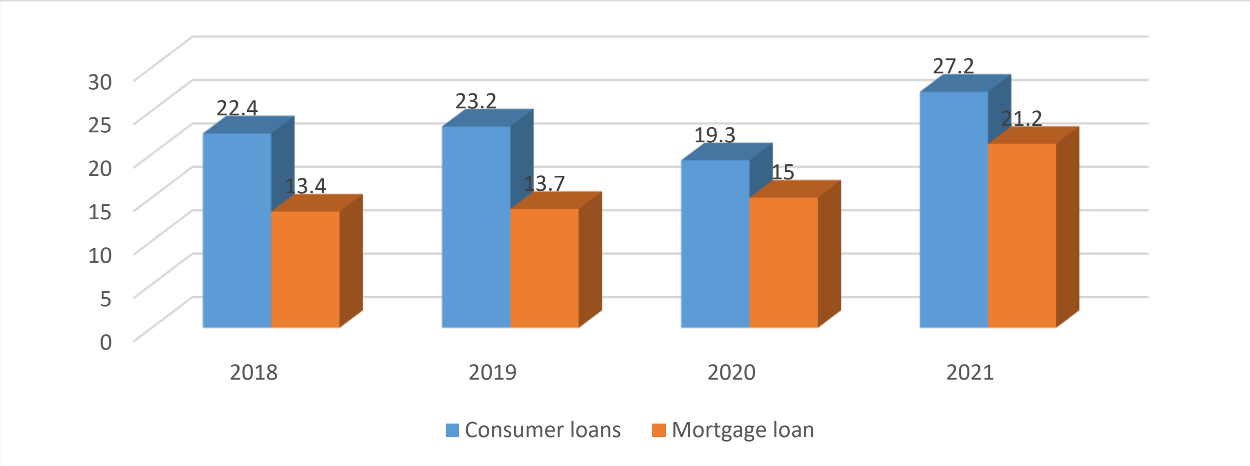

Fig. 4. Evolution of consumer loans and mortgage loans (2018-2021)
Source: own processing [14, 15, 16].

It is thus established that if in 2018 consumer loans, granted either in lei or in Euros, had a total value of 22.4 billion lei, in 2021 they reached a value of 27.2 billion. Regarding the value of mortgage loans, if in 2018 they amounted to 13.4 billion lei (both for loans granted in lei and for those in Euros), in 2021 they increased by 58% compared to 2018, reaching a value of 21.2 billion lei. It is also the highest growth rate of consumer loans and mortgage loans in the last 10 years.

On the other hand, the value of the loans we granted to both individuals and legal entities totaled 84 billion lei in 2021. Even though the economy had a decrease of approximately 4%, non-governmental credits increased. The degree of financial intermediation was also increasing, in 2020 this intermediation was almost 27%, up by 2% compared to the previous year, which indicates a maturation of these categories of investments on the part of companies and the population. However, Romania is not in a very good position compared to other neighboring countries, members of the European Union (Bulgaria has a degree of financial intermediation of 52%, Hungary of 35%, Poland of 48%). Therefore, the increase in the degree of financial intermediation must be increased, but this must be done on a sustainable basis, so that it can lead to financial advantages for investors,

Regarding the possibility of payment suspension, the data published in the BNR reports show that only in the first three months of 2021, almost 21 thousand requests were registered, of which only 4% were requests from companies, the rest coming from individuals. This aspect is correlated with the number and value of non-performing loans. However, as seen from the data presented above, the share of these credits decreased considerably in 2021, which translates, from the banks' point of view, into an increase in additional capital. In the case of legal entities, at the level of 2020, the rate of non-performing loans decreased from 7.2% to 6.6%, to reach around 4% in 2021 [14].

By sector of activity, it is found that the largest share of lending is held by natural persons (which varied around the share of 39% in the period 2018-2021), followed by the service sector (approximately 24%), by industry (approximately 16%), constructions (approximately 7%).

Agriculture had a share of approximately 4.5%, maintaining its dynamic pace of growth. The increase from October 2020 compared to October 2019 was 12%, due to the fact that in absolute value in 2019 the value of credits granted to the agricultural sector was 18.7 billion lei, and in 2020 they were 20.9 billion lei. In 2021, their value was 23.7 billion lei. The data show that compared to the other sectors of activity, agriculture ranked first in accessing credits, followed by public administration and services.

In 2022, however, this advance held by agriculture began to increase, in March of this year the value of the credits was 23.9 billion lei. Thus, the financial intermediation sector took the first position with a variation compared to the previous year of 49.1%, followed by the public administration sector with a variation of 12.7%.

In agriculture, the credit system is dictated both by the need for modernization, by the expansion of the agricultural areas owned or leased by the economic entities in this field, but also by the access to European funds that come to support investments in agriculture.

CONCLUSIONS

The Covid-19 pandemic has determined changes at the level of the entire economy, including changes in the banking system whose major role is to finance the business environment, but also to support the population in making investments.

What can be seen from the case study is that, especially in the case of natural persons, the behavior regarding the reality with the banking institutions has changed, both with regard to saving, but also with regard to lending. Regarding the degree of saving, it decreased in favor of investment operations in financial instruments, and regarding the degree of crediting, a preference for mortgage loans is noted in favor of consumer loans.

The companies in their turn became more responsible, they started to think much better about their investment strategy or making investments.

After the year 2020 was characterized by a decrease in economic activities, the year 2021 recorded a return to the level of all economies, including in Romania, economies that had to be supported by the banking system.

Unlike other EU countries or the world, Romania has benefited from a favorable situation regarding the banking system, which, although it also presents certain vulnerabilities (the deterioration of the national currency, the increase in inflation, financial instability, more recently the outbreak of the war in Ukraine) manages to ensure sufficient liquidity to support the economic environment.

At the same time, the pandemic meant a modernization of the banking system, a much faster transition to digitalization, both on the part of banking institutions and among companies or individuals.

Through the actions carried out, the banks managed to fulfil their role in this period, that of supporting the economy.

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THE IMPORTANCE OF URBAN AND PERI-URBAN AGRICULTURE IN SUSTAINABLE DEVELOPMENT AND INCREASING FOOD SECURITY

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Abstract

The concepts of urban and peri-urban agriculture, although they are not new, are current as a result of the fact that one of the problems that arose during the Covid-19 crisis was that of food security as a result of the need to ensure food resources from nearby sources , in the conditions in which transport and other sectors of activity have reduced or suspended their activity. In this paper, we propose that, starting from the study of the specialized literature regarding urban and peri-urban agriculture, to identify their development possibilities, to identify the forms of practice of urban and peri-urban agriculture, to present the strengths and weaknesses weak related to their development and to propose solutions for their integration in the development of cities on a sustainable basis. The research methodology assumed the study of specialized literature, the consultation of internal and international databases, the processing and analysis of data with the aim of formulating conclusions that can be the basis of future studies, but also formulating conclusions that can be integrated into future policies regarding the development of urban and peri-urban agriculture, taking into account the fact that at the moment there is still no exact formulation regarding their support.

Key words**:** *peri-urban agriculture, food security, resilience*

INTRODUCTION

Crises, regardless of their nature (economic, sanitary, social) bring into discussion concepts that already exist, but which have not always been given enough attention, and which can be constituted as solutions at hand to get out of such situations. The Covid-19 crisis was accompanied by a lot of unknown problems, which required immediate and efficient solutions. One of these problems was that of food security, which appeared against the background of the interruption of transport, of food chains, of the reduction or suspension of activity in numerous sectors of activity. Such events come to demonstrate the fragility of the existing systems and the limits of globalization, this time it is about the supply systems [15, 19]. Ensuring the food needs thus brought into discussion the concept of urban and peri-urban agriculture and the need for their development.

Urban and peri-urban agriculture are not new concepts, but their application raises problems related to the way of implementation and ensuring a sustainable supply [13].

Initially, urban and peri-urban agriculture represented a way of ensuring the necessary resources for the poor population in urban areas [2]. Later they represented ways of expressing the hobby or ecological education [5, 11]. However, at some point they became the subject of public policies and concerns related to food security, food resilience and social cohesion [1, 17, 20, 24] in the conditions where, even without crisis situations, considering the fact that the world's population is growing, and food resources being limited will represent an ever greater problem [21].

According to Statista data from 2019, the world population is expected to exceed 9.74 billion in 2050 (Fig. 1), which will put great pressure on the ability to provide the necessary living resources, while creating a

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strong pressure on the environment. So concerns about resource depletion are well-founded.

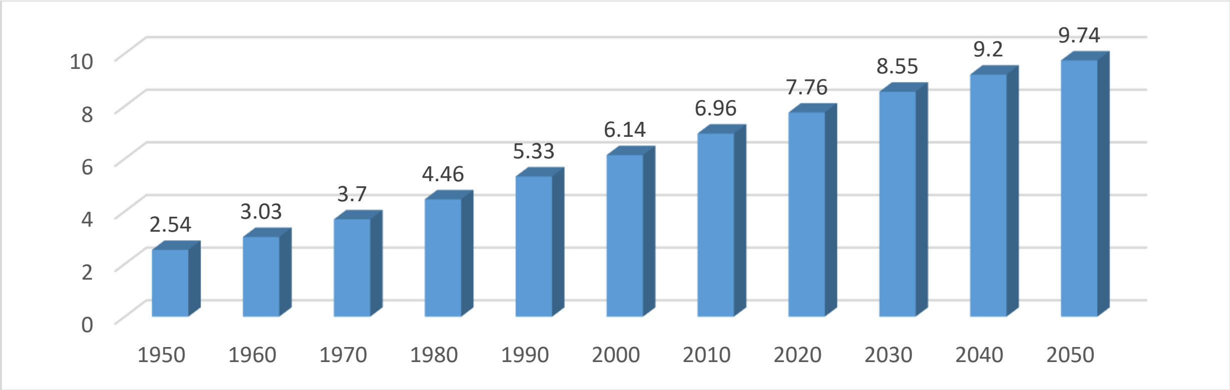

Fig. 1. Evolution of the world population in the period 1950-2050 (billions inhabitants)
Source: own processing [27].

In support of the mentioned comes the statistical data that show that at the current date (6.08.2022) the world's population is 7.96 billion inhabitants. The largest share is held by the 0-14 age group (25%), followed by the 15-29 age group (23%) and the 30-44 age group (22%). The 45-59 age group represents 17% of the world's population, the 60-74 age group represents 11%, and people over 75 years old represent 2%. There is therefore an increase in the world's population that will face a high pressure regarding the provision of food resources, even in the conditions where the rate of population growth has slowed down between 1950 and 2050 (Fig. 2). The maximum value of the growth rate was recorded in 1970, when the increase compared to 1960 was over 22%. This rate continued to grow, estimating that in 2020 it will be 5.86%. The Covid-19 pandemic contributed to a reduction in the growth rate. In 2022, compared to 2019, the growth rate was 3.8%.

Therefore, it is understandable the concern that preoccupies not only the political circles, the world organizations, but also the concerns at the individual level regarding the way the future will look. At the same time, it is justified to try to find viable solutions for a sustainable development, given that the challenges appear every day and are getting bigger and bigger.

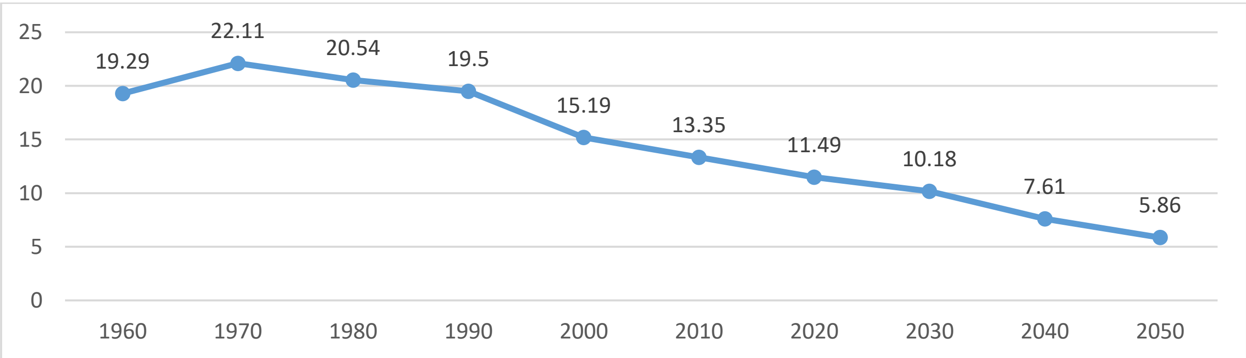

Fig. 2. The pace of world population growth in the period 1950-2050
Source: own processing [27].

The war in Ukraine is such a challenge and we find that it brings with it the same problems related to the provision of food resources. The interruption of exports due to the impossibility of maritime transport represents a serious food security problem, given that this country is the second grain exporter in the world and ranks 5th among grain producers.

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That's why urban and peri-urban agriculture can represent not only temporary, but also long-term solutions.

Peri-urban agriculture is still a sector that is not sufficiently integrated in agricultural policies, being rather an informal sector. It is defined as a form of agriculture carried out in the city or in its neighboring areas and which involves growing plants, raising animals, fishing and forestry, both with the aim of producing food for own or commercial purposes, but also for recreational, social or educational services .

Peri-urban agriculture has also been called metropolitan agriculture [12] or marginal urban agriculture [4], but regardless of the name or definition, these forms of agricultural practice have potential for development.

At the level of the European Union there are initiatives for their development. Thus, the Communal Agricultural Policy from the period 2007-2013 supported through the LEADER axis the development of local communities through public-private partnerships, and for the period 2014-2020 the financial aid measures were addressed to all eligible farmers, including those from peri-urban areas or urban. These measures are continued for the period 2021-2027.

MATERIALS AND METHODS

The research method involved the review of specialized literature regarding the concept of urban and peri-urban agriculture, being analyzed works published in the period 1997-2022 in the databases Web of Science, Scopus, WorldCat, Google Scholar. The search was carried out starting from keywords that were found in the title of the work, in the summary or within the work, namely: urban agriculture, peri-urban, food security, food resilience, urbanization. Starting from the resulting information, we were able to identify the practice typologies of urban and peri-urban agriculture and we were able to formulate conclusions regarding the possibility of developing these forms of agriculture, as well as their advantages and disadvantages.

RESULTS AND DISCUSSIONS

After reviewing the specialized literature, we identified several forms of urban and peri-urban agriculture, the difficulty of delimiting these two forms resulting from the very definition of the terms urban and peri-urban.

Thus, among the most common forms of practicing urban and peri-urban agriculture are:

Community gardens that produce food or ornamental products for their own consumption or for the purpose of marketing, being organized individually or in groups where members can use resources in common [23, 25]. Also, the financing of activities can take different forms, but the form of ownership can also differ [10].

The private gardens that are located either in the courtyards of the houses, or on the balcony or in other annexed spaces and aim to obtain food or ornamental products intended for own consumption [14, 16].

Farms and rooftop gardens can be individual or collective, they are found in urban areas, not appearing in statistics as forms of organization of agricultural activities [26].

Allotments are individual or family properties, found in Europe and which can have legal personality, they operate according to management principles [3].

Urban or peri-urban farms are located in the immediate vicinity of cities, have the form of legal organization and carry out production activities, but also social, educational, etc. [7].

Peri-urban agricultural holdings are those that carry out agricultural activities as a main or secondary object of activity, which are legally organized, which have an economic function and which have the same right as other agricultural holdings to receive subsidies.

There are other categories of practicing urban and peri-urban agriculture, which are not only for economic purposes, but through which agricultural activities are carried out, namely:

The social farms that, in addition to the economic activities carried out, also have an important social role, addressing target groups that are part of certain categories of people (either disadvantaged or people with integration problems), also following the integration of some social services.

Intercultural gardens that address disadvantaged people, migrants, refugees and operate on the principle of tolerance and mutual respect, having the role of bringing together people from different cultural backgrounds. They have the role of providing them with a means of living (by cultivating individual and collective plots of land), confidence in their own strength, communication and cultural diversity [22].

The educational gardens appeared with the aim of teaching the participants, both children and adults, about the way to grow plants, about healthy eating, protecting the environment.

Therapeutic gardens have the role of helping people suffering from various diseases (mental, cancer, etc.) or people with disabilities to socialize, to relax, to eliminate stress, also being able to use animals as a therapy process [9].

Ecological care farms are found in the Netherlands and are a variant of old people's homes, which appeared as a result of the positive effect on the elderly due to social interaction, their involvement in physical activities, etc. In the same way, they can also address disadvantaged people [6].

Whatever the form of organization under which urban or peri-urban agricultural activities are carried out, regardless of their economic or social advantages, their development involves disputing the land surfaces between the surfaces intended for residential spaces and the practice of agriculture, which is why the subject creates disputes regarding finding the right solutions for the implementation of this form of agricultural practice, which, in addition to its supporters, also has its critics. The problems are complex and are also related to urbanization, the definition of the notion of peri-urban and the sensitive boundaries between urban and peri-urban.

The attempt to identify the advantages brought by the practice of urban and peri-urban agriculture is also accompanied by the barriers that appear in their development.

Because habitable areas developed into fertile agricultural areas that allowed the expansion and development of cities or residential areas, it is considered that agricultural land was sacrificed in favor of urban development. On the other hand, the practice of agriculture leads to an increase in pollution in already intensely polluted areas.

By practicing these forms of agriculture, food chains would be shorter, food would be cheaper, different composts resulting from urban waste could be used, but urban and peri-urban agriculture also have their environmental costs.

On the one hand, greenhouse gas emissions due to transport could be reduced, as well as fuel consumption, which are objectives to be achieved through environmental policy.

Another important aspect is related to biodiversity, because they contribute to the maintenance of some species belonging to the flora and fauna, so they have an ecological role. Due to the fact that they use less aggressive technologies, they can also reduce soil degradation. And they can also use innovative, much more efficient technologies leading to an increase in the degree of innovation.

Urban and peri-urban agriculture can contribute to the implementation of circular economy principles.

They can also contribute to mitigating climate change by reducing urban temperatures, filtering dust, air, etc.

Urban and peri-urban farms can attract less qualified labor, thus ensuring integration on the labor market. They can also attract qualified labor through the social, medical and leisure activities they offer.

As far as the positive effects on human health are concerned, they can also be quantified by the fact that they allow the development of physical activities, but at the same time recreational ones.

A feeling of solidarity between producers and consumers can develop, but it can also increase a feeling of responsibility towards the environment and appreciation of the activity carried out by those who carry out their activity in urban and peri-urban agriculture. Another advantage is represented by the fact that new business models can be developed that are based on diversification and specialization, as important elements of food resilience. But as I mentioned, in addition to the advantages of practicing these forms of agriculture, there are also disadvantages, barriers to their development.

Among the weak points of agricultural practices in urban and peri-urban areas we can list: the fact that agricultural activity is less profitable compared to the use of the respective lands for residential purposes; the agricultural activity can be less profitable also as a result of the size of the farms or agricultural holdings where the activity is carried out, but also due to the lack of training or the applied technology; the practice of agriculture can lead to pollution with chemical fertilizers that would occur near urban areas; the reduced areas do not allow the use of agricultural machinery, which leads to a higher volume of work and a lower efficiency with a direct impact on the profitability and financing of the activity.

However, the subject is one that must be addressed, and the success of such initiatives certainly depends on the local, national or community policies through which these activities can be supported, because the role that urban agriculture and peri-urban can have it on economic development and economic cohesion, without forgetting the need to ensure food security.

CONCLUSIONS

There are many aspects that must be taken into account in terms of the implementation of urban and peri-urban agriculture. The future has its challenges, and one of them is ensuring the food resources necessary for a growing population that will be increasingly difficult to provide [18]. Under these conditions, urban and peri-urban agriculture will represent solutions that are already found in the existing agricultural and food policies both at the level of the European Union and in other countries of the world. Although agricultural land conservation policies have reduced the cultivated areas in peri-urban areas, peri-urban agricultural production is still found in programming documents encouraging the obtaining of local products to support producers disadvantaged by the effects of globalization.

Another important aspect is related to the identification of vulnerability indicators that cover the technical, social, ecological aspects of urban areas and the way in which they interact with the elements of globalization and that could lead to the quantification of the advantages and disadvantages of urban and peri-urban agriculture [8].

In conclusion, we consider that in the conditions in which the paradigms related to production growth and economic development have often been called into question, concepts such as urban and peri-urban agriculture can be considered solutions within reach that can contribute to the sustainable development of society, to protect the environment and to ensure food security.

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STUDY ON THE IMPACT OF COVID-19 ON EXPERIENTIAL TOURISM AND TRANSFORMATIVE TOURISM

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Abstract

Over time, the way people have practiced tourism has evolved, the reasons being both income growth, increased mobility due to globalization, but also a change in thinking or changing priorities in terms of living. In this way it has gone from the simple leisure in tourist destinations, to more complex concepts such as ecological tourism, slow tourism, experiential tourism, and now to the concept of transformative tourism, which during the Covid-19 pandemic it seemed to be even more current than before, considering the fact that this moment was considered to be one of resetting, of rethinking the way in which humanity will continue its activity and life. Therefore, in this paper the purpose was to analyze the way in which experiential and transformative tourism have evolved worldwide, but also the ways in which these forms of tourism can be developed for the benefit of tourists and destination countries. The research methodology involved the bibliographic study of the literature, the collection of information from domestic and international databases, their processing using statistical indicators, their interpretation and the formulation of conclusions on the development prospects of these forms of tourism. The data analyzed in the work show that tourism in general recorded losses during 2020 and 2021, and that, in turn, transformational tourism recorded losses. The advantages of transformational tourism are real, they bring numerous personal benefits, but also related to environmental protection, contributions to the sustainable development of less developed areas. The conclusions we reached demonstrate the fact that there are different forms of transformational tourism, both in the world and in Romania, but they are not sufficiently regulated. Their development could contribute both to the sustainable development of tourist areas, but also to the promotion of a tourism that is much closer to the aspirations of the new generations.

Key words**:** *transformative tourism, experiential tourism, sustainability*

INTRODUCTION

As people managed to meet their basic needs, they wanted more and had the resources to meet more and more complex needs, reaching their cognitive needs: knowledge, exploitation, understanding, self-realization or self-transcendence. These needs contribute to personal development, one of the aspects to which the present generations attach great importance.

Therefore, the development of modern society has contributed not only to the development of tourism, but also to the development of practices that contribute not only to protecting the environment and reducing resource consumption, but also to reconnecting with origins, ensuring physical health and mental development of the people, which together means the development of the hospitality industry. Over time, there has been talk of concepts such as eco-tourism, sustainable tourism, slow tourism, experiential tourism, as modern forms of tourism, and at present the term transformational tourism is current [8].

If experiential tourism, which is not a new form of tourism, but rather a rediscovered one, is defined by 4 factors, namely: short duration of stay; satisfaction with the tourist experience; the interaction between the tourist and the locals or natives; environmental protection [2, 5, 14], being a form of tourism that is based on cultural, gastronomic, social values, transformational tourism also explores the emotional side, relying more on emotion than on experiences, more on living the moment, than on sharing that experience with others through social media, which requires transforming the way the hospitality industry responds to these new challenges.

Technology also contributes to this. The fact that at the moment tourists are better informed, they are much more adaptable and always looking for authentic things is one of the advantages of the development of technology, of the way of communication, of globalization. And most of the time, authenticity is related to tradition, emotion, spending time offline and creating unique experiences that lead to meeting those cognitive needs.

Therefore, transformative tourism based on experience and innovation, can contribute to the development of the existing tourist offer at regional level, attracting tourists concerned about culture and environment, but also tourists who through experiences will be able to benefit from a development process, regardless of age who have it or their social status [12].

Therefore, the difference between experiential tourism and transformative tourism lies in the fact that tourists want more than an unforgettable experience, they pursue more intensely the inner transformation, knowledge of another culture, but borrowing that culture, deepening it, so as to there is a post-travel effect with favorable implications for the community they come from. That is why transformative tourism is considered to be that form of tourism that produces lasting changes, significant changes in the lives of those who practice it [3].

The 3 elements that underlie transformative tourism are considered to be by Luke Bailes: authenticity - understood as a way to protect the environment and the local community; the connection - with nature, with the local culture and personalization - because each one of us is unique, which makes the travel preferences different.

Moreover, authenticity is linked to tradition, emotion, spending time offline and creating unique experiences that lead to the satisfaction of cognitive needs.

Therefore, this form of tourism opens new perspectives, while challenging the field of hospitality to find ways to organize leisure, much more creative, allowing tourists to discover both their passions and their destination suitable tourist. In addition, it must provide them with additional information on how they can visit their respective destinations and how they will influence the environment, which makes this form of tourism a much more responsible tourism.

Transforming tourism can aim to learn about traditional cuisine, folk customs, food festivals, volunteer experiences, yoga retreats or other forms of wellness tourism. To these can be added "stayable experiences", "animal experiences" or space tourism.

The practice of transformative tourism does not exclude the cities from the organization of such routes or the technology, which used properly, can simplify the development of the stay and the observance of the criteria for defining it.

MATERIALS AND METHODS

The analysis of the forms of transformative and experiential tourism was made on the basis of some indicators that characterize the tourist activity, namely:

(i) total number of trips worldwide;

(ii) recorded revenues and expenditures, on different forms of tourism;

(iii) the share of tourism, by regions of the world;

(iv) the share of tourist volunteering, by categories of activities;

(v) the total number of tourists, for Romania;

(vi) the total number of overnight stays, for Romania

Data on the global situation were collected from reports published by the Global Wellness Institute, as well as from other international databases, and those on Romania were taken from statistics published by the National Institute of Statistics.

The study took into account the period 2017-2020.

Fixed base indicators as well as structure indicators were used for data processing and interpretation. Their calculation was made according to the following formulas:

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- Fixed base index [4]:
$I\% = (X_t/X_0) \times 100$ ....(1)
where:
- X_t - the level of the indicator X in the year t,
- X_0 - the level of the indicator X in the basis year."
- The structural index (SI%)[4]:
$SI\ (\%) = \frac{f}{\Sigma f}$ ....(2)
"where:
f- the size of the analyzed phenomenon,
Σf – the volume of the analyzed item.

RESULTS AND DISCUSSIONS

Starting from the existing data in the domestic and international databases, we proposed that in this paper we analyze how different forms of transformative or experiential tourism (wellness tourism, spa tourism, thermal tourism, volunteer tourism) are carried out during the Covid-19 pandemic. Wellness tourism is defined as any form of travel associated with the activity of maintaining or improving personal well-being [7, 15]. Although compared to other forms of tourism, wellness tourism was less affected than other forms of tourism, the general data show that if in 2017 its value amounts to 617 US $ trillion, in 2019 the increase was 17% (720 US $ trillion). The Covid-19 pandemic, the closure of borders and the suspension or limitation of travel brought the value of wellness tourism to just US $ 438 trillion in 2020, a 39% reduction from the previous year.

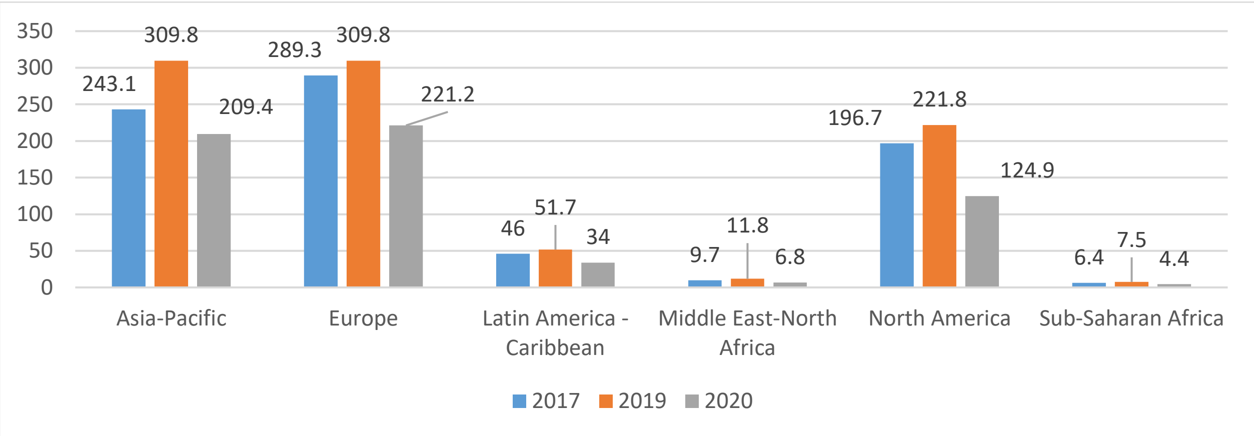

Fig. 1. Number of trips in wellness tourism, by geographical region in the world
Source: Own processing [6].

Data released by the GWI show that in Sub-Sharan Africa, Middle East-North Africa and Latin America - Caribbean are regions where wellness tourism is not as well represented as other regions of the world. Moreover, this form of tourism is based on international tourists, compared to other regions where domestic tourism also contributes to its practice.
Globally, in 2020 there will be a decrease in the number of wellness trips of 36%. The smallest decreases were recorded in Asia-Pacific (32%), and the largest decrease in North America (44%). However, Europe and Latin America also had decreases of 32%, due to the fact that wellness tourists are mainly domestic tourists. Another characteristic of this category of tourists is that they spend larger amounts of money compared to the amounts spent on other forms of tourism.
Global wellness tourism spending fell by 60% in 2020 compared to 2019. However, the largest declines were in Latin America-Caribbean, Middle East-North Africa and Sub-Saharan Africa where spending fell almost in half. The smallest decrease was in Europe, this being 35%, this being due both to the travel restrictions that appeared later, to the relaxation of these restrictions during the holidays, but also to the change of travel destinations from Asia-Pacific areas for example, to areas closer to the country of origin.

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Table 1. The situation of wellness tourism expenditures, in the period 2017-2020, by regions (US$ billions)

	2017	2019	2020
Asia-Pacific	119	145	80
Europe	217	248	160
Latin America - Caribbean	28	32	16
Middle East-North Africa	10	12	6
North America	239	277	170
Sub-Saharan Africa	5	6	3
WORLD	**618**	**720**	**435**

Source: Own processing [6].

Another form of tourism is spa tourism. According to the GWI definition, spa tourism is that form of tourism that provides therapeutic and professional services in order to create well-being, not only by ensuring the health of the body, but also by renewing the spirit and mind [6].

At the level of 2019, there were over 165 thousand tourist units in the world that offered spa services and that obtained revenues of approximately 111 billion US $, increasing by 18% compared to 2017. In 2020, however, they decreased by almost 40%.

Data for the period 2017-2020, by region, show that again the largest decreases in income in 2020 were recorded in the Middle East - North Africa and Sub-Saharan Africa regions, which were reduced by half compared to 2019 In North America, Asia-Pacific and Europe, spa tourism revenues fell by about 38%, and in North America they fell by 35%.

Table 2. The situation of spa tourism revenues, in the period 2017-2020, by regions (US$ billions)

	2017	2019	2020
Asia-Pacific	26.4	31.3	19
Europe	33.2	39.8	25.1
Latin America - Caribbean	6.5	7.4	4.1
Middle East-North Africa	2.7	3.8	2.0
North America	22.8	26.1	16.4
Sub-Saharan Africa	1.5	2.1	1.1
WORLD	93.1	110.5	67.7

Source: Own processing [6].

In turn, thermal or spa tourism is that form of tourism that creates well-being or recreation by offering services that consist of treatments that use thermal waters or mineral waters.

Statistical data show that in 2019 there were over 34 thousand such tourist units in the world, the largest share of which (76%) being in the Asia-Pacific region.

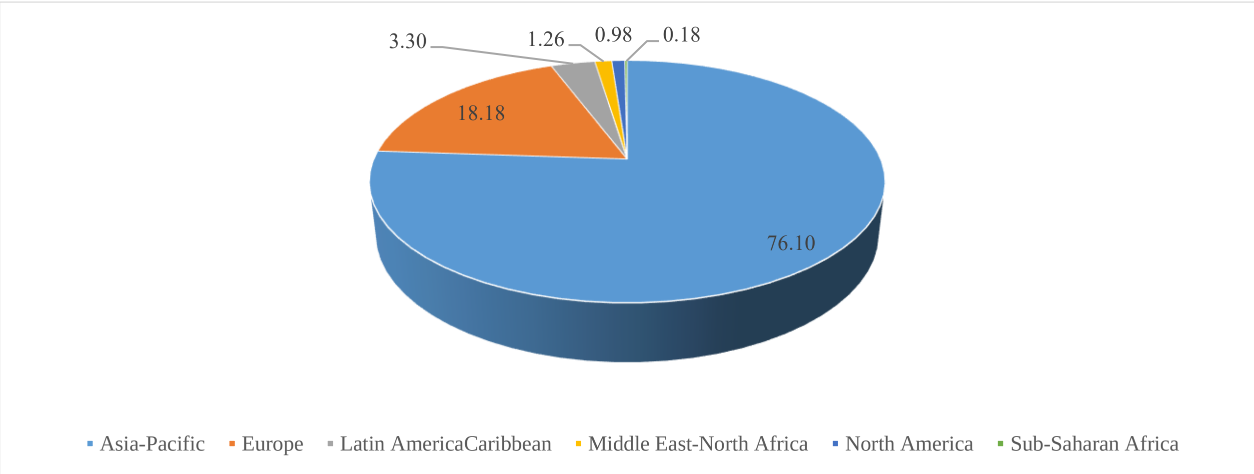

Fig. 2. The share of thermal tourist units, by regions, in 2019
Source: Own processing [1].

Europe also owns more than 18% of its total, while North America is close to 1%. The sub-Saharan region of Africa is the least developed in terms of thermal tourism, given the climatic and hydrographic characteristics of the area. The revenues registered worldwide from thermal tourism highlight the same trend as in the case of wellness and spa tourism, that is, a decrease in the period 2017-2020 (Table 3). However, the largest decrease in 2020 compared to 2019 was in the Middle East - North Africa region (60%) and also in the Sub-Saharan Africa (55%) and Latin America - Caribbean (50%) regions.

The Asia-Pacific and Europe regions, as regions that are best represented from the point of view of this form of tourism, the decrease of incomes being of 38%, respectively 39%, which, although significant, ranks it among the least affected region providing thermal tourism services.

Table 3. The situation of thermal tourism revenues, in the period 2017-2020, by regions (US$ billions)

	2017	2019	2020
Asia-Pacific	31.6	36.7	22.7
Europe	21.7	24.1	14.6
Latin America - Caribbean	1.5	1.6	0.8
Middle East-North Africa	0.5	0.5	0.2
North America	0.7	0.9	0.7
Sub-Saharan Africa	0.08	0.09	0.04
WORLD	**56.08**	**63.89**	**39.04**

Source*:* Own processing [6].

Another form of transformational tourism is volunteer tourism, a niche tourism, which offers its practitioners the opportunity not only to travel to different parts of the world, but at the same time to live new experiences, away from established tourist destinations and which it allows them to put their altruism into practice in relation to individualistic or consumerist practices [13]. Volunteer tourism is considered to be the best way to experience what is called cultural immersion.

Volunteer tourism has been criticized by the media for the fact that in many cases other interests were hidden behind volunteering or for the fact that the principles of volunteering were often violated, which slowed down the pace of development of this form of tourism.

Among the advantages of volunteer tourism are: increasing social inclusion, increasing the income of the native population and increasing the standard of living, etc. [1].

The practice of this form of tourism presupposes the existence of three actors, namely: tourists, voluntary organizations and local communities.

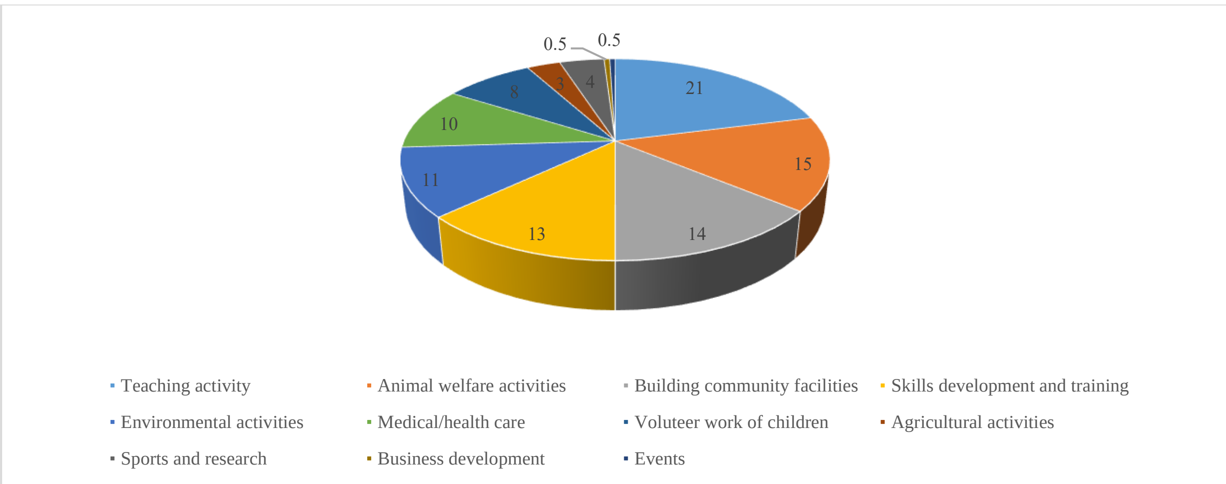

Fig. 3. The structure of volunteering
Source: Own processing [1].

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The APEC report published in 2018 shows that the structure of activities in which volunteers are involved in areas where they provide support is diverse, starting with teaching activities (21%) or skills development and training (15%), but also environmental activities (11%).), medical care (10%), sports and research (4%) or business development (0.5%). Volunteering can be combined with tourist activities: safaris, adventure activities (bungee jumping, diving, climbing, surfing, boating, rafting etc.).

Worldwide, however, statistics show that in 2017, volunteering was worth US $ 173 trillion. This form of tourism is developed primarily in the less developed regions of the world, which places it in Sub-Saharan Africa or North Africa. But there are also other countries in the world where volunteering takes the form of tourism.

The Covid-19 pandemic also affected volunteer tourism, which on the one hand faced reduced mobility, and on the other hand the accelerated support provided by international organizations to countries with vulnerable health systems and which needed additional support during this period.

Romania also registered a decrease in the revenues obtained from these forms of transformative tourism.

In Romania, there are, in 2020, a number of 620 tourist units that offer thermal or spa services and that total a number of 36,554 accommodation places.

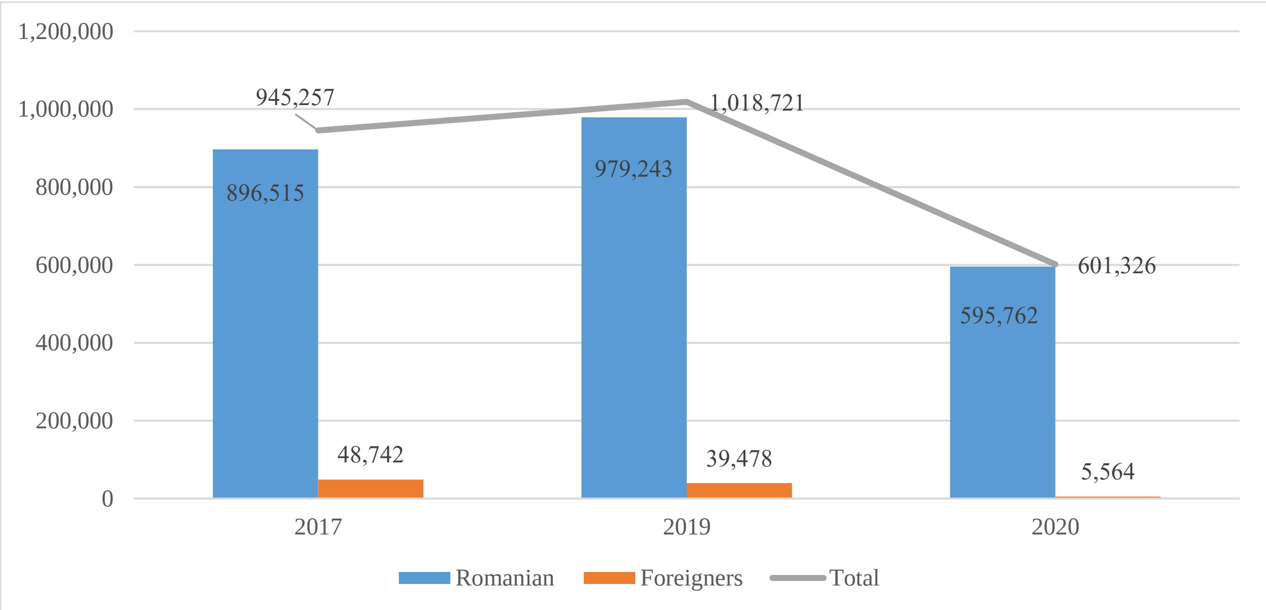

Fig. 4. The evolution of the number of tourists, during 2017-2020, in Romania
Source: Own processing [3, 9, 10, 11].

Although in 2019 compared to 2017 Romanian tourists became more concerned about their physical and mental well-being, so that their number increased by 9%, in 2020 the decrease was in line with the world trend, so that the total number of tourists who used services thermal or spa decreased by 41%. Even if at the domestic level the decrease was 39%, the 2 percent were due to the fact that the number of foreign tourists coming for such treatments decreased from over 39 thousand in 2019 to just over 5 thousand in 2020, which in percent represents about 80%.

In terms of the number of overnight stays, they had reached almost 4.5 million in 2019, which means an average per stay of 4.3 nights. In 2020, however, the number of overnight stays has decreased much more than the number of tourists, the decrease being 50% for total tourists and 85% for foreign tourists. For Romanian tourists, the number of overnight stays decreased by 49%, which means that the average stay was 3.7 days.

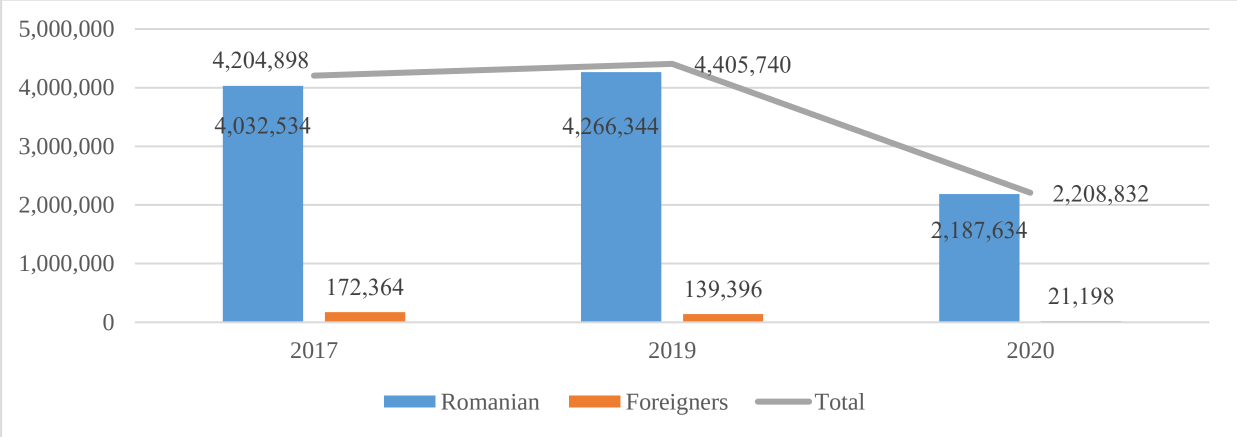

Fig. 5. The evolution of the number of overnight stays, in the period 2017-2020, in Romania
Source: Own processing [3, 9, 10, 11].

Regarding the other forms of tourism considered as transformative and experiential, there are not enough data in the databases to allow us to perform an analysis, but correlating the data reported at national level and those existing worldwide we can appreciate that they are part of the same trend.

On the other hand, as we showed earlier, transformative tourism takes different forms, and one of them is "open-mind" tourism, a tourism in which people live in cohesion forming a tolerant, diverse, welcoming society that combines religions, cultures and traditions.

In one of the rankings made at European level, the city of Sibiu is among these "open-mind" places, being on the 8th place in a ranking of 15 destinations. Sibiu is considered a cosmopolitan city, with a sustainable tourism, with a high quality of life, with a rich cultural heritage, with modern infrastructure and countless tourist facilities. Along with Sibiu and other cities in Romania, they can fall into this category: Cluj, Oradea, Timisoara, Sighisoara, which will create new opportunities to attract foreign tourists, but also Romanian tourists.

CONCLUSIONS

Transformational and experiential tourism is not only a way to travel, but also personal development, interaction with different cultural environments, learning a new language, developing communication skills, thinking, access to new and creative ideas.

As in any other field of activity, tourism also registered losses between 2020 and 2021. The decrease in the number of tourists and incomes was much higher in 2020, the year in which the restrictions related to mobility were much higher than in 2021. De also, in the transformational and experiential tourism there were decreases, as well as in the other forms of tourism. Although the decreases existed in all regions of the world, they were more or less affected areas, the reason being both the level of development of various forms of tourist services in those areas, but the degree of mobility required by national regulations.

The Covid-19 pandemic has had the effect of recognizing that we need physical and mental well-being to meet the new challenges we face in the modern world. Holidays are not only a period of pause, but also of transformation, of our care, of reflection on holistic concepts regarding our own life, social activity, environment, creativity, nutrition, etc. and which aim to reduce the stress we face on a daily basis.

After the period of isolation, of reduced mobility, people felt the need to resume their pre-pandemic travels, but were much more concerned about their health and transformation.

Therefore, we consider that the transformative and experiential tourism will recover in the immediate period what they lost in the years 2020 and 2021, there being possibilities for their continuous development.

The hospitality industry, based on surveying the preferences of its customers, will be able to create customized tourist packages that meet the deeper requirements of its customers, which will change both the way of practicing tourism and the way of response of operators in this field.

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CHANGES IN THE BEHAVIOR OF VEGETABLE CONSUMERS IN BUCHAREST AND THE NEIGHBORING AREAS CAUSED BY THE COVID-19 CRISIS

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Abstract

Romania ranks third in the hierarchy of vegetable growing countries in Europe. This study focuses on the determinants of the decision to buy fresh and canned vegetables and on the satisfaction of buyers on these purchases. The quantitative survey was used as a method of collecting information, and the investigation technique was used as an investigation technique, structured in the form of an opinion poll. The opinion poll applied is a questionnaire-based survey that provided information on the situation of vegetable consumers and the change in consumption behavior caused by the COVID -19 health crisis. Most respondents prefer buying directly from the market, buying between 1-3 kg per purchase. If in previous years taste and provenance were the basic criteria in the purchase of vegetables, the economic crisis caused by the health crisis COVID-19, brought the price in the first place, due to the decrease of buyers' incomes or other financial problems. The need for consumption/family, however, did not suffer, the quantities purchased being comparable to those of previous years, buyers turning to vegetables with a low degree of perishability. The study provides results on consumers' criteria for selecting vegetables and their hierarchical changes during the COVID-19 health crisis.

Key words: *consumer behavior, vegetables, Covid -19, Romania*

INTRODUCTION

As is well known, the horticultural sector is of strategic importance to agriculture and consumers, generating direct and indirect employment in many regions of the European continent. Romania ranks third in the hierarchy of vegetable growing countries in Europe, producing 3.2% of the total amount of vegetables produced in the European Union, on an area that represents 9% of the total vegetable areas in the EU [6, 7, 8].

Panic buying is “the action of buying large quantities of a particular product or commodity due to sudden fears of a forthcoming shortage or price increase”. For instance, when consumers start panic buying dry pasta, eventually, the whole supply chain with raw and auxiliary materials, involving eggs, flour, wheat, is affected [9].

The impacts of COVID-19 pandemic on food systems can be divided between direct impacts of the virus outbreak, and indirect impacts derived from containment measures (e.g. lockdown, mobility restrictions, shops closure) adopted at different levels, from local to global.

While all food systems across the globe have been affected by the pandemic, it is argued that vulnerability is different for different types of food systems. Long food supply chains have been particularly affected by COVID-19 crisis; however, it is important to avoid universalization of impacts and responses as agri-food systems are characterized by a huge diversity and heterogeneity [13].

The significant increase in the average energy density of solid foods consumed by participants was not reflected in changes in fruit and vegetable intake, expected to decrease, or snack food intake, expected to increase [12].

The pandemic led to various transformations in the food retail industry, including changes in consumers perception and behavior. Although the pandemic has a situational nature, such transformations could have both temporary and long-lasting effects on reforms of the grocery retail industry [17].

The aim of the study is to emphasize the determinants of the decision to buy fresh and canned vegetables, the degree of satisfaction of buyers in Bucharest and surrounding areas, highlighting their behavioral changes caused by the Covid-19 health crisis.

MATERIALS AND METHODS

The fact that food consumption is vital for human well-being makes this an important area to investigate in terms of the impact of COVID-19. This research was carried out to investigate the changes in consumers' food consumption behaviour and habits during the COVID-19 pandemic and determine the factors that explain these changes [4].

The first research method used in this study is ”the bibliographic analysis”. Its purpose is to extract official data that exists in the research sphere of the study. The data collection has been made by accessing the data base of The National Institute of Statistics, of Eurostat and WHO, of the Ministry of Agriculture and Rural Development, news published on the MARD site, Romanian Government publications. The second method used is the quantitative survey in order to collect information, structured as an opinion survey. The opinion survey is based on an enquiry that provided information about the situation of vegetable consumers and the change of the consumption behavior caused by the COVID-19 health crisis. As a method of gathering information we used the quantitative inquiry and as an investigation technique, the enquiry. A total of 932 responses were collected, out of which 46 were eliminated due to incomplete forms. As a sampling method we have used the quota sampling method that consist of respecting the sample representativity principle compared to the entire researched collectivity. The representativity is followed through independent criteria: gender, age and income. The justification of using the quota method resides in the hypothesis according to which if the sample is a fair sample then the researched population from the point of view of the criteria taken under consideration within the sampling, it will be representative also regarding other features like habitudes, behaviors and attitudes, etc. Thus, the research results can be extrapolated on the entire researched population. The entire population is Bucharest and its bordering areas population, that being the main outlet for canned vegetables from manufacturers in the region. At a total population of 2,155,240 people, with a level of trust of 95%, the size of the calculated sample has been of 858 people.

The study of the consumer preference for vegetables and canned vegetables is very important, aiming at increasing the efficiency of capitalization by increasing consumption, decreasing losses in the pathway, supplying the market without syncope [15, 16]. The necessary information for this study is grouped under:

– information regarding the surveyed people: number, gender, age, income level;

– information regarding the consumption behavior: „who is eating?”, „where does the eating take place?”, „when do they eat?”, „what do they eat?”, „how much do they eat?”;

– information regarding the people’s mentality (needs, motivations, desires, expectations).

In order to set the research objectives, assumptions have been made based on the results of previous researches as well as on a documentary study conducted previously, based on the analysis of the demand on longitudinal section.

The aims and assumptions of our research are:

- to identify the number of vegetables and canned vegetables consumers;
- to identify the average consumption rate of vegetables and canned vegetables;
- to identify the average consumption of vegetables and canned vegetables;
- to identify the place of purchase of vegetables and canned vegetables;
- to identify the consumer preference regarding the origin of vegetables and canned vegetables;

- to identify the source of provenance of vegetables and canned vegetables;
- to identify the average budget allocated for purchasing vegetables and canned vegetables;
- to rank the criteria of selection of vegetables and canned vegetables: taste, provenance and price.

The survey has 16 closed questions. After is has been developed the survey had been tested on 24 people, in order to collect feed-back regarding question comprehension and thus improve the research quality. The questions relate to information regarding the socio-demographic traits of the respondents, the so-called population identification questions from the sample, questions regarding the pattern of purchase, needs and preferences of consumers regarding the purchase of vegetables and canned vegetables, their choosing criteria, the assigned budget for these products, etc.

The variables used to study the vegetables and canned vegetables market are:

– variables dependent on: consumers preference for fresh vegetables and canned vegetables,
– independent variables: gender, age, income.

The survey was conducted using the google forms platform. The questionnaire was sent by e-mail or on whatsapp to younger people. People over the age of 65 answered the phone. The survey was conducted between July and August 2021. The duration of the survey, ie the time required for participants to complete the survey, was approximately 10 minutes, and the average length of the telephone interview ranged from 15 to 25 minutes.

The survey has been completed by 858 respondents sampled according to certain criteria, as shown in Table 1.

Table 1. Sample structure by gender

Variable	Sample	
	Frequency	Percent (%)
Men	206	24
Women	652	76
TOTAL	858	100

Source: Questionnaire data.

All the subjects of the survey are of Romanian nationality. Of all the respondent people more than a half are women, respectively 76%, the difference of 24% being men (Table 1).

Table 2. Sample structure by age groups

Variable	Sample	
	Frequency	Percent (%)
18 – 35 years	172	20
36 - 49 years	343	40
50 – 65 years	206	24
Over 65 years	137	16
TOTAL	858	100

Source: Questionnaire data.

Sorted by age groups the largest ratios belong to the people between 36-65 years, as they have together 64% of total respondent people which is natural given the fact that this age segment coincides with their active period (Table 2).

The sample has all the categories of professional status from student to retired. 76% of respondents are active people (employees) (Table 3).

Table 3. Sample structure according to professional status

Variable	Sample	
	Frequency	Percent (%)
Student	33	4
Entrepreneur	0	0
Employee	652	76
Unemployed	33	4
Retired	140	16
TOTAL	858	100

Source: Questionnaire data.

Table 4. Sample structure according to family income

Variable	Sample	
	Frequency	Percent (%)
Below 1,500 lei	0	0
1,501-3,000 lei	178	21
3,001-4,500 lei	143	17
Over 4,500 lei	537	62
TOTAL	858	100

Source: Questionnaire data.

Considering the high recovery prices of the vegetables they are purchased with a 79% percentage by people with a family income higher than 3,000 lei/month (Table 4), and the families generally consist of 3 members (Table 5).

Table 5. Sample structure according to family size

Variable	Sample	
	Frequency	Percent (%)
2 people	251	29
3 people	358	42
4 people	251	29
5 people	0	0
Over 5 people	0	0
TOTAL	858	100

Source: Questionnaire data.

RESULTS AND DISCUSSIONS

The agricultural production of a country is the main source of providing the national food security. The degree in which it's achieved from own production shows the degree of food self-sufficiency. Around the world there are gaps between countries regarding food self-sufficiency. In the European countries and USA, agriculture provides the demand for food to satisfy human needs. In the Emirates for example, the demand for food is insured at a 10% rate from intern resources and the rest comes from export.

According to WHO [18], the recommended vegetable consumption is of 400 grams per day per person, respectively 140 kg per year. According to data provided by NIS [10] and [11], the average annual vegetable consumption per inhabitant in our country has varied in the last 10 years, between 75.5 kg/inhabitant/year and 96.9 kg/inhabitant/year. Compared with this average, in Romania the average consumption has been of 142.5 grams per day per person, respectively 54 kg per year [14].

Results that in Romania the annual average consumption is 61.43% of WHO recommendations [18].

All the respondents (858) eat fresh and canned vegetables all year round, not only during the season, for health reasons, or because they appreciate their remarkable taste. As seen in Figure 1, 720 people (84%) purchase vegetables and canned vegetables from the supermarket/hypermarket assessing that in those locations there's a higher degree of product control, but 652 (76%) subjects keep on going also on the classic version – purchasing from the market.

Only 172 people (20%) eat vegetables and canned vegetables from their own garden. 103 people (12%) have refocused supplying straight from the manufacturer through orders or purchasing straight from the farm's door.

Those who constantly make supplies of vegetables and canned vegetables didn't form a habit of purchasing products from a certain manufacturer (96% respondents). Very few, only 4% (34 people) chose to supply from the same manufacturer, the majority being driven by momentary instinct and considering especially the price.

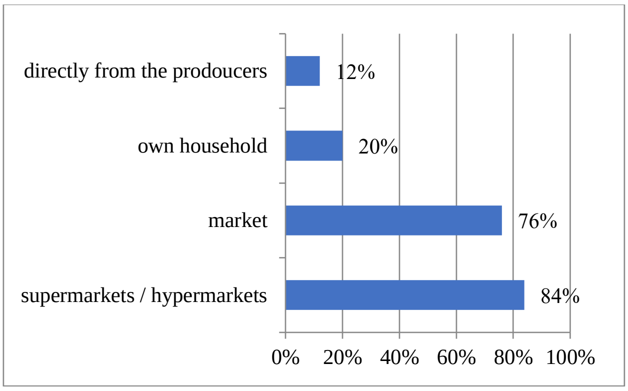

Fig. 1. Provenance of consumed vegetables and vegetable products
Source: Questionnaire data.

As seen in Figure 2, 500 people (58%) out of respondents make supplies of vegetables and canned vegetables usually weekly with larger quantities (over 5 kg/week), in order to meet the family's needs for the whole period.

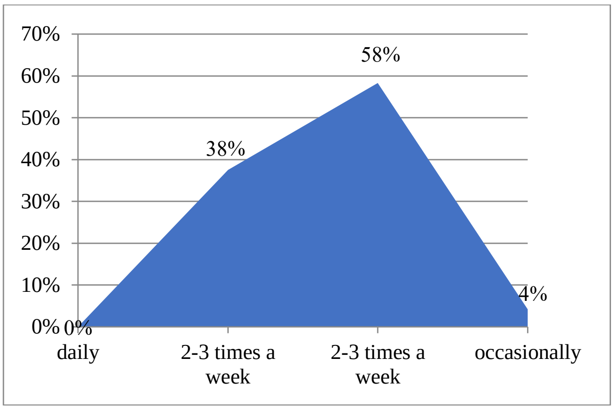

Fig. 2. Supplying frequency
Source: Questionnaire data.

In this category there are generally young people, employees that have extended working hours. 38% (322 people) make

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supplies of vegetables and canned vegetables 2-3 times a week (1-2 kg per purchase). In this category there are the ones who prefer to buy as much as they eat on one or two meals and elders who purchase what they need from shops that are close to home. Among the respondents there are 36 people (4%) that buy vegetables and canned vegetables occasionally.

Depending on the number of members from which the family is made of, on their eating habits and on income, the price that they pay for their weekly vegetable cart has varied between 9-56 lei, the majority of the respondents (583 people, meaning 68%) spending between 11-25 lei/week (Figure 3).

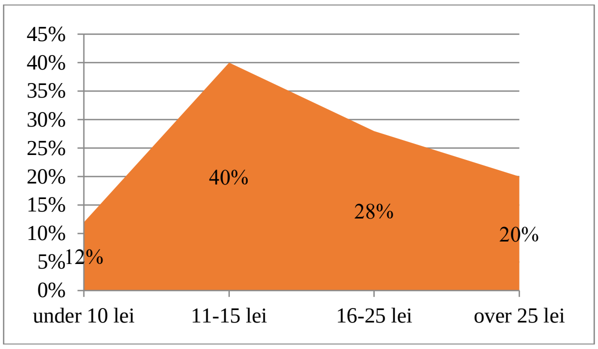

Fig. 3. The paid price for the weekly vegetable cart
Source: Questionnaire data.

The degree of satisfaction regarding the purchased vegetables and canned vegetables is over 84% (12% very satisfied, to which we add the 72% satisfied) (Figure 4), the consumers having their own criteria for selection: vintage, taste, price, origin (Figure 5).

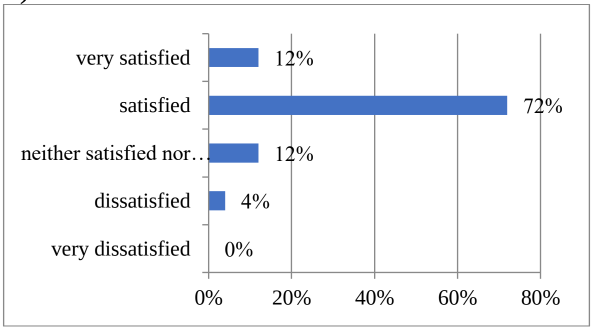

Fig. 4. The degree of satisfaction regarding vegetables and canned vegetables purchased usually
Source: Questionnaire data.

Until 2020, based on the previous surveys taken by vegetables and canned vegetables consumers, the main criteria had been the country of origin, the majority of the respondents back then preferring Romanian vegetables for their taste and appearance. The health crisis, through its imposed restrictions, had enhanced the deepening of the economic crisis, which led to the reduction of income to certain categories of people. Which is why in 2021, the main selection criteria is the price, as the buyers don't take into account the country of origin anymore. However, the vegetables taste remains important, even though it's no longer a priority (Figure 5).

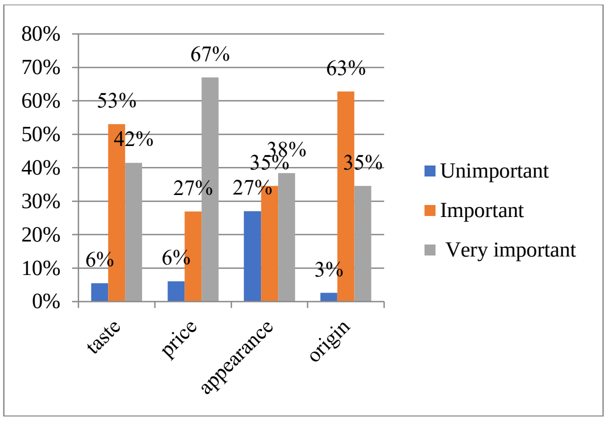

Fig. 5. The selection criteria of vegetables and canned vegetables
Source: Questionnaire data.

As seen in Figure 6, the consumers preferences go towards vegetables with a lower degree of outage: potatoes (52%), onion (50%), roots (including: carrots, celery, parsnip, parsley root – 46%), garlic (19%), cabbage (15%) and bean/lentil (15%). Even if they are expensive, tomatoes (38%), cucumbers (27%) and peppers (19%) are consumed for their remarkable taste.

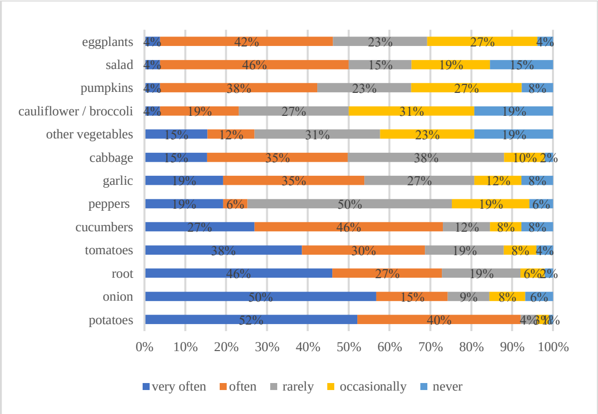

Fig. 6. The preferences of the vegetable consumers
Source: Questionnaire data.

The majority of the respondents, 652 people (76%), prefer to see the fresh vegetables displayed in display cases at the supermarket/hypermarket, so that they can choose themselves. The same goes for the 60% of those who make supplies from the market. 20% (172 people) of the respondents went during this period on specialized platforms, e-mail or websites to see and order vegetables to be brought to their homes (Figure 7).

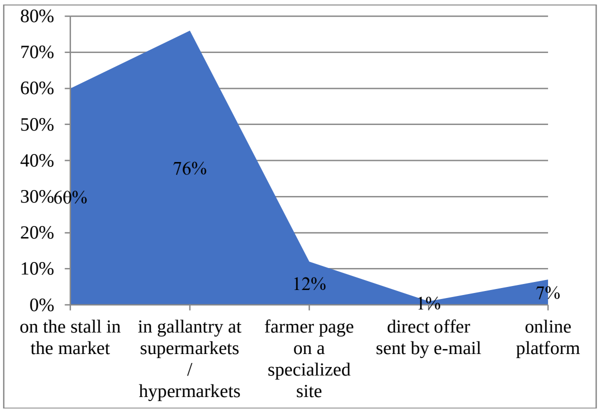

Fig. 7. Consumers preferences regarding the way of displaying fresh vegetables
Source: Questionnaire data.

No matter how they see the vegetables, consumers prefer to choose them themselves, either directly from the market, the supermarket or the hypermarket, either ordering directly from producers/traders, without being compelled by a predetermined cart. 583 (68%) of the respondents rejected the idea of a subscription regarding vegetable supplying (Figure 8).

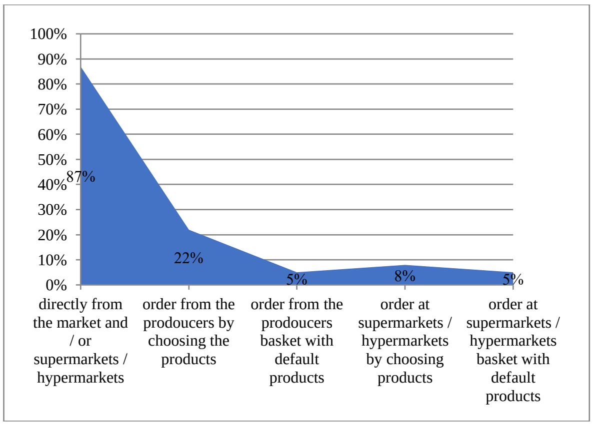

Fig. 8. Consumers preferences regarding the purchasing method of fresh vegetables
Source: Questionnaire data.

Regarding the payment method, 500 people, meaning 58% of respondents, pay for vegetables with cash, while 358 people, meaning 42% of respondents, pay for vegetables using credit card or bank transfer (supermarket/hypermarket or orders on-line).

At the question:"How has your fresh vegetables purchasing behavior been affected by the COVID-19 health crisis?" 500 of respondents said that they purchase the vegetables the same as before the crisis, meaning straight from the market/stores, 330 order from supermarkets/hypermarkets while 28 people order straight from producers. 71% (607 people) expressed their opinion that after the health crisis ends they don't know or they will not continue to order on-line (Figure 9).

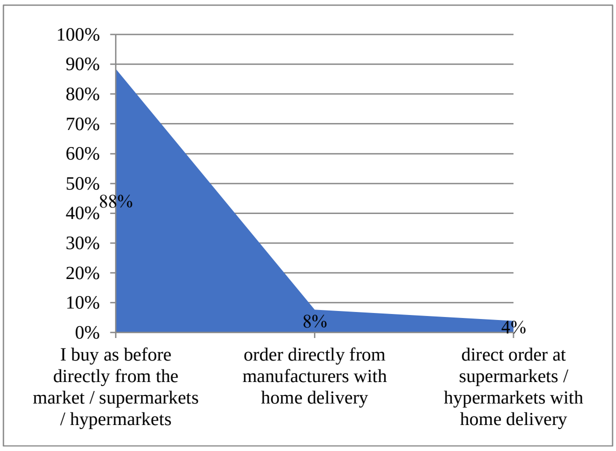

Fig. 9. How has your vegetables purchasing behavior been affected?
Source: Questionnaire data.

Hodbod A. and co-workers found in their 2021 study that the majority of consumers in France, Germany, the Netherlands, Italy, and Spain, where it took place the study, reported that most households consuming "less than before" or "not at all.", ranging from 38 to 66% - depending on the sector. Secondly, households reduce their consumption correlated with severity COVID-19 health crisis and individually, depending on personal experience with COVID-19 [5].

CONCLUSIONS

From the previous studies made by ICEADR [1], it resulted that most Romanian consumers have a conservative behavior, preferring to buy vegetables from the vegetable market and/or hypermerket/supermarket, because this way of direct purchase gives them the opportunity to choose products and give them health safety comfort. As a method of payment, they preferred to use cash. The imposition of a state of emergency has brought about changes in behavior for both producers and consumers. The traffic restrictions imposed in the State of Emergency have determined consumers to resort to modern methods of supply: direct orders to farmers/traders, orders on specialized platforms, telephone orders. These new ways of marketing have imposed new methods of payment, namely the use of the bank card. Uncertainty about the future is also found in the opinions of consumers regarding the continued use of modern ordering and payment methods. In the short term, it were the best solution. It is interesting to see what will happen in the future, whether or not the newly acquired purchasing and payment habits will be maintained. If in previous years taste and origin were the main criteria for purchasing vegetables, the health crisis Covid-19, brought the price to the top. The justification would be the decrease of the buyer's income and various financial problems. The prices on the Bucharest markets are high and very high for imported vegetables as well as for those of Romanian origin, the local ones sometimes exceeding 2-3 times the imported ones. On the Romanian market, there is a sharp concentration of sales of vegetables and canned vegetables through supermarkets and hypermarkets to the detriment of small and medium producers. This is how the Romanian producer arrives quite difficult with the production in the big shopping centers, due to the fact that he produces in a seasonal regime, and the obtained production is very small and does not correspond to the quality requirements imposed by the big operators. This fact explains, to a large extent, the large quantity of imported vegetables and canned vegetables that exist on the Romanian market. In order to increase the current consumption of vegetables and canned vegetables in Romania (54 kg/person/year) and bring it closer to the WHO recommendations (140 kg/person/ year), the state must support producers with appropriate levers to cover their expenses and to encourage them to produce more, but at affordable prices for buyers. Food autonomy is a political goal of all states, but on different levels of importance, depending on the degree of development of the country, depending on its financial resources. In developed countries, this goal is of minor importance because it covers the need for food from our own production. In developing countries, such as Romania, increasing agricultural production and ensuring food autonomy is a key objective.

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USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN SUPPORTING BUSINESS DECISIONS FOR STORING ENERGY IN GRAVITATIONAL FORM

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Abstract

Energy management is important for all farms and choosing the most suitable form of storing energy is essential in mitigating associated risks, seizing opportunities and thus maximizing productivity. We propose the small scale environmentally friendly method of storing energy in gravitational form, which involves pumping water available in open ponds to higher altitudes to store surplus energy, and releasing it to lower altitudes when additional energy is required. For small farms that benefit of suitable geographical position for storing energy this way, i.e. sufficiently high height gradient, this method would be particularly beneficial as it decreases the need to rely on external energy providers. In addition, it has the potential of helping the environment, as local flora and fauna may benefit from the presence of water especially during drought periods. For the purpose of remote control and data acquisition in such locations, we propose using long range and low power communication (LoRa) infrastructure and LoraWAN protocol - such infrastructure has the added benefit of assisting farmers in making better decisions for their crops, as well as providing warnings if required. To assess the feasibility of the method, we carried out a case study on a local small farm. Initial results indicate that the costs involved when using this method are comparable to other energy storage methods, but storing energy gravitationally has the added advantage of being more environmentally friendly. For a more detailed and larger scale feasibility test, we propose to use Artificial Intelligence (AI) for choosing the most suitable locations for placing the ponds and Machine Learning (ML) techniques to examine correlations and draw a conclusion on whether the presence of new ponds is overall beneficial. Such an investigation also offers insight from a quantitative perspective, informing economic calculations such as pay-back period (PBP) and Return on Investment (ROI) of the project.

Key words: *artificial intelligence, machine learning, LoRa, LoRaWAN, renewable energy, energy storing*

INTRODUCTION

In the present context regarding the energy crisis, it is important not only to explore the ways of increasing the energy usage efficiency, but to also analyze the possibility of producing and storing energy at local level. This is especially relevant for small businesses located in rural areas which may be irreversibly affected by energy price and/or its availability (Figure 1, Table 1). From a durable development point of view, the best approach is to find a way to store the energy in an ecological and environmentally friendly way, with a positive environmental impact.

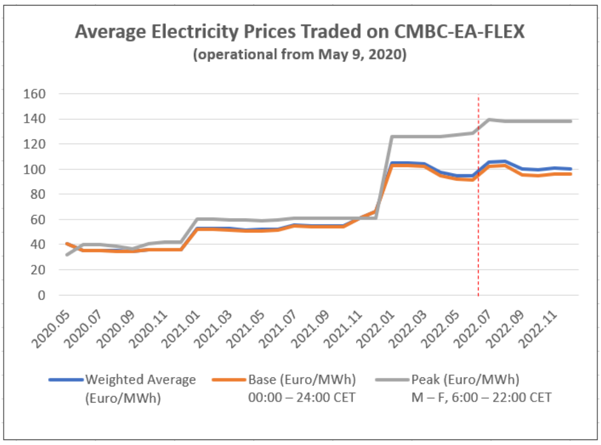

Fig. 1. Average Electricity Prices Trade on OPCOM CMBC-EA-FLEX
Source: own processing based on OPCOM statistics [22].

Table 1. Average Prices Traded on CMBC-EA-FLEX, extract

Month	Weighted Average (Euro/MWh)	Base (Euro/MWh) 00:00–24:00 CET	Peak (Euro/MWh) M – F, 6:00–22:00 CET
2021.11	60.99	61	60.92
2021.12	66.13	66.68	61.01
2022.01	104.55	102.69	126.02
2022.02	104.66	102.71	126.04
2022.03	103.97	101.94	126.05
2022.04	97.2	94.83	126.03
2022.05	95.07	92.28	127.17
2022.06	94.6	91.5	128.56
2022.07	105.76	102.04	139.13

Source: own processingbased on OPCOM statistics [22].

Based on a study published by the Romanian gas and electricity market operator (OPCOM) up to July 2022, over the last year the Weighted average electricity price has increased by roughly 100%, from 52.29 Euro/MWh in June 2021, up to 105.76 in July 2022. For the Peak price (available from Monday to Friday from 6:00 AM to 10:00 PM)the increase is even more dramatic, from 59.28 Euro/MWh to 139.13 (135% up).

Looking back at the statistics of the indices calculated based on the former model operational by May 2020 (CMBC-EA), the increase in the previous 5 years was around 50% for the Weighted Average Price and 70% for the Peak price. This means the increase in both prices has doubled in the last year in comparison with the increase for the prior 5 years, between 2015 and 2020 (Fig. 2).

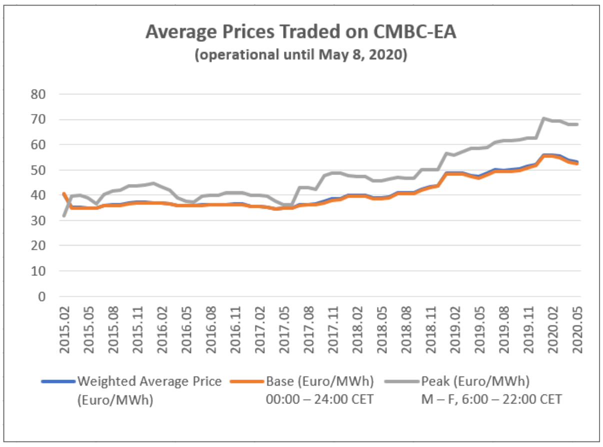

Fig. 2. Average Prices Trade on CMBC-EA
Source: own processingbased on OPCOM statistics [23].

As a consequence of the energy price increase, the water price has also increased. This has a strong impact on farmers as it limits their ability to water the crops, especially during periods of significant drought. All these factors have a negative impact on the quality and quantity of the crops produced by farms.

In order to mitigate these risks, it is advisable for small farmers to analyze their specific conditions and the feasibility of investing in electrical energy production equipment (solar, wind, micro-hydro, micro-thermo, a. s. o.). Larger farms are more likely to be able to afford such analysis and investments.

One very important risk which has to be monitored and taken into consideration for evaluation from qualitative and quantitative perspectives, comes from the uncertainty of the local governmental approach, which, in the case of Romania, is very likely to be changed on very short legal notice, which may affect the initial business plan as well.

The notion of "prosumer" was introduced into the Romanian legislation five years ago, in March 2017. A prosumer is an end user that also has the capacity of producing energy. By law, prosumers are integrated into the national distribution infrastructure. When it comes to the commercial perspective, the approach was changed during the short period of time since the concept was introduced. For the time being, the current approach in Romania is to exchange the active energy produced and transferred on-grid with the one consumed from the grid by the prosumers in a "1 to 1" ratio. Nevertheless, the prosumers pay the same fixed costs per KWh of the energy consumed from the national electrical system, like all end users.

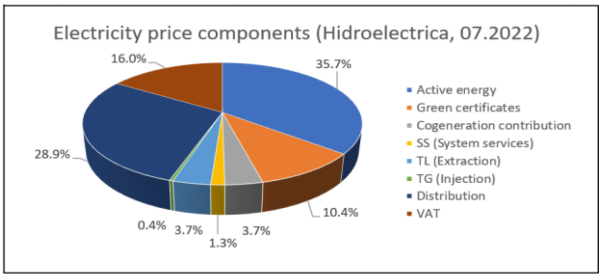

Fig. 3. Electricity bill price structure in July, 2022.
Source: own processing based on Hidroelectrica invoice.

Table 2. Example of energy invoice before legal modification in 2022

Invoiced services	Invoicing period	Quantity	Unit	Unit price wo VAT (RON/unit)	Value wo VAT (RON)	VAT (RON)
Active energy time zone 1	09/25/2021-10/31/2021	213	KWh	0.68543	146.00	27.74
Contribution to cogeneration	09/25/2021-10/31/2022	213	KWh	0.01712	3.65	0.69
Green certificates	09/25/2021-10/31/2021	213	KWh	0.0640659	13.65	2.59
Excise duties	-	213	KWh	0.00523	1.11	0.21
Total					164.41	31.23
Active energy delivered on-grid	09/25/2021-10/31/2021	260	KWh	0.19656	-51.11	
To be paid					113.30	31.23
Total					144.53	

Source: own processing.

Consequently, based on the current legislation, a prosumer has to transfer on-grid more than 250 KWh from its production in order to be able to consume with no additional costs from the system 100 KWh, when needed, i.e. 150% more. In terms of **efficiency** this is **equivalent to a system with h=35.7%**. Before the last legal modification in 2022 the percentage was even lower, less than 25%, due to different energy selling and buying prices (Fig. 4).
In contrast, Canada for example had two types of contracts signed for 20 years with Hydro One [13]:
-Net Metering: this allows saving energy on the grid, similar to a large battery, where it can be later withdrawn from at no charge, or pay 0.077 CAD /KWh for what exceeds the production [13];
-microFIT: this is a sell only contract[14]. The produced power is sold at a fixed rate for cash that is sent every month. This selling rate is 0.29 CAD/KWh, about 3 times the rate paid for under NetMetering.
This means that from an economic point of view, it clearly makes sense to sell what is produced by the micro green plant at the high price (microFIT) and buy for household or farm use at the lower price (NetMetering); both types of contracts could simultaneously be signed for the same location/user, but the systems would need to be independent and not interconnected. It seems not all countries provide this incentive and even Canada has stopped new homes from joining this program, but it will be still active for other 14-15 years for the ones who have already signed such contracts [15].
The example above shows the importance of the local laws/governmental approaches and their stability in time for business and investment decisions.
For storing energy, large or small ponds can be used for collecting water from rain or by pumping from lower altitudes, using surplus energy from a solar or wind power plant or using cheaper off-peak electricity for pumping and deliver during peak hours produced energy through some micro hydro generators. The efficiency of pumping water into small ponds might not be immediately apparent. However, this approach has been used for a long time for large (CHEAP) systems, like Sacuieu–Dragan [12], Frunzaru [28], Tarnita [12][19].
In such big systems, the equipment efficiency is high, about 75%-80% for pumping up and 90%-92% for generating electricity; so total efficiency for large systems is about 70%.This may decrease to 50%-60% when systems are smaller and if water evaporation is taken into consideration. While these figures might seem relatively low, from a commercial perspective in Romania, these systems are almost twice more efficient than injecting energy on-grid.

In the Sacuieu – Dragan hydro system for example, there are two 5MW pumps for elevating the water 190m high. In Frunzaru the pumping power is greater, but the pumping height is lower. The decision for implementing such a project is a centralized one due to its high costs and ecological and political impact, so huge delays may be expected for the implementation. Tarnița project is such an example where the implementation has been postponed several times, so, at the authority level (Ministry of Energy) the interest decreased at such a level as even the project web site is not valid anymore [19]. The Tarnița project was considered economically inefficient, which is debatable since a Swiss project, Nant de Drance power plant, with less capacity (900MW vs 1,000MW) and twice the budget (2 Bln Euro vs 1 Bln Euro) is considered a very successful one after 14 years of implementation [20][27][1].

The same result like in the Sacuieu – Dragan hydro system (10MW total pumping power) may be obtained for example from 5,000 small pumping facilities with a 2KW pumping power each; there is no need to pump up to 190m (which may increase the costs and decrease the efficiency), but water can be very simply pumped up 50-60m high with standard equipment available at small prices due to large scale production for this range of power and pressure values. Regarding the environmental impact of the new small ponds, intuitively we can imagine it would be a positive one as the presence of water helps both the local flora and fauna.

In this context, the purpose of the paper is to analyze and propose the gravitational energy storage in small ponds and manage this resource using remote data acquisition and a cloud machine learning platform which can optimize the process and support farmers in their decisions.

MATERIALS AND METHODS

In this paper we propose to use Artificial Intelligence (AI) and Machine Learning (ML) as methods to analyze data sets collected through drone cameras or various sensors transmitting relevant field parameters using low power communication (LoRa).

AI "is the science and engineering of making intelligent machines, especially intelligent computer programs" [18]. Intelligence is thought of as an ability of acquiring and applying knowledge and skills. It is a trait specific to humans and a few animal species, and nowadays an argument can be made that intelligence is specific to some machines as well. Rapidly evolving technology, both hardware and software, allows us to develop very powerful algorithms that run on performant machines. For a long time, humans have tried simulating true intelligence on computers, but in the last 70 decades, significant progress has been made. In the 1950s, Alan Turing proposed the Turing test. This test was designed for detecting human-like intelligence in a machine.

ML "is the study of computer algorithms that improve automatically through experience and by the use of data" [30]. ML aims to address the problem of creating machines that learn and evolve through experience [17]. It combines the fields of computer science and statistics and resides at the heart of AI and data science.

The three main learning paradigms in ML are supervised, unsupervised, and reinforcement learning.

- Supervised learning: learning with previously labeled inputs that serve as objectives. There is a set of input information comprised of information-target pairs. This set is usually split into an information vector, and a vector containing one or more associated defined output values for each training example [24].
- Unsupervised learning: is distinguished by the absence of labels in the training set. Most of the time, the criterion for success is a network's ability to increase or decrease a cost function correlated to it [24].
- Reinforcement learning: models learn to make a sequence of decisions. The model gains the ability of completing a task in a rather complex and ambiguous

environment. The encountered scenario is similar to a game. In order to solve the problem, the computer uses a "trial and error" system. It is then rewarded or punished based on the decision outcome. The aim of the algorithm is to maximize the total score [3].

Data harvesting is a crucial part of ML. In order for the training process to succeed in supervised learning, the training data must be structured as follows:

- The content - the data representing what the program should be able to predict
- The correct answer (known as target attribute) - the correct identifier for the data that the model should predict/classify. This is what allows the model to acknowledge if the prediction was correct or not.

A model is a program that has been provided with a set of data and an algorithm to interpret that data (a learning algorithm). The desired result is an improved program that can now make predictions on data that is not in the training set, but has similar characteristics. The model artifact developed by the process of training is referred to as an ML model [17]. The learning algorithm searches the training data for patterns that connect the input data attributes to the goal (the result to be predicted), and it outputs a ML model that uses these patterns. The generated model is then used for making predictions for new data, for which it does not know the target attributes.

Artificial neural networks (ANNs) are computer systems that are loosely based on the biological networks that make up both the animal and human brain. An ANN, which can be used with all three ML paradigms, is constructed of nodes (often called artificial neurons). These nodes are connected, much like in a biological brain. Each connection can send a signal to other neurons. One such neuron has the ability to receive a signal, take some action based on it and afterwards send new signals to other connected neurons. The motivation behind this architecture is the massive amount of computation that can be done by the human brain, which is remarkably good at recognition and classification tasks. Such tasks are accomplished using a biological neural network that may be mathematically modeled as a weighted and directed graph of highly interconnected vertices [11]. The most significant advantage of ANNs over traditional systems is their high degree of parallelism, as opposed to the traditional sequentially operated system. Artificial neural networks are organized in layers such as convolutional layers, pooling layers, fully connected layers, recurrent layers or normalization layers. These layers serve the purpose of receiving data, processing it, and outputting a certain result [4]. A layer's output usually serves as the next layer's input. Every connection between 2 neurons is associated with a numerical value which represents the strength of the connection and is called weight [4]. The most significant aspect in transforming an input into an output is the weights. This is because when the network gets an input for one node, it is transferred to the next node via the connection between them, but only after it has been multiplied with that connection's weight [4].

Activation functions have the purpose of deciding what neurons should be active based on the weighted sum calculated [10]. This in turn defines the output produced by the layer [2]. There are plenty of activation functions, and some of them are better suited in some cases than others. For example: while a recurrent neural network most often uses sigmoid activation or tanh activation, multilayer perceptrons and convolutional neural networks are usually coupled with ReLU activation.

Gradient Descent "is an optimization algorithm for finding a local minimum of a differentiable function" [5]. Gradient Descent is used for identifying the values of the parameters of a function in order to minimize the cost function [5]. This cost function represents the average of all loss functions (loss functions compute the loss of the model at a certain point in training) [5].

Backpropagation is a common approach for the calculation of derivatives inside an ANN and is vital for the process of training a feed-forward network [31]. The gradient of a loss function can be calculated via backpropagation for each of the network's weights. This allows each weight to be updated independently across several training iterations, lowering the loss function [31]. The gradient is computed while moving back through front through the model, from the final layer to the first [31].

RESULTS AND DISCUSSIONS

Use case

In small solar, wind or micro-hydro implementations for farms or household usage, an inverter is normally used for converting variable electrical parameters inputs to fixed output voltage (230V/240V/380V) suitable for all devices or appliances. In order to store the surplus energy produced by this kind of system, a special type of inverter is needed (a hybrid inverter which uses batteries).The batteries are modular and usually a multiple of 3KWh or 5KWh.

For gravitationally storing 5KWh of energy a volume of 30 m^3 of water should be elevated 60 meters, or 60m^3 for 30 meters (Fig. 4).

A 30 m^3 pond is equivalent to a medium home swimming pool of 4m*7m*1.1m. From the investment point of view a battery module of 5KWh is equivalent to a system consisting of one 1KW pump, one 1KW Home Scale Micro Hydro, one 30 m^3 frame pool and corresponding piping.

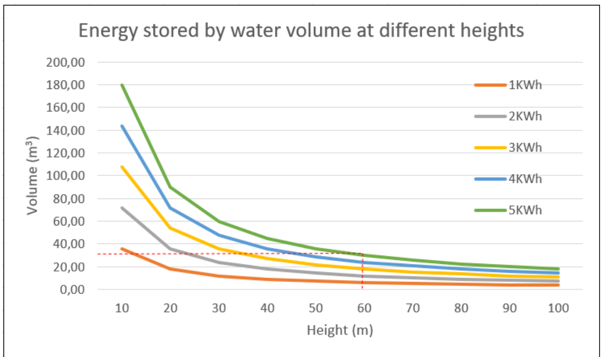

Fig. 4. Water volume needed for storing different energy levels depending on height
Source: own processing.

So, only based on this financial criterion it is not obvious which approach is better to be selected for storing energy. Very important for optimizing the system yield is the functioning point of the pump, as this parameter can vary a lot and thus dramatically influence the overall system efficiency. For example, from the characteristic functioning curves for Pedrollo 4Block pump series, including efficiency graph [26], the maximum pump efficiency is **h=67%** for 100l/min and decrease to **h=30.6%** for 40 l/min or 200l/min. Very important is also the piping system as the energy loss on thin tubes is very high.

The scaling of the battery storage is linear while the price per water storage installed KWh decreases, so, for larger capacities the gravitational storage might be a better option. From the operational point of view a combined approach can cover more requirements: the smallest battery present in the inverter system can very quickly cover any energy request (due to increased power demand, outage or a line defect for example) including any automated start of the micro-hydro generator, while a pond can accumulate energy cheaper, even free from rain, and in larger quantities.

From the eco point of view a pond is more friendly to the environment in comparison to a battery which has a large non-eco footprint.

Specific to the solar and wind renewable energy sources is their uncertainty in terms of quantity and time of production, which runs the risk of not being aligned with the needs. Therefore, it is very useful to be able to store the energy and potentially also transfer it on-grid when in excess. On the other hand, once water is accumulated in the ponds, micro-hydro and hydro generators can start to produce energy on demand, but with variable delay (depending mainly on size).

The typical load curve has a base load during day time, two peaks (during mornings and evenings) and off-peak during nights (Fig.5).

The national electrical power system (which is now interconnected with the systems from the neighboring countries) is more efficient to constant loads; each increase in demand needs technical actions to the system in order to adapt. This deviation is also reflected in the price due to the law of supply and demand (Fig. 6).

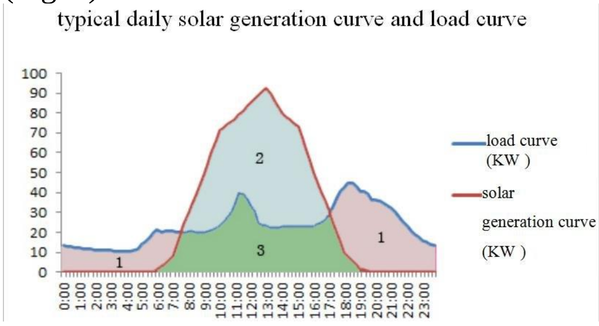

Fig. 5. Typical daily solar generation curve and load curve according to Yan Fan
Source: [8].

Unfortunately, for the time being in Romania, the price paid to the prosumers for the injected electrical power into the national system is not differentiated based on the delivery time (peak or off-peak). So, this opportunity cannot be seized locally by consuming/storing energy off-peak and delivering it during peak hours like in the large pumping hydro power plants.

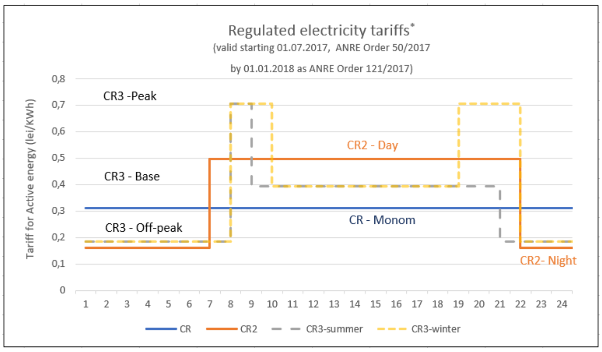

Fig.6. Regulated electricity tariffs by 01.01.2018
Source: own processingbased on ANRE Order [21].

The plot in Fig. 7. is a qualitative one, corresponding on average to some specific monitoring period; the amplitudes differ from summer to winter, both to load and solar generation curves.

Ponds placement

This section presents the usage of AI first in obtaining a high-resolution aerial view of an area including the 3D Digital Terrain Model (DTM) based on an overfly with a home-use Mavic Pro drone. This is a very important step for identifying the most suitable location for placing a water accumulation pond.

The area of interest is isolated based on several constraints:

- altitude differences
- property status and possibility of using it for building a pond
- easy access for digging and piping between ponds

Specialized software is then used for planning the flight [6] (Figure 8). Several input parameters must be established:

- flight altitude
- needed resolution
- requested precision

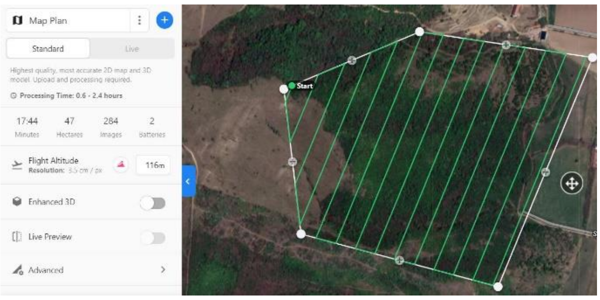

Fig. 7. Planned flight path over the analyzed area
Source: own processing.

The resulting set of 2D aerial photos are then processed for obtaining AI-generated DTMs and topographic maps or orthophoto plans (aerial views not affected by optical distortions, built using these photos like in a puzzle) [7]. Using strong AI algorithms, similar points are identified in the photos and thus the measurement of the distances between them from different points of view can be done. By using this technique, the altitudes of the points can be calculated. Points with the same elevation are put on the same level curve (Fig. 8 and Fig. 9).

It is important to note that the obtained level curves are optical ones and not ground level curves. This is more relevant in areas with trees where the curves correspond to trees tops, not to ground.

The most suitable areas for placing ponds are the ones with lower curve density, where the terrain is approximately flat.

It is also important to note that such local investigation is needed as usual topographic plans or Google Maps Terrain are not suitable for such small areas targeted by small pond projects due to their low accuracy precision for this purpose.

Fig. 8. The resulted ortophotoplanand 3D DTM for the surveyed area
Source: own processing.

Fig.9. The 3D DTM for the surveyed area
Source: own processing.

Among the identified flat areas some are located closer to roads or easier to access and these are the ones to be selected for further analysis. The “short listed areas” should be directly inspected and evaluated more precisely on field.

Using this cheap method, the most suitable areas can be identified and the project can continue further with the next steps.

More precise DTM results can be obtained using LIDAR scanners (Laser Imaging, Detection, and Ranging), but this approach is an expensive one and specialized equipment and services are required.

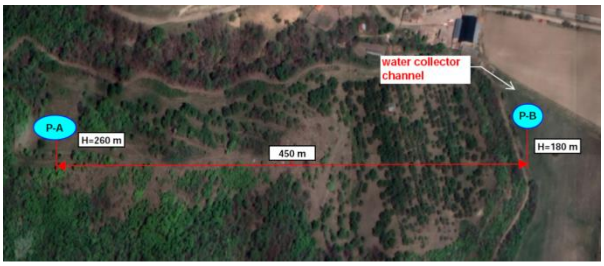

Fig. 10. The ponds positions and dimensional parameters
Source: own processing.

As a result of this process two locations were chosen, Pond A (at 260m altitude) and Pond B (at 180m altitude). The direct distance between the ponds is 450m and the piping length is about 600m. There is a forest road nearby which can be used for installing the system and for facilitating further maintenance activities. In that area the system can also benefit from a rainwater collector channel in order to store such a natural resource instead of just letting it drain into the nearest river (Fig. 10).

Machine learning in energy storage systems

Due to the current technological advancements, energy storage systems (ESS) and energy storage devices (ESD) must have higher performance, greater reliability, have better durability and better management strategies. Since these systems rely on the condition of numerous indicators, advanced control strategies must consider trade-offs with respect to a large number of parameters when designing such systems. ML has the power of significantly speeding up calculations, capturing intricate systems in order to increase prediction accuracy, and taking the best decisions possible based on complete data readings. It is appropriate for real-time management thanks to the computational efficiency [9].

There are various types of energy storage devices. Some energy storage devices use electrochemical technology: batteries, flow batteries, capacitors, fuel cells. Other ESDs are of physical nature: pumped-storage, compressed air storage, superconducting magnets, molten salts, etc.

Thanks to the massive computational processing power of modern computers, ML is very useful in multi-factor problems. Layers of highly connected neurons process the input data and identify the optimal solution for the targeted problem.

Due to the number of factors involved in calculating optimizations for the production, storage and supply of energy, ML is a powerful tool to employ for its management.

The prosumer is faced with the problem of choosing the best course of action for the use of produced energy. Depending on the time of day, price per KWh varies, but so does the production of energy and the household use.

The amount of energy stored in the available ESDs is also an important factor. ML can be used in the optimization of energy production as well as in the management of the produced energy. Depending on factors such as the time of day, weather, precipitation and price of the KWh, different ESDs would be optimal. A ML model trained on data collected previously would be able to make predictions based on this information and maximize the financial outcome. The model could be retrained with an enriched training dataset (obtained by adding the newly harvested data).

The model could then employ "trialand error" approach in order to optimize the performance.

The adaptability of pumped-storage hydropower plants (PSHP) offsets the unpredictable and inconsistent nature of photovoltaic and wind power output. This helps increase the reliability of the power grid and encourage the integration of renewable energy (RE) sources [25]. The need for high-quality control of the pumped-storage unit is becoming more and more clear as PSHP and RE integrated systems grow in size. The control of the pumped storage unit has demonstrated to be more challenging than the control of the conventional hydropower generating unit. In the paper "Controller Optimization Approach Using LSTM-Based Identification Model for Pumped-Storage Units", Feng et al. have attempted the optimization of a Pumped-Storage Unit through the use of Long Short-Term Memory networks (LSTMs). Their results have revealed that the ML model had a better accuracy and better generalization capability than the other approaches.

Machine learning in the impact on the environment

At first glance, the environmental impact generated by the introduction of 2 open water reservoirs appears to be positive. Open water reservoirs increase the relative humidity in the area through the process of water evaporation. Out of all fire risk spikes (on the FWI95 and ISI95 scale systems), decreased relative humidity was the determining factor in 75% of the cases [16]. The impact on the local fauna should be a positive one as well. Two drinking water sources would be introduced into the environment.

The impact of the introduction of accumulation ponds can be analyzed using ML. A plethora of factors are required for conducting a comprehensive analysis. ML is particularly useful in multi-factor problems thanks to the impressive computing capacity. Data should be collected from the location of the lakes as well as from a control area. The data harvested could help in making correlations between humidity levels and fire risk, or water availability and fauna well-being. ML could help in discovering complex correlations and also quantitative relationships that could not be discovered through human judgement.

ML is thus very useful in status analyzing, forecasts and decision making but it requires specific IT knowledge and powerful computational capabilities. For small to medium farms, it is not feasible to implement such systems in order to better manage (including energy management). For large farms it might be feasible, but, as this is not their core business, investments are more likely to go to their specific needs. So, a platform which offers data collecting and processing capabilities (including ML) can help farms of all sizes in optimizing their activities, receiving alerts based on "spot signals" collected and interpreted by ML models and even drive some of the activities (for example the command of watering systems or the energy management in order to optimize consumption, storage and generation). Such a service is planned to be offered on myiot.ro platform developed through the PleIT project by Smart League Company [29].

CONCLUSIONS

Long range and low power communication (LoRa) infrastructure, LoRaWAN protocol and the Machine Learning platform form a system that has the added benefit of assisting farmers in collecting data, receive warnings, making better decisions for their crops and even drive some of the remote activities (for example the command of watering systems or the energy management in order to optimize consumption, storage and generation).The system output can be used for building a project charter and in taking operational and investments decisions.

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CORPORATE INSOLVENCIES EVOLUTION IN REPUBLIC OF MOLDOVA AND UKRAINE DURING 2013 – 2020 PERIOD

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Abstract

The study of the corporate insolvencies' evolution is very important especially for the management of the company and in for the internal audit, control and performances forecasting. The objectives of the article is to analyse the evolution of number of insolvencies and to analyse some legal aspects regarding the corporate insolvencies in the Ukraine and Republic of Moldova till 2021. For this reason, this study try to answer the next three questions: 1) What was the evolution of number of corporate insolvencies in Republic of Moldova and Ukraine during 2013-2020? 2) What are the legislative regulations regarding insolvency proceedings in Republic of Moldova and Ukraine? 3) What is the level of development of the research of the corporate insolvencies forecast methods in these two countries? For this purpose, the following methods were applied: comparative-critical analysis of the literature, documentation, and documentary analysis, statistical methods of analysis, constructivist approach, and positivist approach. The results of this research show that these two countries are characterized by different directions of modifications of number of corporate insolvencies during the analysed period, excepting 2020 year, when the COVID-19 pandemic had a major impact. At the same time, the performed econometric analysis, shows that the Republic of Moldova and Ukrainian models have a relatively high adjustment to the empirical data, demonstrating the possibility to forecast the number of corporate insolvencies. Regarding the legislative regulations, can be remarked that the main differences established in the legislation of these two countries relate to the amount and term of non-payment of debts. In addition, the corporate insolvencies forecast methods in Ukraine are much more advanced then in Republic of Moldova.

Key words: *corporate insolvency, bankruptcy risk, Ukraine, Republic of Moldova*

INTRODUCTION

Research regarding the corporate insolvencies' evolution is relevant because it aims to identify the future trends of number of insolvencies and the issues regarding legislative regulations of insolvency proceedings efficiency.

The purpose of the institution of insolvency is, on the one hand, to help default companies to overcome the financial crisis, on the other hand, to exclude unprofitable and inefficient production and services activities from the economic system by legislative means.

In developed countries, the first bankruptcy (insolvency) law was drafted into British law in 1732. Then, in 1800, this type of law appeared in the United States, France, Spain, and Germany. The first attempt of bankruptcy (insolvency) law adjustment by the introduction of reorganization procedure was made in Austrian law in 1914. Only in 1978 in US law appeared the modern reorganization procedure of firms, followed by legislative reforms in Italy (1979), France (1985), Great Britain (1986), New Zealand (1989), Australia and Canada (1992), Germany (1994 and 1999), Sweden (1996), Japan and Mexico (2000) [19].

Regarding the first bankruptcy assessment studies, in developed counties, they appeared at the beginning of the 1920s. Initial study was performed in the USA. In 1966 Beaver [2] used for the first time statistical (econometrical) methods in order to forecast and asses the level of bankruptcy risk. In

1968, by Altman [1] was created the first and most famous bankruptcy prediction model - "Z-score". Ever since, were developed and elaborated more and more bankruptcy models prediction. In the 1970s and early 1980s, appeared a new direction in bankruptcy risk prediction and evaluation - the logit and probit analysis (Santomero and Vinso (1977) and Martin (1977)) cited by [18]. Then, in 1990s the progress of statistical and analytical tools has allowed the use of non-parametric methods for assessing corporate bankruptcy risk, especially artificial neural networks. (Odom and Shard in 1990) [21]. Recently, can be remarked a new group of methods for predicting the risk of corporate insolvencies related to soft computing methods (Korol, 2010a, 2013) [8], which may process information in cases that are difficult to exemplify in the form of algorithms, and do so simultaneously with the symbolic representation of knowledge (Korol, 2010b) [9] .

As for post-Soviet countries, the studies on this research topic date back to the early 1990s, because during this period the first cases of insolvencies appeared and, consequently, the first legislative changes took place [17]. In terms of research, in Central and Eastern Europe corporate insolvencies started to be studied only in the 1990s. Initially, due to the lack of databases, most countries of Central and Eastern Europe used the generally accepted methods of financial analysis. Subsequently, more complex studies and national assessment models were elaborated. The most famous national models were developed in Poland, the Czech Republic and Slovakia. Advanced models have also been elaborated in Russia, Estonia, and Hungary. To a lesser extent, can be mentioned Ukraine, Romania and Lithuania. Bulgaria and the Republic of Moldova are considered to be the weakest in this domain [18].

At the level of the European Union, every year more than 200,000 companies are declared insolvent with a direct loss of more than 1.7 million jobs [6]. This is the main reason why EU pay attention to this area [20, 21]. In particular, the issue of corporate insolvencies became a pressing one during the COVID 19 pandemic, when a huge number of entities, practically throughout the globe, were forced to cease their activities. Lemerle et al. [12] demonstrates that the government intervention helped to prevent one of two insolvencies in Western Europe and one of three in the US, representing an overall decrease of (-12%) in 2020. As a result, the level of business insolvencies rests low in most countries until the end of 2021, the normalization being delayed until 2022.

Therefore, the main objective of this research is to try to analyse the evolution and some legal aspects regarding the corporate insolvencies in the Ukraine and Republic of Moldova till the 2021 year. Thus, the analysis was performed during the period 2013-2020. The data were collected from the Credit reform and of Euler Hermes reports.

MATERIALS AND METHODS

This article attempts to answer the following questions:

(1)What was the evolution of number of corporate insolvencies in Republic of Moldova and Ukraine during 2013-2020 period?

(2)What are the legislative regulations regarding insolvency proceedings in Republic of Moldova and Ukraine?

(3)What is the level of development of the research of the corporate insolvencies forecast methods in these two countries?

For this purpose, the method of scientific literature analysis was applied. Moreover, during the study was applied the universal method of dialectics and its procedures: deduction and induction, synthesis and analysis, analogy, correlation, scientific abstraction, and those of economic analysis of information processing: systematization, comparison, etc. At the same time, such methods were used as: comparative-critical analysis of the literature, documentation, and documentary analysis, statistical methods of analysis, constructivist approach, and positivist approach.

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The theoretical and methodological aspects are based on the fundamental works of scientists from the U.S., C.S.I., Europe, and other countries, normative and legislative acts of the Republic of Moldova and Ukraine. The chosen publications were mainly selected from the Google Scholar and Research Gate databases.

In order to perform the evolution analysis of number of corporate insolvencies the data was taken from the Credit reform reports [4]. The evolution analysis was made by using chain indices. A chain index is calculated with the goal to show the modification of the effective (current) value in comparison with the value from previous year:

$$\boldsymbol{I_{\frac{t}{t}-1}} = \frac{\boldsymbol{I_t}}{\boldsymbol{I_{t-1}}} \bullet \mathbf{100}, \qquad (1)$$

where:

yt – number of corporate insolvencies in current period;

yt–1 – number of corporate insolvencies in previous year.

The calculation results can be seen in the Table 1.

Then, we made the econometric analysis using the classic least-squares method, and elaborating trend models [5] for the Republic of Moldova and Ukraine. As a dependent variable was chosen the number of insolvencies.

The economic trend models were made by using the polynomial trend models of the r level:

$$Y_t = \sum_{j=0}^{r} a_j t^j + n_t \qquad (2)$$

where:

t represents the time variable $t = 1, 2, ..., n$;

r – time variable polynomial trend.

The econometric analysis can be seen in Tables 2 and 3.

RESULTS AND DISCUSSIONS

In order to answer to the question one:

(1)What was the evolution of number of corporate insolvencies in Republic of Moldova and Ukraine during 2013-2020?

and to appreciate the evolution of corporate insolvencies in Republic of Moldova and Ukraine, was drawn the Table 1.

Table 1. The evolution of number of the corporate insolvencies in Republic of Moldova and Ukraine during 2013–2020

Years	Number of corporate insolvencies		Years	The chain indices of the corporate insolvencies,%	
	Ukraine	RM		Ukraine	RM
2013	8,811	2,808	-	-	-
2014	13,198	2,770	2014/ 2013	149.79	98.65
2015	13,696	3,905	2015/ 2014	103.77	140.97
2016	19,853	4,055	2016/ 2015	144.95	103.84
2017	19,975	8,540	2017/ 2016	100.61	210.60
2018	20,146	7,847	2018/ 2017	100.86	91.89
2019	20,076	3,038	2019/ 2018	99.65	38.72
2020	19,875	2,762	2020/ 2019	99.00	90.92

Source: Own calculations based on Credit reform data.

The dynamic analysis performed in Table 1, on the base of chain indices, shows that these two countries are characterized by different directions of modifications of number of corporate insolvencies during the analysed period, excepting 2020 year. Ukraine achieved the highest increase in the number of insolvencies in 2016, and this trend of increase persisted till 2019. In Republic of Moldova the highest rise of the number of corporate insolvencies was observed in 2017. The 2017 year in Moldova was characterized by lack of economic growth and lack of reforms implementation, by a slow recovery from bank fraud, by different attempts to promote dubious laws, and by small investments in business environment. At the same time, the energy dependence on the Russian Federation was one of the main economic problems of RM in those periods.

Analysing chain indices trend, may be remarked a significant decrease in 2020 of number of insolvencies for the both analysed countries. The 2020 year was one of the most unexpected and unusual years in European economy, because of the pandemic COVID-19 impact: lockdowns, ceased activities, uncertainties. Thus, during 2020 year, the business environment was deteriorated. That is why in this period, almost all national governments, Ukrainian and the Republic of Moldova governments as well, tried to support and help business and affected branches. This is the reason why the number of insolvencies in Ukraine and Republic of Moldova, does not reflect the reality in 2020 and a huge increase are to be expected in next years.

Table 2. The trend model of the number of insolvencies in Ukraine (2013–2020)
Dependent Variable: Y_UKARAINE
Method: Least Squares
Date: 04/01/22 Time: 16:46
Sample: 2013 2020
Included observations: 8

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2726.190	1734.088	1.572118	0.1670
T	6118.998	796.2257	7.685004	0.0003
T^2	-540.3214	77.65438	-6.958029	0.0004

R-squared	0.915452	Mean dependent var	16211.00
Adjusted R-squared	0.887269	S.D. dependent var	4059.007
S.E. of regression	1362.829	Akaike info criterion	17.53371
Sum squared resid	11143815	Schwarz criterion	17.59946
Log likelihood	-75.90171	Hannan-Quinn criter.	17.39184
F-statistic	32.48273	Durbin-Watson stat	2.914303
Prob(F-statistic)	0.000604		

Source: Own calculations.

Table 3. The trend model of the number of insolvencies in Republic of Moldova (2013–2020)
Dependent Variable: Y_MOLDOVA
Method: Least Squares
Date: 04/01/22 Time: 16:51
Sample (adjusted): 2013 2020
Included observations: 8 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1233.518	2811.030	-0.438813	0.6791
T	3068.780	1433.181	2.141236	0.0852
T^2	-318.0536	155.4503	-2.046014	0.0961

R-squared	0.480599	Mean dependent var	4465.625
Adjusted R-squared	0.272838	S.D. dependent var	2362.821
S.E. of regression	2014.867	Akaike info criterion	18.33449
Sum squared resid	20298436	Schwarz criterion	18.36428
Log likelihood	-70.33796	Hannan-Quinn criter.	18.13356
F-statistic	2.313235	Durbin-Watson stat	1.953450
Prob(F-statistic)	0.194427		

Source: Own calculations.

After performing the dynamic analysis of number of insolvencies, in Table 2 and Table 3 the econometric trend models with the help of the classic least-squares method have been estimated, with the goal to describe the trend of corporate insolvencies in Ukraine and in the Republic of Moldova.

The above trend models may be considered as well adjusted to the empirical data. For Ukraine the R-squared coefficient of determination is higher than 91%. For the Republic of Moldova this coefficient exceeds only 48%. Even though, the time variables of the models are statistically significant, because they are not higher than 3%. There is no autocorrelation of the random component in the models and the residuals have a regular distribution [13]. There is no autocorrelation because R-squared is under critical value in Quennouille test [3]. This indicates that the null hypothesis should not to be rejected. Null hypothesis shows that is not any autocorrelation of the random component in the model, and demonstrates the lack of this phenomenon. More than it, the estimated tools ca be used in order to forecast the number of corporate insolvencies for the Republic of Moldova and Ukraine due to the relatively high adjustment of the models to empirical data.

In order to answer to the next two questions:

(2)What are the legislative regulations regarding insolvency proceedings in Republic of Moldova and Ukraine?

(3)What is the level of development of the research of the corporate insolvencies forecast methods in these two countries?,

we will use comparative-critical analysis of the literature, documentation, and documentary analysis.

The purpose of initiating insolvency proceedings is to protect creditors so that they can recover their debts, at least in part. Legal provisions must guarantee this protection, through such regulations that would promote discipline and integrity in the financial management of the insolvent entity [24]. Further we will analyse the basic legislation regarding insolvency proceedings in the Republic of Moldova and Ukraine, and the level of development of the research of the corporate insolvencies forecast methods in these two countries.

Experience of the Republic of Moldova

Moldovan bankruptcy (insolvency) law has undergone an intense evolution from the independence to present times, culminating by the adoption in 2012 of the fourth law regarding the institution of bankruptcy. Unfortunately, in the bankruptcy laws from 1992 and 1996 were not sufficient regulations regarding the resolution of insolvency issues, and regarding the pre-bankruptcy procedures.

Although the Bankruptcy Act of 2001 was a major step forward in the regulation of insolvency proceedings, it was only the first step in streamlining litigation.

An important step in the insolvency procedures streamlining was the adoption of the insolvency law in 2012, which includes a progressive procedure so called the accelerated restructuring procedure. Although it has a similar name as the restructuring procedure, which is an alternative to the bankruptcy procedure, the accelerated restructuring procedure represent a pre-bankruptcy procedure that cannot be applied by persons who are already bankrupt. This law was revised and entered into force on 13.07.21 [11].

Therefore, before the entry into force of the new law, interest in the issue of predicting the risks of bankruptcy of the company was insignificant. Interest in these issues especially intensified in the second half of the first decade of the 21st century, when Ruslan Mihalachi (2011) [16] elaborated a model for the corporate sector and Eugeniu Raetchi (2020) elaborated a model on a sample of 16 banks. The models were built using linear multivariate methods, discriminatory analysis and were designed to assess the risk of general bankruptcy. The models are considered more theoretical than practical ones and have never been officially recognized as tools for predicting bankruptcy risk.

This is because the law of the Republic of Moldova does not establish a bankruptcy risk assessment methodology, but only takes into account the ratio between the statutory capital and the value of net assets.

However, Muntean N. (2019) [17, 20, 21] developed her own bankruptcy analysis model, studying the impact of corruption, the level of economic growth, the quality of governance, fiscal policy and business freedom on number of insolvencies in European countries.

Experience of Ukraine

Ukraine gained independence in 1991, and the bankruptcy law came into force on July 1, 1992. The first national models for assesing the bankruptcy risk of Ukrainian companies appeared at the beginning of the 21st century and were developed by Martynenko and Tereshchenko. Both authors used the method of linear discriminative analysis. Matviychuk (2010) [14] came to conclusions that foreign models would not work in Ukrainian conditions. Therefore, Matviychuk developed national models using the methods of linear discriminant analysis and fuzzy logic using financial indicators as independent variables. A comparative analysis of the effectiveness of the models: Altman, Konan and Holder, Lis, Taffler, Springate, Beaver, the universal model based on the discriminant function, Chepurko, Saifullin, Kadykov and Sumy was carried out by Druzin (2013) on a sample of 15 firms as cited by [18]. He demonstrated that the most correct results can be achieved using the Springate, Lis and Beaver models. The author also remarked that the main problem in forecasting the bankruptcy risk of Ukrainian companies is the lack of available financial data. An interesting concept of a business bankruptcy prediction model was proposed by Kozak et al. (2013) as cited by [18]. They merged quantitative and qualitative variables, creating causal relations. The authors utilised a combination of fuzzy logic and cognitive technologies to build the model. This method is known theoretically as fuzzy cognitive maps. However, the authors did not show how it should be implemented in practice.

Kornilyuk (2014), cited by [18], conducted a study of the key factors that determine the risk of bankruptcy of Ukrainian banks. Banks with external capital are less exposed to the insolvency risk than banks with internal capital. Neskorodeva and Pustovgar (2015), cited by [18], used the Kohonen neural network and financial indicators to build a model of steel companies. In 2015, Kleban (2015), cited by [18], proposed, using fuzzy logic, to predict the bankruptcies of enterprises. He utilised the Takagi-Sugeno algorithm with financials and numbers as independent variables. Litvin (2015), cited by [18], developed models to predict insurer bankruptcies using the support machine technique. Klebanova et al. (2016) developed a bankruptcy forecasting model for agricultural enterprises based on 12 bankrupt and 24 non-bankrupt enterprises. To this effect, they applied a concept merging artificial neural networks and fuzzy logic as cited by [18].

As a result of the legislative acts analysis of these two countries, we came to the conclusion that the general financial criteria for initiating the insolvency process of a company are:

- Inability to pay (inability to pay one's obligations on time);
- Over-indebtedness (excess of debts over the company's assets).

The main differences between the insolvency norms, established in the legislation of these two countries, relate to the amount and term of non-payment of debts (Table 4).

Table 4. General criteria for substantiating insolvency proceedings

Country	Criteria 1	Criteria 2
Ukraine [15, 23]	debts > 300 minimum wages; 3 months after the due date	Debts > assets
Moldova [11]	the amount is not specified; 15 days after notification	Debts > assets

Source: Developed by the authors based on the normative acts of the analysed countries.

At the same time, to identify the insolvency of large companies, the regulations of the Republic of Moldova [10] suggest the use of the "net assets" method, which is directly identified with the concept of the company's equity, although the economic essence of this approach is much broader. According to the provisions of the International Accounting Standard (ISA) no. 321: "The net assets of an organization are those assets that remain after deducting all claims related to its assets."[7]

After analysing the level of development of the research of the corporate insolvencies forecast methods in Republic of Moldova and Ukraine, in Table 5 we identified the three, most important areas, namely:

-the methods used to develop national corporate bankruptcy forecasting models,
-types of variables,
-and information on sectoral models.

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Table 5. Summary of studies on predicting corporate insolvencies risk in the Republic of Moldova and Ukraine.

Countries	Used methods	Used variables	Industry Models
Republic of Moldova	multiple discriminant linear analysis	financial ratios	banks, universal model
Ukraine	multiple discriminant linear analysis, fuzzy logic method, Kohonen neural network, Takagi-Sugeno algorithm	financial ratios, in the case of banks - qualitative factors (e.g. capital structure)	banks, metallurgical industry, agricultural sector

Source: own compilation.

The data from Table 5 show that the most advanced methods are used in Ukraine, while only classical methods are introduced in Republic of Moldova. In Ukraine, alongside the financial indicators were used as independent variables other variables. In the Republic of Moldova are utilised only financial rates. In Ukraine have been developed industry models as well. In the Republic of Moldova only 2 universal models have been elaborated.

CONCLUSIONS

Research regarding the corporate insolvencies' evolution is relevant and this fact is confirmed by a grate number of scientific articles and papers.

In this article were discussed such aspects as:

-a review of the relevance of the researched issue;

-an analyse of the corporate insolvencies' evolution with the help of chain indices in the Republic of Moldova and Ukraine during 2013-2020;

-an econometric analysis, using the classic least-squares method, with the goal to describe the trend of corporate insolvencies in Ukraine and in the Republic of Moldova;

-an analysis of the legislative acts of these two countries regarding the insolvency process of a company;

-a description of the level of development of the research of the corporate insolvencies forecast methods in Republic of Moldova and Ukraine.

The results of the evolution analysis shows that these two countries are characterized by different directions of modifications of number of corporate insolvencies during the analysed period, excepting 2020 year. During 2020 year, because of the COVID-19 pandemic impact, the business environment was deteriorated. That is why in this period Ukrainian and the Republic of Moldova governments tried to support and help business and affected branches. This is the reason why the number of insolvencies in Ukraine and Republic of Moldova, does not reflect the reality in 2020 and a huge increase are to be expected in next years.

At the same time, the performed econometric analysis, shows that the Republic of Moldova and Ukrainian models have a relatively high adjustment to the empirical data, demonstrating the possibility of the estimated tools usage in order to forecast the number of corporate insolvencies.

As a result of the legislative acts analysis of these two countries, we came to the conclusion that the main differences between the insolvency norms, established in the legislation, relate to the amount and term of non-payment of debts.

After analysing the level of development of the research of the corporate insolvencies forecast methods in Republic of Moldova and Ukraine, we concluded that the most advanced methods are used in Ukraine, while only classical methods are introduced in Republic of Moldova.

Thus, corporate insolvencies are not a mass phenomenon, and the research performed in this paper represent a strong confirmation of this fact. More than it, this article may ensure relevant data for other researchers on this topic.

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ECOLOGICAL ISSUES OF ENSURING SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN AZERBAIJAN

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Abstract

The sustainable development of the agricultural sector is determined by three closely interrelated components: economic, social and environmental. In the paper, we have tried to identify environmental problems in the sustainable development of the agricultural sector, focusing on the environmental component of sustainable development. At the same time, the system of factors determining the sustainable development of agricultural production was substantiated during the study. The purpose of the study to systematize and justify the environmental factors that contributes to the sustainable development of agricultural production. Relevance of the study ensuring food security in the context of Azerbaijan's integration into the world market urgently requires sustainable development of the agricultural sector. The high level of environmental tensions in the development of agriculture requires a radical renewal of the strategy and tactics of agricultural development, strengthening the role of the agricultural sector.

Key words**:** *sustainable development, agriculture, environmental factors, food security*

INTRODUCTION

The concepts of "sustainable development" and "sustainable economic growth" are closely linked. And sustainable development means sustainable economic growth. The main task of sustainable development is expressed in the continuous (sustainable) satisfaction of the needs and desires of society. Sustainable economic development is the gradual improvement of one state by another as a result of dynamic growth and the balanced interaction of the components of the economic system in the long run. The instability of the economic system is its inability to continue to move on a positive growth trajectory due to its negative components [27].

The principles of sustainable development by researchers include the following:

1) Stability, i.e. the mandatory existence of three interrelated components of compliance with the triple concept, which combines economic, social and environmental aspects;

2) Sustainability, i.e. development in any sector of the economy should show a certain dynamics of change (even negative), because it is impossible to talk about sustainable development only in the conditions of complete cessation of this process;

3) Positivity, i.e. changes in all three components must be positive. In other words, such development of a sector or economy is unsustainable if production or economic indicators that aggravate environmental or social parameters are achieved.

Currently, the most accepted concept in the world is the concept of "Sustainable Development". The concept was adopted at the UN Conference in Rio de Janeiro-92 and is used in the development of national strategies for sustainable development. Since 2003, the Azerbaijani state has adopted a National Program for Environmentally Sustainable Socio-Economic Development. The Republic of Azerbaijan signed the Paris Agreement on April 22, 2016, added to the UN Framework Convention on Climate Change, and ratified it in October of that year. According to this agreement, Azerbaijan aims to maintain a 35% reduction in thermal gas emissions by 2030 compared to 1990, as a contribution to global climate change mitigation initiatives. In addition, it has joined the Sustainable Development Goals (SDGs) approved by the UN Summit for Sustainable Development for 2016-2030 [14].

There are problems in life, the solution of which depends not only on humanity, but also on all countries and their populations. Such problems include the protection of the environment, the ecological balance of the biosphere.

Taking into account the current ecological situation and socio-economic situation, the following three main directions of the environmental policy of our republic can be identified:

• Application of advanced methods based on the principles of sustainable development in order to minimize environmental pollution and regulate its protection, based on ensuring environmental safety;

• Efficient use of natural resources to meet the needs of present and future generations, use of inexhaustible energy sources through alternative, non-traditional methods and achieving energy efficiency;

• Assessing needs at the national level on global environmental problems, identifying solutions, expanding relations with international organizations, as well as ensuring their implementation using national potential.

Currently, due to economic, political, technological and other reasons, more than 50% of the world's population lives in cities, and this figure is expected to increase to 70% by 2050. For this reason, the leading countries of the world, with the support of international organizations, are trying to apply sustainable development models that balance economic development and the environment to prevent environmental, demographic and other problems caused by increasing urbanization.

As in many countries, environmental problems in Azerbaijan are more typical for industrial and agricultural regions (Baku, Sumgayit, Shirvan, Ganja, Mingachevir, Nakhchivan).

Pollution of the environment, soil and water is one of the main reasons hindering the sustainable development of agriculture. However, agriculture also plays an important role in polluting the environment, soil and water. Agriculture causes significant and sometimes irreparable damage to the natural environment.

Recently, many publications have seen the achievement of sustainable agriculture in the transition from a man-made farming system to an environmentally sustainable system of “ecologically balanced agriculture”.

In this context the purpose of the paper is to identify environmental problems in the sustainable development of the agricultural sector.

MATERIALS AND METHODS

In this paper used a systematic approach to determine the system of factors contributing to the sustainable development of agricultural production and statistical comparative analysis methods to assess the environmental situation in the agricultural sector. The paper uses data from the Ministry of Ecology and Natural Resources and the Azerbaijan Statistics Committee. In the process of working on the paper were used the relevant laws and national programs of the state, such as Law of the Republic of Azerbaijan “On ecologically clean agriculture”, “State Program on forest protection and sustainable development in the Republic of Azerbaijan for 2022-2030”, “National Strategy for Improving Solid Waste Management in the Republic of Azerbaijan for 2018-2022”, “State Program of Socio-economic Development of the Regions of the Republic of Azerbaijan in 2019-2023” and etc.

RESULTS AND DISCUSSIONS

Agriculture is a complex and multi-level system. In this regard, in our opinion, it is important to identify internal and external factors affecting the sustainable development of agriculture (Figure 1). External factors play a crucial role in sustainable development. From this point of view, the existence and development of these factors is clearly related to the macroeconomic environment. Internal factors cover the level of development and condition of the economy and the enterprise.

Sustainable development is expanded reproduction, where investment, use of material, financial and labor resources, as well as strategic and institutional transformations are interrelated and aimed at meeting the growing needs of society.

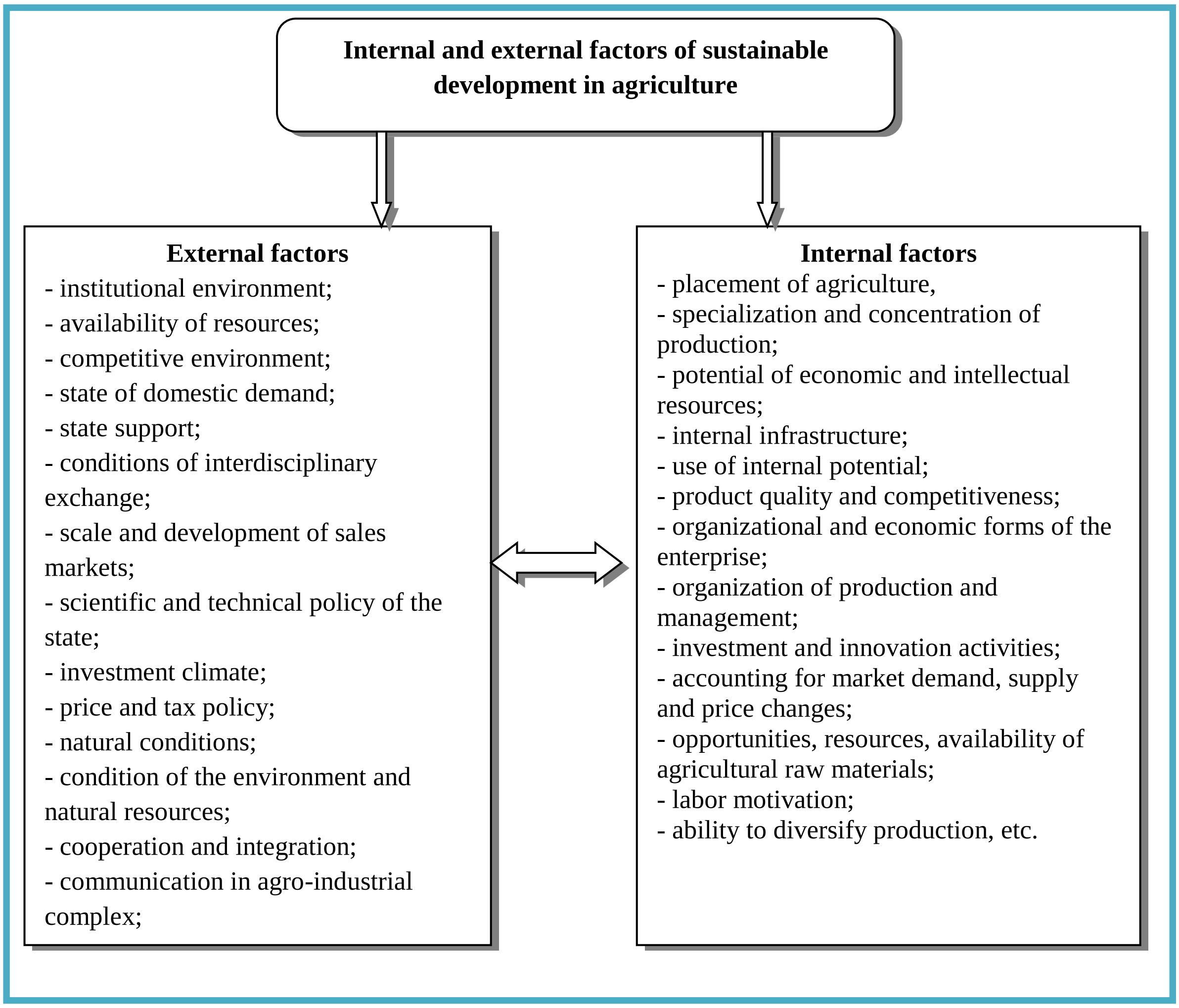

Fig. 1. Classification of internal and external factors affecting sustainable development in agriculture
Source: Compiled by the authors based on the collected information.

When efforts at sustainable economic development are combined at all levels - regional, state, family and individual - in a more compact way, a fertile ground is created for high results [10]. The dependence of agriculture, a key component of sustainable agricultural development, on natural resources and climatic conditions makes it less sustainable than other sectors of the economy and does not allow it to adapt to a market economy. As a result, agriculture cannot develop without state support [11].

In our opinion, state support for agriculture is important. This is because agriculture is the basis of ensuring the country's food security and supplying industry with raw materials. And this support cannot negatively affect sustainable development; on the contrary, it promotes sustainable development.

In contrast to the crises that regularly occur in the world economy during economic development, "sustainable development" involves maintaining a balance between the interrelated elements of the system - the economy, the social sphere and the environment [2]. The concept of sustainable agricultural development is inextricably linked with the growth of food production, efficient use of economic and intellectual resources, improving the welfare and quality of life of the rural population, stable and balanced management of nature. Only a balance of economic, social and environmental components can ensure the sustainable development of this industry for a long time. The relationship between the components of sustainable agriculture development is shown in Figure 2.

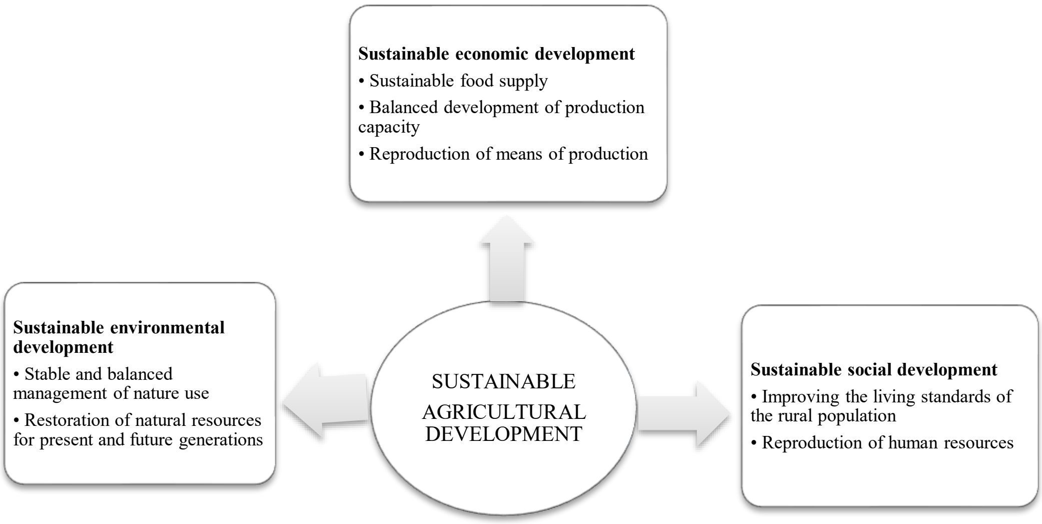

Fig. 2. Interrelation of components of sustainable development of agriculture
Source: https://cyberleninka.ru/article/n/metodologicheskie-osnovy-ustoychivogo-razvitiya-regionalnyh-sotsio-ekologo-ekonomicheskih-sistem [5].

The use of stable, balanced nature is associated with ensuring the current and long-term sustainability of agricultural systems, improving the quality of the environment and protecting natural resources.

Climate change should also be emphasized in terms of agricultural sustainability. Climate change's negative impacts are already being felt, in the form of increasing temperatures, weather variability, shifting agroecosystem boundaries, invasive crops and pests, and more frequent extreme weather events. On farms, climate change is reducing crop yields, the nutritional quality of major cereals, and lowering livestock productivity [25].

Assessment of the impact of the ecological situation in the Republic of Azerbaijan on the sustainable development of agriculture

Agriculture is a field of social production, closely related to the biological laws of the development of the living world. No other field of economic activity is as prominent as in agriculture.

Ensuring the stable and sustainable development of agricultural production, which is the basis of the agrarian sector, depends, above all, on the efficient use of water and land resources, soil productivity enhancement and ensuring its reproduction. It should be noted that after the independence of our country, radical reforms have been carried out in the agricultural sector [15]. The measures taken by the state to improve land use are one of the leading directions of the independent agrarian policy in the country (amelioration, salinization, environmental pollution, etc.). In order to improve the quality of the environment, efficient use and restoration of natural resources, strengthening the legislation in the field of environmental protection, the interaction of nature with society is regulated by the Law of the Republic of Azerbaijan on Environmental Protection adopted on June 8, 1999.

Maintaining the necessary balance between the economy, society and the environment in the context of the global environmental crisis can only be achieved through the formation of a new environmentally safe and economically optimal model of development - sustainable development. In this context, the main priority now is to coordinate global, regional and national tools to achieve the goals of sustainable development [14].

Improving ecological conditions, environmental protection, forestry, hydrometeorology, etc. Great work has been done in the last few years as a result of the principled position of the country's leadership, national and state programs aimed at their comprehensive solution have been approved, legislative acts in the field of ecology and environmental protection have been approved. and government decisions have been made or improved [1, 13, 16, 18, 19, 20, 21].

The liberation of our territories from Armenian occupation in 2020 has set new tasks in the fields of socio-economic and innovative development. In accordance with the "Azerbaijan 2030: National Priorities for Socio-Economic Development", the "Strategy for Socio-Economic Development in 2021-2025" sets the task of implementing reforms, projects and measures in 5 important areas on the basis of national priorities:

1)sustainable, growing and competitive economy;

2)a dynamic, inclusive and socially just society;

3)competitive human capital and space for modern innovations;

4)a great return to the liberated territories;

5)clean environment and "green growth" country.

The analysis shows that the main environmental problems of the country are:

- pollution of water resources with wastewater, including exposure to transboundary pollution;
- low level of quality water supply of settlements, loss of fresh water before delivery to consumers, lack of sewerage lines;
- air pollution by industrial enterprises and vehicles;
- degradation of fertile soils (erosion, salinization, etc.);
- inadequate management of solid industrial and domestic wastes, including hazardous wastes;
- biodiversity thinning;
- reduction of forest resources, fauna, including fish stocks.

Maintaining the necessary balance between the economy, society and the environment in the context of the global environmental crisis can only be achieved through the formation of a new environmentally safe and economically optimal model of development - sustainable development. The main priority here is to coordinate global, regional and national tools for achieving the goals of sustainable development.

To assess the state of the natural elements of the research object, let's consider the climatic features of the country. Most of the territory of the Republic of Azerbaijan is located in the subtropical climate zone, only in the north-eastern temperate zone of the Greater Caucasus Mountains. Of the 7 climate zones in the world, only 2 are in Azerbaijan, of which 65% are subtropical and 35% are temperate. The uniqueness of natural and geographical conditions has created conditions for the diversity of species of flora and fauna. 9 out of 11 climate types on Earth are found in Azerbaijan. This factor plays an important role in the formation of rich biodiversity in the country [14].

The main risks for agricultural production are: uneven distribution of precipitation throughout the year; dry winds that contribute to moisture loss and soil drying.

The main element of the resource potential of agricultural production is land, or more precisely, land cover. However, not enough attention is paid to the problems of biologicalization of agriculture. It takes nature 200-300 years to restore one centimeter of black soil [12]. However, buildings, flooded lands, inefficient agriculture, especially intensive pastures, improper irrigation and plowing have led to the withdrawal of agricultural land in our country.

The implementation of a number of economic and organizational measures to ensure the timely, targeted and high level of capital investment in nature protection measures has become sustainable in the country. Analysis of expenditures on environmental protection shows that expenditures in 2010 increased by about 1.6 times from 260,673.8 thousand manat in 2012 to 419,317.9 thousand manat. Expenditures in 2012-2015 decreased by 3.1 times. The main reason for the decline is the devaluation process that took place in the country in 2015-2017. We see an increasing dynamics of spending between 2016-2019. Expenditures incurred in 2019 compared to 2015 increased by 2.8 times from 136,208.3 thousand manat and amounted to 387,680.4 thousand manat. The decline in 2020 can be seen as a reduction in environmental spending in the structure of global storm and pandemic costs. Thus, compared to 2019, expenditures on environmental protection in 2020 decreased by about 1.6 times and amounted to 239,764.5 thousand manat (Figure 3).

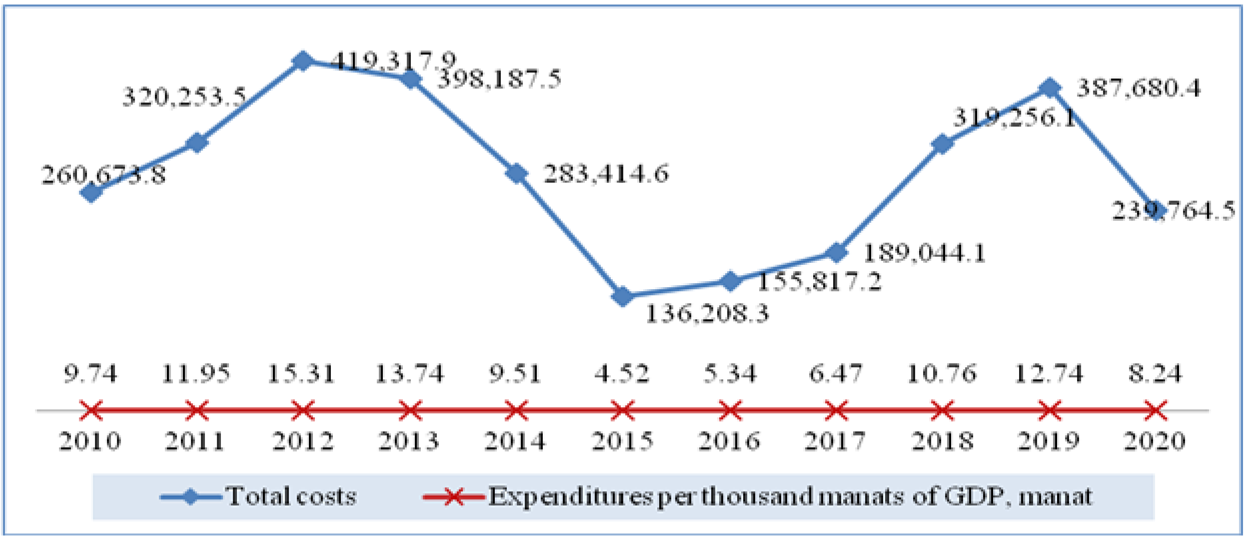

Fig. 3. Expenditures on environmental protection in 2010-2020 (thousand manats)
Source: Compiled by the authors based on the State Statistical Committee of the Republic of Azerbaijan [22].

In the structure of expenditures, current expenditures on environmental protection measures - 15%, overhaul of fixed assets for environmental protection - about 0.3%, maintenance of reserves and national parks, protection and reproduction of wild animals, fish - 1.8%, forestry operations - 2.8% %, funds directed to fixed assets for environmental protection and efficient use of natural resources - 80%. Expenditures per thousand manat of GDP in 2020 amounted to 8.24 manat.

The amount of funds directed to fixed capital for environmental protection and efficient use of natural resources in the Republic of Azerbaijan is given in Table 1. The analysis shows that the volume of major investments in environmental protection and efficient use of natural resources in the country decreased by about 10.4% between 2010 and 2020, from 190,007.2 thousand manat to 170,208.7 thousand manat. It should be noted that the decline in oil revenues has not passed without an impact on investments in fixed assets in the country. Compared to 2010, there was a 1.7-fold decrease in 2016. In 2016, 99.5% of the total investment in this area was directed to the protection and efficient use of water resources.

In the context of population growth and deterioration of the environment, as well as the observed global climate change and declining fertile land resources and drinking water resources, it is necessary to improve the provision of the population with quality food, increase and intensify agricultural production. For these reasons, substantiation and solution of complex scientific views for the development of irrigation and land reclamation complex with modern engineering, economic and environmental safety and more effective protection of the environment, advanced management methods, information technologies in irrigation and land reclamation It is necessary for its application and rapid future development on a completely new level, taking into account the trends in the field [17].

Water is a prerequisite for life, support for sustainable development and is one of the biggest global risks and deserves special attention. This is because water scarcity and mismanagement, especially in transboundary watersheds, can even increase the potential for conflict. At the same time, problems with water resources can exacerbate social, environmental, economic and financial stresses.

It should be noted that the main reason for the increase in the amount of water in large rivers is small rivers. However, recently these small rivers are also in danger of drying up. Rivers also regulate soil, air humidity and microclimate. In this regard, the protection of such areas should always be kept in mind.

Modern agriculture is not only the largest consumer of water resources, but also one of the most polluting areas. It is primarily about the pollution of rivers with organic matter, water bodies with eutrophic nutrients, water sources with pesticides and mineral fertilizers, ground and surface water with oils and waste generated during the cleaning of agricultural machinery.

Our republic has limited water resources. However, research shows that the country's potential water resources can meet the water needs of industry, agriculture and households. Approximately 67-70% of water resources (19.0 - 20.5 cubic km) are formed in transboundary rivers and 9.5-10 cubic km mainly in inland rivers. In dry years, water reserves fall to 27.0-22.6 cubic km. Accordingly, 17.1 - 14.3 cubic km of these waters belong to transboundary rivers. The total surface water resources in Azerbaijan vary between 9.0 and 11.0 cubic km. [23].

The World Economic Forum has listed the water crisis as one of the top three important global risks. This problem is included in the UN 2030 Sustainable Development Goals, the Sendai Framework Program for Disaster Risk Reduction and international agreements such as the Paris Agreement. For this purpose, cross-border diagnostic tests are carried out in our country in order to prevent water pollution and at the same time transboundary pollution. Our country participates in various projects at the national, regional and global levels [24, 26].

In general, no investments were made in air protection in 2010, 2015 and 2016. It is important to pay attention to the protection of the atmosphere in order to improve the ecological situation in our country and ensure environmental security. Research shows that the air situation in the country remains tense.

Agriculture is a major part of the climate problem. It currently generates 19–29% of total greenhouse gas (GHG) emissions. Without action, that percentage could rise substantially as other sectors reduce their emissions. Additionally, 1/3 of food produced globally is either lost or wasted. Addressing food loss and waste is critical to helping meet climate goals and reduce stress on the environment [25]. According to empirical studies, there is a long-term relationship between agricultural production and carbon dioxide (CO_2) emissions in Azerbaijan. Agricultural production and the square of GDP have a negative impact on air pollution [9].

In order to protect the atmosphere, many developed countries have already switched to European standards. In order to prevent air pollution and efficient use of natural resources, the use of technologies to improve energy efficiency, as well as alternative energy sources such as sustainable energy sources (wind, solar, biogas, biomass, geothermal, hydroelectric) has become widespread. In Azerbaijan, this work is very slow.

Land resources are valued as one of the key elements of its existence and potential for the development of all countries. Land, with its natural historical landscape and land cover, is one of the most important natural resources for the life of society. Unlike other natural resources, it is spatially limited and irreplaceable. Being the basis for the development and deployment of the productive forces of society, all sectors of the economy, land resources in agriculture and forestry act as the main means of production, the object of production relations. The economic and environmental well-being of the state depends to a large extent on their condition, how and to what extent they are used. Like any natural resource with which society interacts throughout its life, land resources are subject to structural and qualitative changes in the process of use. Human activity must be strictly in accordance with the laws of nature, and ignoring or underestimating them can lead to unintended consequences. It is the duty of society as a whole to protect the naturl fertility of the soil and to use all types of land resources efficiently.

When assessing the efficiency of land use by changing and improving land relations, the level of protection of soil fertility, the degree of ecological balance, the volume of land improvement work, etc. should be taken into account. is also of great methodological importance [3].

In 2010, 2015, 2016, 29%, 0.5% and 0.5% of total investments were directed to the protection and efficient use of lands, respectively. The volume of investments in land protection increased by 8.6 times in 2019 compared to 2016 and amounted to 4,734.9 thousand manat from 550,000 manat. In 2020, the total investment amounted to 170,208.7 thousand manat, all of which was aimed at the protection of water resources and their efficient use. According to other indicators, no investments were made in 2020.

Table 1. Funds directed to fixed capital for environmental protection and efficient use of natural resources (thousand manats)

	2010	2015	2016	2017	2018	2019	2020
Overall	190,007.2	84,864.4	109,546.0	133,387.0	247,912.2	309,855.6	170,208.7
protection of water resources their efficient use	134,936.9	84,474.4	108,996.0	117,387.0	233,348.1	294,922.5	170,208.7
to protect the atmosphere	-	-	-	16,000.0	13,498.5	10,198.2	-
protection of lands and t efficient use	55,070.3	390.0	550.0	-	1,065.6	4,734.9	-

Source: The State Statistical Committee of the Republic of Azerbaijan [22].

The exogenous environment plays a crucial role in the sustainable development of the national economy. Separately, both the present and the future of each country can be characterized as a function of the complex of relations formed between the national → regional → global levels [4].

At the global level, agriculture is currently in a period of transition from the Green Revolution to the Second Green Revolution or the Biotechnological Revolution. Thus, against the background of limited land and water resources, although intensive production methods have provided a significant increase in global food supply, there have also been serious negative impacts on the environment and ecosystems. This factor has necessitated the expansion of the use of new technologies in modern times that allow for sustainable agricultural production. That is why biotechnology in modern times acts as a means to radically strengthen global food security and reduce the negative impact on the environment. Thanks to biotechnology, plant species resistant to drought, heat, cold, soil salinization, pests, toxic herbicides, as well as animal species resistant to diseases and climate change are created. Such species help to ensure farm efficiency in marginal areas and rehabilitate degraded soils, as well as significantly reduce the need for pesticides and mineral fertilizers. However, the creation of effective national regulatory systems in each country based on international standards is one of the important global challenges to identify and control the negative impacts of the application of biotechnology on the environment and food security.

It is time to introduce completely new and effective methods and approaches to the storage and distribution of food resources in accordance with the requirements of food availability. The responsibility for the treatment of ecosystems, the importance of environmental safety must be made clear to everyone, the scope of awareness-raising in these areas must be significantly expanded, and the views of farmers on the protection of nature and biodiversity must be fully understood in the context of climate change. It should be clear that food producers need to fully understand the important points in this regard [10].

The development of Climate-Smart Agriculture (CSA) is of particular importance in terms of solving environmental problems in the agricultural sector and combating climate change. Climate-Smart Agriculture will help achieve the following goals: increased productivity, enhance resiliense and reduced emissions. According to a study based on an extensive review of scientific evidence relating in particular to climate-smart agriculture (CSA), focusing on the role of the CSA, a set of priority actions for greening systems has been compiled. The results of the analysis provide insight into a new model of system dynamics capable of representing complex causal relationships and non-linear feedback loops between key dimensions and sustainable development actors [6].

The liberation of our territories from Armenian occupation in 2020 has set new tasks in the socio-economic sphere as well as in the environmental sphere. Armenia has committed unimaginable environmental terror in the occupied territories of Azerbaijan for almost 30 years, and it continues to do so. The scale of the environmental catastrophe (environmental terrorism) caused by the Armenian terrorist forces in the region is unimaginable. Unprecedented damage has been inflicted on the flora and fauna of Karabakh and its forests, the agricultural system has been completely destroyed, and our lands have been mined.

The above-mentioned violations of international conventions on ecology and the environment, to which Armenia is a party, including the UN Convention on the Prohibition of the Use of Military or Any Other Hostile Methods of Environmental Change.

According to the land balance, more than 200,000 hectares of land in the liberated areas will be used for agriculture after the restoration of agriculture, of which about 9,000 hectares are backyards.

There is also an accurate assessment of the potential for the establishment of irrigation systems in these areas, and irrigation opportunities in general. After the assessment of land and water resources and the establishment of an accounting system, the main task is undoubtedly to carry out land reform in the liberated areas.

According to estimates, due to the restoration of agricultural production in the region, the total volume of agricultural production in the country is expected to increase by more than 8% [8].

CONCLUSIONS

As a result, it should be noted that all processes between agriculture and the environment are closely linked. The negative manifestation of one does not pass unnoticed to the other. Currently, the depletion of natural resources reduces the base for agricultural production, which can create great economic difficulties in the future. Based on our analysis, let us note that these difficulties are already manifesting themselves. Inefficient use of lands, application of large amounts of fertilizers, improper installation of irrigation systems, etc. causes pollution of soil, water and atmosphere with harmful components, chemicals, exhaust gases.

Given that natural resources are the national wealth of the country, then the issue of solving the environmental problem in the context of economic security should always be in the center of attention during their privatization.

Given the importance of sustainable development investments, the use of material, financial and labor resources, as well as strategic and institutional changes and expanded reproduction to meet the growing needs of society, we must emphasize the importance of the state's role in ensuring sustainable agricultural development in Azerbaijan. Optimization of technological processes aimed at the development and improvement of agriculture is not possible without the financial support of the state. This is very important to prevent environmental pollution and provide the population with healthy and environmentally friendly food. Also increase investments in agricultural R&D, extension and advisory services, as well as capacity development to improve national agricultural innovation systems [7] and the coordination of investments/measures in agriculture and a higher level of knowledge of farmers [6].

In addition, it is important to regularly monitor the current state of environmental factors using qualitative and quantitative indicators to assess threats and limit further unsustainable expansion of economic activity, and to achieve a balanced use of factors of production. Otherwise, in the future, our country may face serious problems related to sustainable development.

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THE INFLUENCE OF THE CASTRATION METHOD ON MEAT CUTS INDICATORS OF PIG CARCASSES

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Abstract

In order to determine the influence of the castration method on the indicators of the meat cuts of pig carcasses, two groups of 74 boars were selected. Surgical castration was carried out in one of them, and immunological vaccination method was used in the other group. Both surgically castrated and immunocastrated boars were reared and fattened under the same conditions. And at the end of fattening, they were slaughtered and their carcasses evaluated for weight and proportion of meat cuts separately in the cervical-scapular, back-lumbar and pelvic-femoral thirds. The result of the assessment was the establishment of a significantly higher value of the weight indicators of such meat cuts as single-grade pork from the neck by 0.3 kg or 20.0% (P <0.01) and the weight of lard with skin by 0.6 kg or 13.64 % (P <0.05) in the shoulder-scapular third of the carcass and single-grade pork per 0.2 kg or 15.38% (P <0.05) in the pelvic-femoral third of the carcass in immunocastrated pigs. A significant difference in the weight and content of other meat cuts of carcasses was not established with the use of immuno- and surgical castration of pigs.

Key words*: *immunocastration, surgical castration, neck meat, brisket, loin, belly

INTRODUCTION

Besides the influence of the pre-slaughtering live weight, castration is another factor with a deep influence on the pork quality [31]. In order to improve the taste qualities of pork, boars are castrated, which is a common component of the production of high-quality meat products in the world. However, recent trends in the humanization of the production process of the use of animals in agriculture require such an organization that minimizes the suffering and pain of pigs and their cruel treatment. The essence of castration comes down to stopping the functioning of the gonads [15] and preventing the accumulation of skatole and androstenol in fatty tissues and muscle bundles, which are the cause of unpleasant taste and specific smell [3]. The traditional method of pig castration is surgical. Physical or surgical castration of boars is currently still a common practice to reduce the appearance of boar taint in male pigs [13], although it is increasingly criticized for its negative impact on pig welfare [4]. In addition to the common method of surgical castration of boars [36], various countries use such methods as artificial reduction of the activity of the hypothalamic-pituitary-gonadal axis [14, 38], local destruction of testicles with chemical components [40], as well as immunocastration [6, 33]. Immunocastration is a way to ensure both high quality products and a high level of animal welfare [22]. However, this method of castration is not universally accepted. In many countries, it has either not yet spread due to the low development of technology in the pig industry, or due to the fears of farmers and consumers about the negative consequences for human health from the consumption of meat products from immunocastrated pigs, which is associated with a lack of information [24].

Surgical castration is a cheaper veterinary procedure compared to immunological castration, and does not require an expensive special vaccine, injection equipment, monitoring of piglets for subcutaneous reaction and repeated twice labor-intensive manipulation [20]. However, surgically castrated males typically consume 10-15% more feed compared to immunocastrated males to produce the same amount of pork [26], which minimizes the cost of surgical castration. And the subsequent higher feed efficiency of immunocastrated boars compared to surgically castrated ones can offset the higher costs of immunological castration of pigs [10].

It has been established that immunocastration as an alternative to surgical castration has a number of advantages and disadvantages. It was found that the disadvantage of surgical castration consists in a noticeable increase in feed costs [8] and higher carcass fat content[17], the risk of bleeding, the development of suppuration of the wound and the formation of hernias after surgical intervention. The use of immunocastration improves both consumption and assimilation of feed, increasing meat content,the area of the back longest muscle, the protein content in the meat and a decrease in the fat content and the thickness of lard [35]. Similar data on a higher calculated percentage of lean meat at approximately the same carcass weight in immunocastrates compared to surgically castrated counterparts were also given in other studies [1].

As revealed in many scientific experiments, immunocastration contributes not only to a greater meat yield from boar carcasses, but also to an increase in the most valuable large-piece semi-finished products. In particular, other comparisons of immunocastrates with surgical castrates show their advantages in terms of carcass quality (less carcass fat, heavier leg and shoulder) [11]. It was established that the carcasses of immunocastrated pigs differed from the carcasses of surgically castrated pigs by higher carcass weight [25], longer carcass length and length of the bacon half, and lower bacon thickness at all measurement points [29]. In addition, scientists also report better carcass quality from immunocastrated pigs due to increased meat content, reduced boneless shoulder fat and leg fat, as well as reduced total fat and skin content [16]. There are reports that the use of immunocastration in boars leads not only to a decrease in fatness of carcasses, but also to an improvement in growth, compared to the effect of surgical castration [27]. In published similar data, we found that during the period of fattening, the best average daily gain was distinguished by immunocastrated pigs, which consumed 0.09 or 2.8% less feed per kilogram of gain compared to uncastrated pigs and by 11.4% compared to surgical castrates [30].

There are studies that do not confirm the positive effect of immunological castration either on the parameters of carcasses or on the indicators of their large-piece components. In particular, it has been reported that carcass parameters and meat quality are generally not different between immunocastrated and surgically castrated boars [41]. Similarly, it was indicated that no significant difference in the parameters of carcasses and their parts was found between surgically and immunocastrated pigs [39]. For example, pig carcasses with both methods of castration did not differ in length and the length of the bacon half [9].

Moreover, some authors also note the negative impact of immunological castration on the slaughter performance of pigs. In particular, the results of scientific works indicated that immunocastration led to increased fat deposition, although it did not affect the parameters of muscle mass [37]. At the same time, it became known that immunologically castrated pigs lost an average of 0.7% more live weight during transportation and pre-slaughter holding than surgically castrated ones. Surgically castrated pigs had an advantage of 1.43% compared to immunologically castrated ones in terms of carcass yield [7]. It has also been reported that in terms of carcass quality, immunocastrates occupy an intermediate position between surgically castrated and non-castrated pigs [5]. The percentage slaughter yield of immunocastrates compared to surgical castrates was lower, indicating higher economic losses in pork production using immunocastration compared to the surgical castration baseline [32]. In support of such data, a conclusion was found that immunocastrates are economically less profitable for pork production than surgically castrated pigs [21]. It has also been reported that immunocastrated pigs showed more aggressive social activity before receiving the second dose of vaccine compared to surgically castrated counterparts, but their behavior leveled off after revaccination [34].

Therefore, taking into account the diverse views of scientists regarding the effectiveness of using immunocastration of pigs to improve production and increase slaughter qualities, its research is relevant. In this regard, the goal of our work is to study the influence of the castration method on the meat cuts indicators of pig carcases.

MATERIALS AND METHODS

The research material was hybrid pigs obtained from a combination of crossbred Great White and Landrace sows with boars of the Maxgro synthetic line of Irish origin, raised in the conditions of Globinsky Pig Complex LLC, Poltava region, Ukraine, and the object of research was their slaughter qualities, namely, high weight-pieces of carcass meat cuts. Two pairs of normally developed sows, close in weight, numbered with red and blue tags with individual numbers, were selected for research during the farrowing period of sows, and weighed individually.

Pigs of the first (control) group in the number of 74 heads marked with red tags were surgically castrated on the same day, and boars of the second (experimental) group also in the number of 74 heads marked with blue tags were left uncastrated for their further immunological castration with Improvac Boar Taint Vaccine (Zoetis, South Africa).

Six days after being put on fattening at the age of 77 days, uncastrated piglets were injected with the Improvac vaccine in a dose of 2 ml. Repeated vaccination with the same vaccine was carried out on the 125th day of life in a dose of 2 ml. At the end of fattening, all animals after a 24-hour waiting period were individually weighed with a fixation of the weight on the animal's back, after which 30 heads weighing close to 100 kg were selected from each group and sent to the meat processing plant. Group I included surgically castrated animals with a live weight of 100.5 kg. The II group included immunologically castrated animals with a live weight of 100.5 kg, respectively. On the same day, the animals of both groups were slaughtered in accordance with ISO 23781:2021 [18] at Globinsky Meat Factory LLC, Poltava region, Ukraine, and their carcasses were placed in a refrigerator for intensive cooling for 24 hours. The carcasses were deboned in accordance with ISO 3100-1 [19] in the deboning unit of the slaughterhouse. During deboning and according to its results, the mass and proportion of the most valuable large-piece parts of the carcass were evaluated.

The calculation of statistical data processing included: determination of the average value of the indicator, standard error of the value, standard deviation. The significance of the discrepancy ($p \leq 0.01$) of carcass indicators of different groups ($n = 30$) was determined using the Student's t-test. The indicated statistical calculations were performed using Microsoft Office Excel 2010.

The feeding, castration and other manipulations of the pigs in the study were humane and did not cause pain or cruelty and met the requirements of Council Directive 86/609/EEC [12]. The methodological part of the experiment was approved by the Bioethical Commissions of Animal Care and Use during scientific (experimental) research of Sumy National Agrarian University (ethical approval number BT-22-0122-05).

RESULTS AND DISCUSSIONS

The evaluation of the mass of large-piece semi-finished products in the shoulder-scapula third of the carcass of experimental pigs revealed that immunocastrated pigs had a significantly higher value of the weight of neck single-grade pork from the neck by 0.3 kg or 20.0% ($p < 0.01$) and a higher value of the weight of lard with skin by 0.6 kg or 13.64% ($p < 0.05$). According to such parts of the carcass as the neck with the bone, meat from the neck, meat from the shoulder blade, single-grade pork from the shoulder blade in the shoulder-scapula third of the carcass between surgically and immunocastrated animals, there was no probable difference (Table 1).

According to the share of the main large-piece semi-finished products in the shoulder-scapula third (Fig. 1), a slight advantage of immunological castrates was established in terms of the content of neck with bone, neck meat, neck single-grade pork, shoulder blade meat without bone, and a significantly lower lard content in it.

Table 1. Mass of large-piece semi-finished products in the shoulder-scapulathird of the carcass, n=30

Indicator	Group I	Group II
Mass of the shoulder-scapular third, kg	25.0±1.41	25.3±1.38
Neck with bone, kg	8.2±0.46	8.6±0.49
Neck meat, kg	4.4±0.24	4.6±0.20
Neck bone, kg	2.3±0.15	2.1±0.21
Neck single grade pork, kg	1.5±0.07	$1.8{\pm}0.08^2$
Shoulder blade meat, kg	8.6±0.48	9.1±0.55
Shoulder bone, kg	1.9±0.10	2.2±0.26
Shoulder single grade pork, kg	1.9±0.12	2.1±0.12
Lard with skin, kg	4.4±0.25	$3.8{\pm}0.08^1$

1 – P < 0.05; 2 – P < 0.01
Source: own calculations.

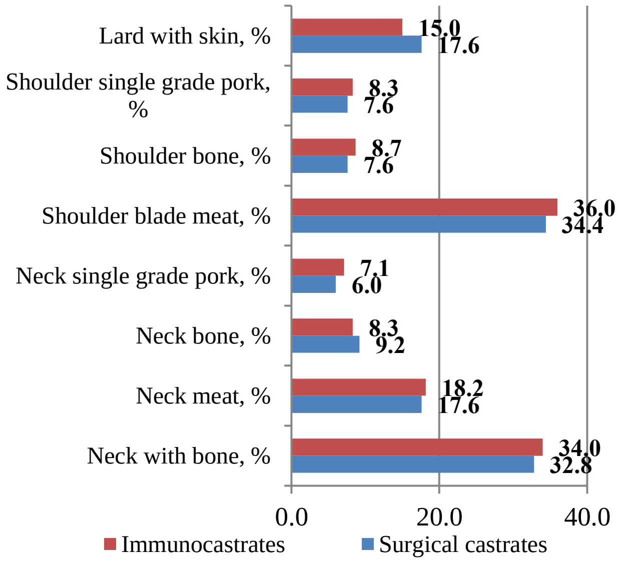

Fig. 1. Part of large-piece semi-finished products in the shoulder-scapula third of the carcass
Source: own calculations.

Table 2. Mass of large-piece semi-finished products in the back-lumbar third of the carcass, n=30

Indicator	Group I	Group II
Mass ofback-lumbar third, kg	26.6±1.82	26.4±1.74
Loin bone-in, kg	12.1±0.76	12.3±0.93
Belly bone-in, kg	14.4±1.06	14.1±0.81
Eye of loin, kg	5.9±0.26	5.9±0.37
Bone of loin, kg	2.2±0.04	2.4±0.12
Belly, kg	12.4±0.99	11.9±0.73
Bone of belly, kg	2.0±0.04	2.1±0.06
Single grade meat, kg	0.4±0.03	0.4±0.03
Spine lard with skin, kg	3.7±0.48	3.6±0.43

Source: own calculations.

When analyzing the mass of large-piece semi-finished products in the back-lumbar third of the carcass (Table 2), no significant difference was found in pigs with both types of castration.

Analyzing the share of the main large-piece semi-finished products in the back-lumbar third of the carcass (Fig. 2), an increase in the content of pork belly in the carcass of immunocastrated animals was established. At the same time, the content of brisket and lard was higher in surgically castrated pigs.

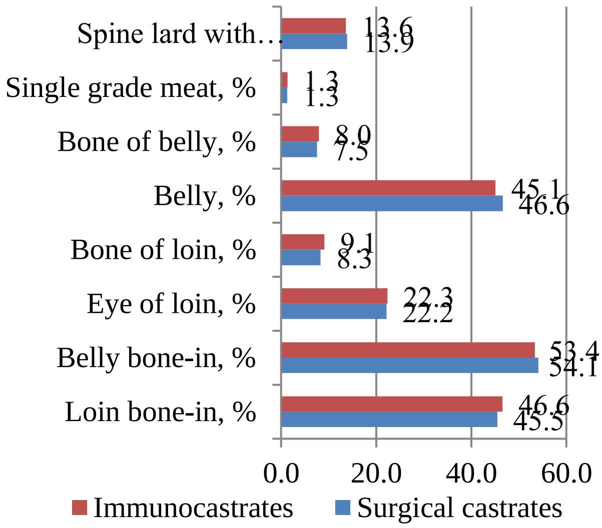

Fig. 2. The share of large-piece semi-finished products in the back-lumbar third of the carcass
Source: own calculations.

In the pelvic-femoral part of the carcass, an increase in the mass of single-grade pork was observed by 0.2 kg or 15.38% ($p < 0.05$) in immunocastrated pigs. The method of castration had no effect on the weight of leg boneless and fat pork with skin (Table 3).

Table 3. Mass of large-piece semi-finished products in the pelvic-femoral third of the carcass, n=30

Indicator	Group I	Group II
Mass of pelvic-femoral third, kg	26.9±1.52	26.8±1.50
Leg boneless, kg	17.6±0.88	17.4±1.18
Bone of Leg, kg	2.5±0.13	2.6±0.11
Tail, kg	0.4±0.02	0.4±0.01
Single grade pork, kg	1.3±0.07	1.5±0.04[1]
Fat pork with skin, kg	5.1±0.44	5.0±0.16

1 – $P < 0.05$
Source: own calculations.

Analyzing the proportion of large-piece semi-finished products in the pelvic-femoral part of the carcass (Fig. 3), an increase in the proportion of the leg boneless and an increase in the proportion of fatty pork with skin in the carcasses of surgical castrates compared to the carcasses of animals castrated with the help of the Improvak vaccine was found.

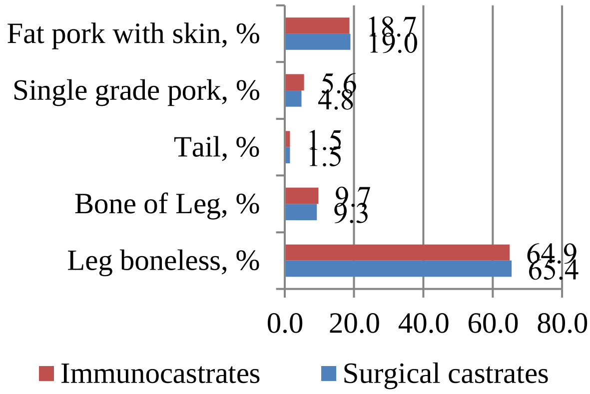

Fig. 3. The share of large-piece semi-finished products in the pelvic-femoral third of the carcass
Source: own calculations.

Thus, in general, the difference in the most valuable large-piece parts of the carcass in immuno- and surgically castrated pigs was minimal. Our results do not coincide with published data on the difference in carcass parts for different methods of castration. Thus, the authors found that in the carcasses of immunocastrated pigs, there is a tendency to increase the proportion of eye of loin in them by 0.44%. However, we did not find a significant difference in this indicator in pigs of both groups [2].

Also, our study did not confirm reports that immunocastrated male pigs showed greater weight of large meat cuts such as hindshank ($P<0.05$), as well as shoulder boneless and leg cuts ($P<0.05$), compared with a control group of surgically castrated boars. We can state a lower amount of lard in surgically castrated pigs in our experiment, similar to data [23], which indicate similar results, where surgically castrated pigs had less lard ($P <0.05$) compared to immunocastrated counterparts, which resulted in meat semi-finished products with a lower amount of fat and, therefore, with a higher yield of meat.

Our data contradict the results of the research of other authors [28], the evaluation of the yield of large-piece semi-finished products proved the superiority of the carcasses of immunocastrated pigs.

So, it is indicated that the tenderloin was heavier by 0.16%, the neck by 0.38%, the eye of loin by 0.68%, the leg boneless by 1.98%. In general, the advantage of the group of immunocastrated pigs over the surgically castrated ones in the content of the most valuable large-piece semi-finished products was 3.20%.

We did not obtain a reliable difference in the weight of the indicated large-piece semi-finished products for the use of immunological and surgical castration.

We did not obtain similar results with the data [11] on heavier leg boneless and shoulder blades in immunocastrated pigs, and the indicated meat cuts in our study were the same for pig carcasses with both castration methods.

Also, our finding of 0.6 kg or 13.64% ($P < 0.05$) higher lard and skin content in immunocastrated pigs directly contradicts the results [16], which indicated a positive effect of immunocastration on lard content and skin in carcasses compared to the effect of the surgical method.

Basically, our findings coincided with the statements [38, 40] that no significant difference in the parameters of carcasses and their parts was found between surgically and immunocastrated pigs.

CONCLUSIONS

Compared to surgically castrated pigs, immunocastrated pigs showed a higher value of the weight of neck single-grade porkby 0.3 kg or 20.0% ($p < 0.01$) and a higher value of the weight of lard with skin by 0.6 kg or 13.64% ($p < 0.05$) in the shoulder-scapula third of the carcass and a higher value of the weight of single-grade pork by 0.2 kg or 15.38% ($p < 0.05$) in the pelvic-femoral third of the carcass.

There was no statistically significant difference in the weight and proportion of other large-piece meat cuts in all three parts of the carcass, regardless of the method of pig castration.

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STUDY ON SOCIAL RESPONSIBILITY AND SUSTAINABLE DEVELOPMENT WITHIN AGRICULTURAL SMEs IN THE SOUTH-MUNTENIA REGION, ROMANIA

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Abstract

Corporate social responsibility (CSR) can be a basic element of regional sustainable development (SD), but this aspect is conditioned by the authorities' support. Even if, at present, social responsibility isn't well known and implemented in Romania, through a good cooperation between the public sector, the private one and the authorities, it is possible to increase the standard of living of the local population, especially for the inhabitants of rural environment. In order to assess the level of knowledge and applicability of CSR campaigns, a 19-question questionnaire has been drawn up and distributed online and physically, in order to obtain as many responses as possible. By addressing the questionnaire to a category with a good representativeness in the South-Muntenia Region, namely that of the managers of SMEs in the agricultural sector, it turned out that the interest in these subjects is low, in a first phase only 51 responses were obtained online, which means 7.29% from the requests. After the second stage, that of physical meetings, a total of 321 responses were received, i.e. 53.14%. As a result of the investigation, it can be concluded that the agricultural managers of the South-Muntenia Region don't have confidence in the success of social responsibility actions, as a result they don't want to allocate a part of their turnover to set this mechanism in motion, especially since about 20% of those interviewed aren't interested in the sustainable development of the region.

Key words: *corporate social responsibility (CSR), sustainable development (SD), agricultural sector, SME, South-Muntenia Region*

INTRODUCTION

According to several authors from all over the world [2, 3, 5, 11, 13], social responsibility is a way that contributes to sustainable development, especially in rural areas, which has been neglected for a long time [12]. This is especially true for Romania, where we can say that the agricultural sector is a significant recipient of corporate social responsibility (CSR). The role of SMEs in regional development is a large, indisputable one, which has managed to add social values to the already existing and implicit economic ones. Policymakers are currently paying special attention to the role of SMEs. In this sense, they created a series of laws, resolutions and all kinds of facilities to support their development [14]. So, we could say that SMEs are a balancing factor for economic and social life, at the local and regional level. In terms of sustainable development, SMEs seem to be the main form of organization for a sustainable development of the world. As traditional agricultural practices negatively affect resources, the environment and human health [1], the need for sustainable agriculture has become a pressing issue. Sustainable agriculture, in turn, is essential for sustainable development, as agriculture has been and will continue to be the generator of the economy [8]. The change is the one that leads to dynamic sustainability against the background of reducing consumption and designing a safer future for humanity and the Planet, but also for regional and national spaces [10].

Over time, the rural environment was affected by very low living conditions, which led young people to go to nearby cities or, on the contrary, outside the country [4]. They were no longer interested in the resuscitation of local communities, which is very visible in the evolution of human resources in the rural environment [6]. Farm consolidation is mainly based on supporting members of recognized associative forms, young farmers, farms in disadvantaged areas, and over time will have the effect of improving farm incomes. Considering their economic importance and environmental aspects, it is also absolutely necessary to accelerate the restructuring and modernization of agricultural holdings [9], to ensure the development of a competitive and sustainable agriculture in accordance with the requirements of cross-compliance. The participation of rural communities' members in the local development process and the encouragement of innovative actions cannot be achieved without risks [7], which are inevitable when it comes to new initiatives, aimed at helping to find new solutions to old problems, introducing and developing new products, the modernization of traditional activities through the application of new technologies and others. Through the questionnaire, two sets of results were intended to be obtained, and others came naturally, following the attempt to achieve as many concrete answers as possible. The two initial objectives were proposed in this research:

(1)establishing the level of knowledge, understanding and application of the concepts of CSR and SD in each of the counties of the South-Muntenia Region of Romania;

(2)establishing the degree to which SME managers want to get involved in the sustainable development of the South-Muntenia Region through CSR initiatives.

MATERIALS AND METHODS

In the last decade, conducting studies based on questionnaires has been increasingly appreciated, even in the consumer market, for the collection of statistical data, but also for the evaluation of knowledge and the desire to act. It is, by far, the most effective way to collect answers to multiple questions, allowing people to voice their opinions on a given topic.

It is necessary to start by stating that the research topic that is the subject of the questionnaire isn't a well-known one that is on everyone's lips, for the following reasons:

• many of the SME managers in Romania haven't heard of the organizational social responsibility (CSR) concept;

• those who heard about CSR believed that it didn't directly target them and, therefore, avoided any involvement in actions of this kind;

• SMEs don't have the necessary resources to plan and support CSR initiatives;

• SMEs aren't obliged, according to the law, to carry out CSR campaigns.

In order to draw up the questionnaire, it was determined that a brief introduction to the topic addressed is very useful, so that each of those surveyed knows what it is about and to be able to associate these aspects with those carried out by them in the current activity of their companies. For the question part, several components were used and a concentrated format was chosen, so that in the shortest possible time required to complete it, to obtain as much useful information as possible. The detailed structure of the questionnaire is shown in Fig. 1.

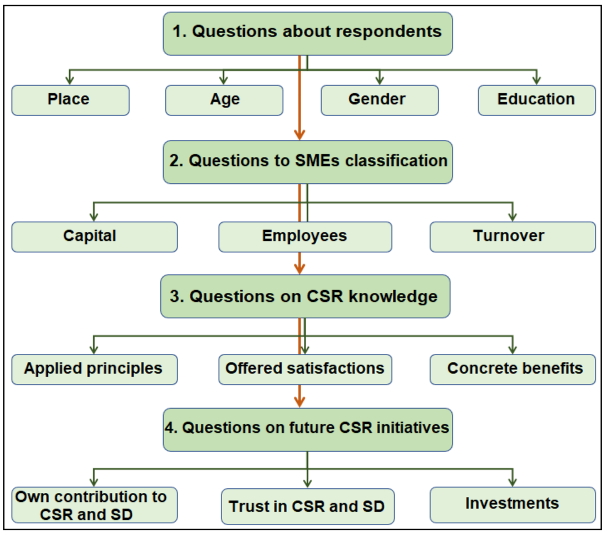

Fig. 1. The chart for planning the development of the questionnaire, with its categories of questions
Source: Own determination.

In the end, the questionnaire had a total number of 19 questions, of which 18 were grids and one was a matrix. The optimal time required to go through and fill in the questionnaire is a maximum of 10 minutes.

The questionnaire is addressed to the agricultural SMEs in the South-Muntenia Region. The sample size was n = 372 managers of SMEs, considered representative for N = total number of SMEs' managers operating in the seven counties of South Muntenia region.

Cochran's sample size formula (1977) was used for p=0.5, t = 1.96 and marginal error e= 0.05.

According to all the analyses compiled and presented in tabular and graphical form, agriculture is one of the basic areas of the region, still insufficiently exploited and with a great potential for development.

This was also the reason why it was considered that the social responsibility realized and implemented by very small, small and medium-sized companies, very numerous, can generate a flow of development of the region.

At the same time, large companies, whether they also have an agricultural profile, already apply social responsibility strategies, but they are few in number, more precisely in the South-Muntenia Region there are only 4.

For the homogeneity of the study, given the research period, namely February 2021 - February 2022, two ways of applying the questionnaire were approached: online and physical, in this way managing to identify what percentage of managers are interested in the issue of organizational social responsibility and in the possibility of sustainable regional development for the coming years.

RESULTS AND DISCUSSIONS

The online survey, carried out by sending the online questionnaire, ran from 09.02.2021 to 09.08.2021, during which, every two weeks, the email was retransmitted to those who didn’t answered.

In order not to disturb additionally, at the moment of receiving the confirmation of completing the questionnaire, messages of thanks were sent, and the e-mail address of the respective person was removed from the database. In addition, individuals in the target group were contacted by phone regarding the questionnaire and they promised to complete it as soon as possible. None of the interlocutors agreed to complete the questionnaire during the phone conversation, on the grounds that they didn’t have time then or that they wanted to read the electronic message first. However, very few responses were received in the 6 months, more precisely only 51 questionnaires from all 7 counties of the Sud-Muntenia Region, which represents only 7.29% of the selected target group.

In autumn of 2021, having less restrictions, physical meetings could be set up with some of the managers of agricultural SMEs in the area, with whom we were able to complete the questionnaires and discuss in detail about CSR.

During the 6 months of online distribution of the questionnaires (09.02.2021 – 09.08.2021), several conclusions were drawn regarding the low response rate:

(1)during the pandemic, they were assaulted with online requests, which they ultimately decided to ignore, as they involved a considerable waste of time;

(2)lack of any real benefit as a result of allocating time to provide objective answers;

(3)agriculture continued its activity throughout the period of restrictions, that is why the managers didn’t have more time at their disposal;

(4)many of the managers in agriculture prefer face-to-face interactions, being used to this by large companies, which send sales agents, customers, with whom they meet in person;

(5)some of the managers of SMEs don’t handle so well the technical part, which is why they don’t use the computer and go for classic options – phone discussions and/or meetings;

(6)some of the managers didn’t understood the topic of the questionnaire and preferred not to express their opinion about something they don't know. In the second part of the research activity, also carried out over a period of 6 months (01.09.2021-01.03.2022), when people active in agriculture had a less crowded period, being the winter period, when the plants are in vegetative rest and agricultural work cannot be carried out, appointments were made by phone and trips were made to farms to complete the questionnaires. It should be noted that all people in the target group were called, except for those who completed the questionnaire in Google Forms, and those with whom an appointment couldn't be arranged fall into one of the following categories:

(1)no one answered the phone;

(2)they said they weren't interested in such a discussion;

(30they stated that they do'nt have time.

The interviewed managers were much more receptive in the face-to-face interaction, even if they had no knowledge of social responsibility and what their duties would be from the perspective of this concept related to sustainable development. The difficulty was, in this case, in observing the times set for the meetings, especially in the case of counties located at a great distance.

Table 1. Number of CSR questionnaires completed in 2021-2022, distribution according to the way of answering

No.	Type / County	Face to face	Online	Total
		Number		
1	**Arges**	41	4	45
2	**Calarasi**	54	4	58
3	**Dambovita**	44	5	49
4	**Giurgiu**	42	4	46
5	**Ialomita**	39	2	41
6	**Prahova**	48	2	50
7	**Teleorman**	53	30	83
	Total	**321**	**51**	**372**
	Share (%)	**45.85%**	**7.29%**	**53.14%**

Source: Own calculation.

During November 2021 – February 2022, the performance of completing up to 8 surveys per day (within eight meetings) was achieved, which was a substantial improvement compared to what happened online. At the end of the 6 months, it was possible to collect a number of 321 questionnaires from the field, distributed by counties as shown in Table 1, where the online values are also accumulated.

At the end of the investigation process by means of the survey, a response rate of 53.14% of the total target group was reached, percentages distributed very differently – 46% of responses for physical and 7% for online.

If in the case of the face to face survey there is a fairly high homogeneity between the counties, the online one has broken this balance, tilting the balance in favor of Teleorman county, which has a response rate of 83%. Of the 19 questions, those related to CSR and SD received very interesting responses, often in very different percentages depending on how the responses were collected. It is difficult to address discussions related to CSR as long as there are no promotion and awareness campaigns, and the involvement of the authorities in this area is non-existent. Most of the managers of agricultural SMEs admit that they know very little or not at all (47.5%) what social responsibility is and what does it entails (Table 2).

Table 2. Presentation in parallel of the online and cumulative responses (%), for the question related to the knowledge of CSR

No.	Type / Variant	Online	Online + Face to face
1	**Very large extent**	9.8%	5.4%
2	**Large extent**	21.6%	12.4%
3	**Somewhat**	39.2%	34.7%
4	**Small extent**	19.6%	27.4%
5	**At all**	9.8%	20.1%

Source: Own calculation.

The problem of sustainable development aroused the interest of the managers, who mastered the subject quite well here. However, even in this case there is no unified vision, and the business environment represented by the SMEs in the South-Muntenia Region, at least the one in agriculture, doesn't seem well connected.

Face to face interviewing led most to say they were very interested in such a plan, while the online environment again shows a relaxation on the subject, with opinions split between the top three variants, but also with people which are not at all interested in the subject, being regardless of whether the region will develop in the future or not (Table 3).

Table 3. Presentation in parallel of the online and cumulative responses (%), for the question regarding the interest in a SD plan

No.	Type / Variant	Online	Online + Face to face
1	**Very large extent**	25.5%	54.3%
2	**Large extent**	41.2%	28.0%
3	**Somewhat**	23.5%	11.8%
4	**Small extent**	7.8%	4.8%
5	**At all**	2.0%	1.1%

Source: Own calculation.

Several of the questions were mainly related to the future, more precisely to the desire of agricultural SMEs' managers to contribute to regional sustainable development by investing in CSR strategies and campaigns.

Table 4. Number and share of the answers collected in 2021-2022, concerning the desire of SMEs' managers to be involved in increasing the standard of living of the population

No.	Variant / County	Very large extent		Large extent		Some-what		Small extent		At all	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	**Arges**	13	28.9	12	26.7	18	40.0	1	2.2	1	2.2
2	**Calarasi**	12	20.7	19	32.8	18	31.0	6	10.3	3	5.2
3	**Dambovita**	18	36.7	10	20.4	13	26.5	5	10.2	3	6.2
4	**Giurgiu**	13	28.3	9	19.6	14	30.4	8	17.4	2	4.3
5	**Ialomita**	16	39.0	8	19.5	12	29.3	5	12.2	0	-
6	**Prahova**	22	44.0	15	30.0	8	16.0	4	8.0	1	2.0
7	**Teleorman**	31	37.4	21	25.3	23	27.7	5	6.0	3	3.6
	Total	**125**	**33.6**	**94**	**25.3**	**106**	**28.5**	**34**	**9.1**	**13**	**3.5**
	Online	**18**	**35.3**	**22**	**43.1**	**8**	**15.7**	**2**	**3.9**	**1**	**2.0**

Source: Own calculation.

Thus, the question related to the managers' desire to get involved and contribute to regional sustainable development by improving the standard of living of the local population was addressed. The collected answers are calculated in Table 4 and aren't at all gratifying, as they highlight that only 58.9% of the managers who were part of the target group want their activity to increase the standard of living of the South-Muntenia Region population. On the most concrete question, SME managers are apprehensive, especially when it comes to investing part of their turnover in an ambiguous concept that doesn't offer them any certainty. Combining all the aspects analyzed so far as a result of the stated questions, among which the age, level of education and perception of the respondents, the size of the companies, their turnover, opinions on sustainable development, knowledge related to CSR and others, can justify the answers received to this question (Table 5).

Table 5. Number and share of the answers collected in 2021-2022, depending on how much they are willing to invest in CSR actions

No.	Turnover / County	0.1-1%		1.1-2%		2.1-5%		>5%		0%	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	**Arges**	19	42.2	8	17.8	4	8.9	3	6.7	11	24.4
2	**Calarasi**	23	39.7	14	31.1	4	6.9	5	8.6	12	20.7
3	**Dambovita**	29	59.2	7	14.3	3	6.1	2	4.1	8	16.3
4	**Giurgiu**	22	47.8	9	19.6	1	2.2	3	6.5	11	23.9
5	**Ialomita**	18	43.9	8	19.5	2	4.9	4	9.8	9	21.9
6	**Prahova**	33	66.0	7	14.0	3	6.0	1	2.0	6	12.0
7	**Teleorman**	42	50.6	15	18.1	7	8.4	4	4.8	15	18.1
	Total	**186**	**50.0**	**68**	**18.3**	**24**	**6.5**	**22**	**5.9**	**72**	**19.3**
	Online	**21**	**41.2**	**17**	**33.3**	**7**	**13.7**	**3**	**5.9**	**3**	**5.9**

Source: Own calculation.

See also the parallel with the answers collected exclusively online, which in this case are much more logical, more uniform and given in a much more relaxed state. On the other hand, face-to-face managers were defensive, believing that answering this question would force them to invest that percentage of turnover in social responsibility initiatives. The result was a significantly higher number of those who answered that they would not invest anything at the moment (21.5% of physical respondents and 19.3% of all respondents).

CONCLUSIONS

The survey based on questionnaire aims to evaluate the current situation we face in the region, to find out the opinion of the managers of SMEs active in the agriculture of the South-Muntenia Region regarding organizational social responsibility (CSR) and sustainable development (SD), which can be done with the help of CSR strategies, which are currently not known and/or accepted in the business environment. The responses received from the managers who responded to the questionnaire prepared for this study were analysed for each question separately, and the data were presented in tables and graphs, highlighting the essential aspects for the research topic addressed.

Some conclusions deserved to be drawn as follows:

(1)Interest in the proposed questionnaire was extremely low. As a result, in the 6 months of online distribution of the questionnaire, only 51 responses were obtained, so a success rate of only 7.29%;

(2)In the end it was possible to arrange meetings with 321 managers who did not respond to the online questionnaire, which raised the response rate, in total, to 53.14%, which indicates that the proposed topic is not of interest to very many of those involved in the agricultural business environment of the South-Muntenia Region;

(3)Managers of SMEs in agriculture have a low level of knowledge related to CSR;

(4)Almost 20% of those interviewed would not currently invest in social responsibility actions, and those who would choose the minimum amount, of 0.1-1% of the company's turnover, which however it is a starting point;

(5)Considering all the above, however, more than 73% of the total number of people interviewed state that they trust the concepts of social responsibility (CSR) and sustainable development (SD), even if stating this doesn’t influence their actions and doesn’t imply anything concrete;

(6)There is a significant discrepancy between the answers received in the online version and those collected as a result of face-to-face discussions – anonymity led to a greater number of managers stating that they weren’t interested in these topics and don’t want to include them in their future activities.

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ROLE PERCEPTION AND ROLE PERFORMANCE OF EXTENSION AGENTS IN POST-HARVEST ACTIVITIES OF RICE IN SOUTHWESTERN, NIGERIA

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Abstract

The paper assessed role perceived and performed by Extension agents (EAs)) in post-harvest activities (PHAs) of rice in Southwestern Nigeria. Structured questionnaire was employed to elicit quantitative data from 124 EAs across the area of study while focus group discussion guide and in-depth interview guide were used to collect qualitative data from the farmers and local fabricators in the study area. Appropriate descriptive statistics were used to describe and summarise quantitative data while paired T-test was used to test the difference between role perception and performance of respondents in PHAs of rice. Content analysis was used to analyse the qualitative data. The result showed that EAs were competent in traditional method of parboiling paddy rice (mean = 4.46) and sun drying of paddy rice (mean = 4.30). EAs mostly perceived training rice farmers on rice value addition (96.7%) and facilitating loans for rice farmers (93.5%) however, performed linking rice farmers to markets ((84.7%) and training them on drying paddy to a safe moisture content (80.6%).The result showed that were significant difference existed between the perceived and performed roles ($t = 21.915$; $p \leq 0.05$) of EAs in post- harvest activities of rice. The study concluded that there was a wide gap between perceived and performed roles of EAs in rice postharvest activities. Hence, EAs should be equipped with necessary skills and knowledge in modern PHAs of rice through capacity building in order to perform their roles effectively to enhance utilisation of high-quality enhancing post-harvest technologies.

Key words**: c***ompetence, extension agents, perceived role, performed role, post-harvest activities*

INTRODUCTION

According [10], agricultural development lies at the heart of income generation, poverty reduction and food security of most developing countries. The onus to achieve these trio goals is strongly dependent on the extent to which agricultural extension service delivery is efficiently performed. It is therefore a basic tool in government programmes and projects that aim at bringing about changes in all facets of agricultural production and raise rural living standards, positive change in agricultural production and improved standard of living can be achieved from intensive and sustainable engagement of agricultural extension.

According [15], Nigeria is the largest producer of Rice (paddy) in Africa with an average production volume of 8 million metric tonnes. As of 2019, Nigeria was ranked as the 14th largest producer of rice in the world with China being the top producing country [11] reported that Nigeria has increased rice production from 2.9 metric tonnes in in 2005 to 4.1 million tonnes in 2014, with further increased in 2015 to 4.3 metric tonnes and 4.8 metric tonnes in 2016. [11] established that there are evidence from past studies that despite increase in local rice production, there is still persistence deficit in its supply compared to the excess demand for the commodity [7]. One of the reasons attributed to the situation is the inability of the local rice to compete favourably with imported rice based on the submission of [1] that most Nigerian rice processors/farmers lack adequate technology to meet international standards, as locally produced rice contains a lot of stones and other impurities. By implication improved technologies of handling rice processing can address the problem of post-harvest loss and its inability to compete with imported products in terms of taste, packaging and quality. To achieve this, farmers must be given an opportunity to access appropriate post-harvest technologies of rice and necessary information on markets. This is expected to be done by extension workers.

The failure of agricultural extension had been traced to inadequate communication infrastructure, training and inefficient link with researchers and industrialists or fabricators. Despite all the highlighted problems of extension, new technological advances in post-harvest handling of rice need be transferred to the farmers. Extension agents in the study area are often involved in technology transfer at the expense of providing marketing services to rice farmers. The Ministry type extension organisations largely embark on technology transfer rather than services that impinge on improved income and profit maximization [2].

According to [12] [16], the conventional transfer of technology models was the top down and feedback models. The top-down technology transfer is a one-way process where technologies developed by scientists are passed on to extension services to be transferred to users. The functioning of the feedback model solely rests with the extension service organization. [5], cited in [6], reported that the great challenge facing the agricultural technology transfer is not just how to approach the end users, but how to sustain the use of technology to meet the future challenge. [11] cited in [16] stated that agricultural extension has changed over times. It is no longer restricted to the emphasis on technology transfer reflected by the Training and Visit (T & V) System but has moved towards broader concepts which include developing the skills and management capacities of farming families. Extension helped to facilitate the access of farmers, their organizations and other market actors to knowledge and technology and facilitate their interaction with similar organizations.

[10] further explained that sustainability and productivity of agricultural sector worldwide depends on the quality and effectiveness of extension services among other factors. He also observed that in developing countries, there is a gap between agricultural performance and available research information. This has also been attributed to poor extension services delivery as well as limited interaction between technology developers (researchers) and extension workers. [10] also reported that poor communication between actors in extension services delivery particularly the Government, NGOs, private sector (agribusiness) and farmers has also been shown to hinder flow of developed technologies to farming communities.

In addition, dissemination of modern post-harvest activities of rice is not adequate as reported by [8] that a large number of rice farmers claimed not have heard of many posts–harvest technologies. This is affirmed the recommendation of past study submitted by [2] that institutional information service should be provided to farmers in developing countries in order to achieve the goal of improving the income of the farmers and livelihood through adoption of improved postharvest technologies. [2] recommended that extension services should explore the possibility of providing more market related information to farmers in order to increase their income and findings of [8] that a large number of farmers in Bangladesh claimed not to have heard of many post-harvest technologies let alone of adopting them. Implicitly, low extension agents-farmers ratio coupled with low competency of extension agents on post-harvest activities of rice forms the basic reason why farmers are facing series of challenges in handling the required postharvest activities in modern way. If the situation is allowed to linger on, all efforts by the government at all levels and that of international donors and research institutes to boost locally produced rice to compete favourably with foreign rice will be in vain.

The situation therefore, calls for prompt action from extension agents as they are in the best position to help develop all the required knowledge and skills needed by farmers to keep abreast of the new innovations on rice post-harvest activities through education, training and advisory services or else farmers may not be able to handle post-harvest operation successfully at all stages. Moreover, studies have been carried out on role perception and performance of extension agents in maize marketing [13] and effectiveness of extension agents in agricultural developments in general but there is scanty literature on roles perception and performance by extension agents in post-harvest activities of rice in Southwestern Nigeria. It is against this background that this study assessed the role perception and performance of EAs in PHAs of rice in the study area.

(i)determine their perceived level of competency in PHAs of rice;

(ii)examine perceived and performed roles of extension agents in post-harvest activities of rice; and

(iii)examine the difference between perceived roles and performed role extension agents in post-harvest activities of rice farmers in the study area

MATERIALS AND METHODS

The study was conducted in Southwestern Nigeria which has six states which can be group into three based on the similar attributes namely: group 1(Osun and Oyo States), group 2 (Ondo and Ekiti States) and group 3 (Lagos and Ogun States). A two-stage sampling procedure was used to select respondents for this study. At the first stage, one state per group was purposively selected to make a total of three states namely: Osun, Ekiti and Ogun States based on their prevalence in production of rice. At the last stage, all serving public field level extension agents Agricultural Development Programmes across the three states, were selected account for 63 EAs in Ogun, 33 in Ekiti and 28 in Osun States making a total of 124 respondents. Two Focus Group Discussion Duly pretested and validated questionnaire was used to collect quantitative data from the respondents. The questionnaire contain both open and closed questions. Primary data collected were summarized and described through the use of frequency counts, percentages, means and standard deviation while paired sample t- test analysis was used to test difference between perceived and performed roles of EAs. Two Focus Group Discussion (FGD) sessions were conducted per state to elicit qualitative information from rice farmers and two In-depth interview sessions were conducted per state from local fabricators to triangulate the quantitative findings, making a total of six FGD sessions and six In-depth interview sessions. Qualitative data were analyzed through the use of content analysis. Content analysis is the systematic analysis of the content of a text (e.g., who says what, to whom, why, and to what extent and with what effect) in a quantitative or qualitative manner. The key informant interviews carried out were recorded with an electronic device and later transcribed. The role perception and performance were measured by asking the EAs to indicate what they perceived as their roles in the list of expected roles in PHAs of rice and each one was scored one point while they were to indicate the one they performed and each performed was scored one point. EAs were also asked to rate their self-perceived level of ability in the 15 competence areas of PHAs of rice by using a Likert type scale with (1) as not competent, (2) little competence, (3) somewhat competent, (4) competent and (5) very competent as used by [4].

RESULTS AND DISCUSSIONS

Competence of EAs in handling various PHAs of rice

Results in Table 1 reveals that the respondents indicated that they were competent in traditional method of parboiling paddy rice (mean = 4.46), sun drying of paddy rice (mean = 4.40), traditional method of rice threshing (mean = 4.35), and adequate information on traditional harvesting (mean = 4.31 while they were somewhat competent in storage handling methods (mean = 3.28), however they either were not competent in other PHAs. This findings revealed that the EAs were competent in traditional method of parboiling paddy rice, sun drying of paddy rice, traditional method of rice threshing, giving adequate information on traditional harvesting and storage handling methods, but less competent in other nine PHAs activities.

Table 1. Competence of EAs in PHAs of rice

Competency variables	Mean	St. Dev.
Traditional method of Parboiling paddy rice	4.46	1.185
Sun drying of paddy Rice	4 .40	1.103
Traditional method of rice threshing	4.35	1.067
Adequate Information on traditional harvesting	4.31	1.205
Storage handling methods	3.28	1.173
Good skill on rice winnowing	2.24	1.157
Knowledge of using ICT to source for modern rice technologies	2.21	1.184
Adequate knowledge on giving financial education for rice farmers	2.09	0.991
Adequate information on rice marketing	2.05	1.104
Adequate knowledge of packaging and labelling milled rice	1.05	1.182
Possession of good knowledge of using de-stoner	1.03	1.103
Possession of knowledge on how to handle processing machines	1.02	0.995
Good knowledge of networking among other actors	1.01	0.991
Adequate knowledge on quality control in rice	1.00	1.092

Source: Field survey, 2019.

The inference that can be drawn from this result is that the respondents were highly competent in performing the activities that involves traditional techniques and tools, but less competent in the aspect that involves modern techniques and equipment's. This finding gives credence to the observation of [8] that most of the processes utilized by rural rice farmers were mostly traditional and so issue of technological advancement in rice processing needs attention. Definitely if attention would be given to the rice sector it has to start with the extension agent that has the mandate to train farmers for the technological advancement as no one can give what he doesn't possess. The FGD excerpt below further support the quantitative finding that EAs were competent in modern postharvest activities.

"They train us the little they can, on what we have known before. There is nothing new in what they teach now. If they really want to help us they should teach us how we can use machine to do most of the post- harvest operations at the same time assist us to get loan so that we can buy our own. The agents should also help us to get market for our rice produce". ***(FGD excerpt from Oke – Mesi in Ekiti west LGA, Ekiti state.***

Perceived and performed roles of EAs in PHAs of rice

The results in Table 2 reveal that respondents had a good perception training them on rice value addition (96.7%), facilitating loans for rice farmers (93.5%), sourcing for new techniques (92.7%), formation farmers into cooperatives (91.1%), drying paddy to a safe moisture content of 13-14% (91.1%), providing information on best time to harvest rice (90.3%); linking them to market (90.3%), providing information on hygiene practices on rice PHAs (88.7%), training rice farmers on destoning of rice (88.7%)and among others as the roles expected of them in rice PHAs. This finding implies that majority of the EAs had a good perception of the roles expected of them to perform in rice PHAs both on their traditional functions and more technical aspect of post-harvest activities such as providing information on best harvesting time of rice, training them on drying paddy to a safe moisture content of 13-14%, demonstrating hygiene practices on rice PHAs, training them on modern drying techniques, training them on destoning of local rice and facilitating how rice farmers group can erect milling machine. That is, the EAs perceived all the expected roles as important that they must perform. This finding contradicts the findings of [13] and

[14] that extension agents only had a good perception in just traditional functions of technology transfer and had less technical aspects of their roles. This finding might be due to assertion of [9] and [12] that agricultural extension service is no longer restricted to transfer of proven technologies but it has assumed a changing roles from a focus on technology transfer to a focus on facilitating a range of interventions in complex contexts.

On the other hand, the results in Table 2 shows that the affirmative responses by the extension agents indicated that they performed satisfactorily postharvest functions of linking rice farmers to markets ((84.7%), training them on drying paddy to a safe moisture content of 13-14 percent (80.6%), providing information on best time to harvest (79.6%), provision of information on how to access loan (72.8%), formation farmer rice group/cooperatives, and in that order. While extension agents performed poorly in training them on modern drying techniques (40.3%), facilitating erection of rice milling machine (18.5%), liaising with policymakers on rice improvement (8.1%), training them on rice value addition (6.5%) and training of fabricators on how to construct rice processing machine (3.2%).

Table 2. Perceived and performed roles in PHAs (n=124)

Post-harvest activities of rice	Perceived roles		Performed roles	
	F	%	F	%
Linking rice farmers to markets	116	93.5	105	84.7
Training farmers on storage techniques	106	85.5	103	63.1
Drying paddy to a safe moisture content of 13-14%	113	91.1	100	80.6
Provide information on best time to harvest	112	90.3	99	79.8
Provision of information on how to access loan	110	88.7	92	74.2
Formation into rice group/cooperatives	113	91.1	90	72.6
Teaching them on destoning of rice through destoning machine	110	88.7	56	45.2
Demonstrate Hygiene Practises on rice PHAs	112	90.3	78	62.9
Training them on rice value addition	102	82.3	8	6.5
Provide adequate Information on threshing	94	75.8	70	56.5
Carry out of advocacy campaign on improved rice processing	119	96	55	44.4
Training them on modern drying techniques	94	74.8	50	40.3
Training them proper parboiling	93	75	84	67.7
Facilitates erection of milling machine	88	71	23	18.5
Introduction of farmers to harvesting machines	98	79	45	36.3
Organize excursions	62	50	42	33.4
Facilitates training of fabricators	93	75	38	30.6
Facilitate construction of storage facilities	98	79	4	3.2
Liaise with policy makers to assist rice farmers	88	71	10	8.1

Source: Field survey, 2018.

The implication of these results is that majority of the EAs only performed the traditional functions of providing information but they performed poorly in the technical aspects of rice postharvest activities such training rice farmers adding value to rice, destoning of rice, proper drying of paddy rice, training them on how to use modern postharvest machines such as milling machines, mechanical threshers and dryer and among others. The result further suggests that although the EAs had a good perceptions of almost all the roles expected of them, there was a wide gap between their role perception and performance. This could be attributed to poor competency of EAs in the use of modern postharvest technologies of rice. This consequently lead to continuous use of traditional processing techniques by rice farmers which account for poor quality of most of locally produced rice in the country as pointed out by [1] that poor extension service delivery contributed to poor quality of local rice in Nigeria. The excerpts from focus group discussion (FGD) and key informant Interview (KII) disagreed with the claimed of EAs in the performance of their expected roles as most farmers reported that they did not benefit much from the activities of EAs in rice PHAs in the study area. This is similar to the findings of [8] that a large number of rice farmers claimed not have heard of many posts–harvest technologies.

"All rice farmers in this area are not enjoying any service from extension agents for the past ten years, we cannot process our paddy rice into milled rice because we don't have access to milling machine and. government should help us by empowering with training. Rice farmers have been suffering because extension agent is no longer available as they used to. The area we would have love extension to intervene most is linking us to market so that we can sell and gain". ***(FGD discursion excerpt from Idi-Ogungun Community, Boripe LGA, Osun State)***

"Extension agents visits them seldomly and that there is not much information from them on PHAs of rice. They only visits during intervention programme from international and private organizations". (***FGD discursion excerpt from Ogunmakin in Obafemi-Owode LGA, Ogun State)*** *----"but ordinarily we are not enjoying their service in post-harvest activities of rice. Unlike the good old days when they are always on their toes to assist farmers to get result. Their service now is occasionally rendered when there is cause for them to do so. Extension agents need to spread useful information that can assist us to solve marketing problems of locally produced rice. All the information we expect them to provide are not forthcoming".* ***(FGD excerpt from Onigbedu Community, Ewekoro LGA, Ogun State)***

"Extension agents have never visited me let alone asking me to fabricate any machine for farmers to process paddy rice. Can the farmers afford it? Maybe that is why they have not been doing that". ***(KII excerpt from a local fabricator in Ado- Ekiti in Ekiti State).***

The inference drawn from the both quantitative and qualitative results is that the discrepancy of opinion between the extension agent and the rice farmers is not a signal of untruthfulness from either party, but a declaration of field reality. The effort of extension agents has not been felt by majority of rice farmers sampled, probably because low extension-farmers ratio in the study area.

Difference in roles perception and roles performance of EAs

The results of paired sample t-test in Table 3 show that there were significant differences between the expected and performed roles ($t = 21.915$; $p \leq 0.05$) of extension agents in the area of study.

The result implies there were observable differences between perceived and performed roles in all the PHAs of rice. The significant differences in all the roles occur because the EAs had better perceptions than their role performance.

This implies that there is a big gap between the perceived and performed roles of extension agents in post-harvest activities of rice in Southwestern Nigeria, which could result in ineffectiveness of extension workers as opined by [3].

This findings can be attributed to low capacity building of extension agents in modern postharvest technology of rice and low extension agents–farmers ratio. Consequently, regularly trainings and workshops need to be given to EAs to bridge the existing gap.

Table 3. Differences between perceived and performed roles (n=124)

Post-Harvest activities	Mean Role perception	Mean Role Performance	t- value	Sig.
Rice PHAs	18.35	10.45	21.915**	0.000

Source: Field survey, 2018.

CONCLUSIONS

Majority of EAs were very competent in traditional roles of providing advisory services to farmers but less competence in technical functions of rice PHAs, They perceived all expected roles in rice PHAs as important but only performed advisory roles. The study concluded that were disparity between perceived and performed role of EAs in rice PHAs in the study area. Based on his findings, it is therefore recommended that extension agents should be equipped with necessary skills and knowledge in modern PHAs of rice through regular and relevant capacity building in order to perform their roles effectively to bridge the gap between perceived and performed roles. This can be done organizing regular workshops, seminars and short courses for extension agents to keep them abreast of modern post- harvest system especially on the use of machines for PHAs by relevant stakeholders (government, research institutes and extension organisations. Finally, government should employed more extension agents to cater for the need of rice farmers through effective dissemination of appropriate post-harvest technologies that will promote utilization of high-quality enhancing post-harvest technologies for sustainable rice production in Nigeria.

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UTILIZATION OF GOOD AGRICULTURAL PRACTICES TECHNOLOGIES AMONG TOMATO FARMERS IN OYO STATE, NIGERIA

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Abstract

The study assessed the utilization of Good Agricultural Practices (GAPs among tomato farmers in Oyo State, Nigeria. Using three stage sampling technique, (240) registered tomato farmers were selected sample size for the study. Interview schedule was utilized to elicit relevant information and data were analysed using descriptive and inferential statistics. Results show that most (65.0%) of the respondents were males, married (50.0%) with mean age, household size and years of formal education of 35±10.5 years, 2 ± 0.6 persons and 13.0±3.9 years, respectively. Most (56.3%) of the respondents were primarily engaged in farming with mean annual income of ₦703,075.00 ±210,922.5 while few (42.5%) belong to social organisation. The most frequently aware of all the practices by the respondents were to look for pest and disease resistance varieties (93.8%) while inadequate knowledge of GAPs (1.46) and high cost of technology (1.29) were the main constraints to utilization of GAPs among tomato farmers in the study area. Positive relationship was found between age (r = 0.531, p≤0.05), years of formal education (r = 0.460, p≤0.05) and utilization of GAPs. The study concluded that GAPs were moderately utilized among the respondents and recommended that government should provide special incentives for the tomato farmers in order to encourage them as well as others who are yet to engaged in GAPs.

Key words*: *Good Agricultural Practices, tomato farmers, utilization

INTRODUCTION

Tomato (*Lycopersicon esculentum)* belongs to the genus *Lycopersicon* and *Solanaceae* family. Tomato is one of the most important solanaceous vegetable crops grown worldwide under outdoor and indoor conditions. It has become an important commercial crop so far as the area, production, industrial values and its contribution to human nutrition is concerned [8]. Tomato is one of the most highly consumed vegetable due to its status as a basic ingredient in a large variety of raw, cooked or processed foods. It belongs to the family Solanaceae, which includes several other commercially important species. Tomato is grown worldwide for local use or as an export crop. Although the crops are believed to have been originated from South America and its many varieties are now widely grown, often in green houses in cooler climate. As it is relatively short duration crop and gives a high yield, it is economically attractive. According to [7], Nigeria is said to have the largest area harvested for fresh tomato in Africa with 541,800Ha followed by Egypt with 214,016Ha. Tomato contribute to a healthy, well balance diet as they are rich in minerals, vitamins, essential amino acids, sugars, dietary fibres, vitamin B and C, iron and phosphorus. Compared to rice, tomato production could generate double economic efficiency [13] which helps to create more job opportunities for farmers. Tomato is the world's largest vegetable crop after sweet potato but it tops the list of canned vegetables [11]. Lycopene is a carotenoid that is present in tomatoes, processed tomato products and other fruits. It is one of the most potent anti-oxidants among dietary carotenoids. Dietary intake of tomatoes and tomato products containing lycopene has shown to be associated with a decreased of chronic disease, such as cancer and cardiovascular disease [4]. It can be processed into different product including tomato juice, tomato ketchup, tomato paste, tomato soup (condensed), raw tomato and spaghetti sauce. Northern part of Nigeria commonly grown tomatoes but largely consumed in the South Western in which Oyo State is one of them. Tomato fruit exhibits amongst the highest postharvest losses in the fruit and vegetable supply chains of Sub Saharan Africa [2]. However, Nigeria is not included in the list of countries exporting tomatoes, and huge amount of money is spent on tomato importation annually. Significant parts of annual production are lost to post-harvest spoilage due to poor handling, microbial deterioration, absence of storage facilities and processing industries [6]. Most farmers engage in vegetable cultivation for income generation improve livelihoods [1]. However, they often face poor yields and low income due to poor farm management and lack of adoption of cost-effective agricultural technologies [3] Introduction of GAPs was one of the ways to increase net income and improve produce quality through modest prevention and /or control of some pest and diseases.

Tomato traders were not interested in the low produced quality due to pest and diseases and damage during transportation. Food and Agricultural Organization of the United Nation (FAO) define Good Agricultural Practices (GAP), as collection of principles to apply for on – farm production and post-production processes, resulting in safe and healthy food and non – food agricultural product, while taking into account economic, social and environmental sustainability. GAP relies on four principles, which are; economically and efficiency produce sufficient (food security), safe (food safety) and nutritious food (food quality), sustain and enhance natural resources and maintain viable farming enterprises and contribute to sustainable livelihood. Guidelines for GAP can cover all aspects of farms production. Whether in the field, in a green house or in barn including crop and seed choice, watering and fertilization, pest and disease control, disposing of manure, harvesting, and handling after harvesting, in food processing and in retail setting. Based on a rapid appraisal survey, farmers who adopted GAP Technologies at various level of location seem to be aware and knowledgeable of improved production technologies, had a better bargaining power in the sale of their produce due to improved produce yield, and perhaps better produce quality.

Unfortunately, farmers in Oyo state still experiences deficiency in critical input, lack of improved technology, low yield and productivity, high post-harvest losses and lack of processing and marketing infrastructure. Bad practices of tomatoes production such as over fertilizing, fertilizer can build up in the soil and cause problems, not watering properly which can lead to multiple problems to tomatoes, including blossom end rot. Planting tomatoes too closely not only stunt their growth and causes a drop in fruit production, but it also makes it too difficult for sun to reach through the plants. Not prune makes it overcrowding which makes it easier for plant disease to spread. Given the needs to address the utilization of good agricultural practices technologies among tomato farmers, it is expedient to describe the socio-economic characteristics of the tomato farmers, determine awareness of respondents on use of GAP technologies utilized by the tomato farmers, identify the GAP technologies utilized by the tomato farmers as well as the constraints faced by tomato farmers in the use of GAP Technologies.

Hypothesis of the study

There is no significant relationship between the socio-economic characteristics of the respondents and the utilization of GAPs Technologies.

MATERIALS AND METHODS

The study was carried out in Oyo state. Agriculture is the major occupation and source of income for a larger portion of the people of Oyo State engaging in over 70% of the state's workforce. Oyo State has a population of 415,030 farm families (2007 Crop enumeration Exercise). This is attributable to the fact that the state is endowed with varied but favorable climatic and ecological conditions, vast agricultural land mass estimated at about 28,000 square kilometers as well as soil structures that support the production of a range of fruits, vegetables, arable and tree crops. The state has untapped and available arable land suitable for large-scale farming with a cultivable size of about 2,710,793 Hectares [12]. The list of registered tomato farmers was extracted from All Farmers Association of Nigeria (AFAN) list in 5 local governments (15%) purposively selected for the study which were Surulere (from Ogbomoso Agricultural zone); Iseyin and Saki West (Saki Agricultural zone); Ido (Ibadan/Ibarapa Agricultural zone) and Atiba (Oyo Agricultural zone) The list has 450 tomato farmers. 53.3% of the respondents were randomly selected to give sample size of 240 tomato farmers. Structured interview schedule was used to collect data. The study contains both dependent and independent variables. The dependent variable of the study is utilization of Good Agricultural Practices Technologies among tomato farmers. This was measured by asking the respondents to indicate the GAP technologies utilized in the study area, and the frequency of utilization of each of the technologies was scored on 4-point rating scale of: Always utilized =3, Occasionally utilized =2, Utilized before but discontinued =1, Not utilized =0. Independent variables were: Age measured in years at ratio level; Education qualification measured as years spent in formal schooling; Household measured as actual number of people living together and eating from same pot; Annual income from tomatoes production measured as actual amount in Naira obtained from sale of tomatoes per year. Frequency counts and percentages were used to describe the data while Pearson correlation was used to establish the relationship between selected variables.

RESULTS AND DISCUSSIONS

Socio-economic characteristics of respondents

The results of socioeconomic characteristics of the respondents as shown in Table 1 indicated that (23.7%) of the respondents are within the age bracket of 41 to 50 years with a mean age of 35 years. This implies that most of the respondents have the ability to engage in productive activities that will enhance their investment and improved technology utilization and hence innovativeness. This finding is in agreement with [10] who reported that farmers within the age range of 41 to 50 years are active, more receptive to innovation and could withstand the stress and strain involved in crop production. The results also showed that majority (65%) of the respondents were males. This corroborates the findings of [9] that the crop production terrain in Nigeria is dominated by the male gender. About (66.67%) of the them were married which shows that most of them had responsibilities and so will be ready to adopt the use of Good Agricultural Practices. Majority (75.0%) of the respondents were literate and this is an advantage for adoption of farm innovation as education has been shown to be a factor in the adoption of high yielding modern farm practices. In other words, the high level of education among the respondents would likely make them more responsive to many agricultural extension programmes and policies. The result further indicated that more than half (56.3%) of the respondents are engaged in farming activities as means of livelihood, while only 43.7% of the respondents are engaged in non-farming activities. This finding is in line with that of [5] who observed that agriculture is the main source of livelihood of rural communities in the south-eastern Nigeria. Furthermore, majority (80.0%) of the respondents have household size of less than 5 persons with a mean size of 2 persons. The result also indicated that majority (71.2%) of the respondents earn annual income of between N501,000 to N1,000,0000 with mean annual income of N 703,750.00. This implies that most of them still earn a very good income annually despite engaging in farming as their primary occupation.

Table 1. Distribution of respondents according to their socio-economic characteristics

Socio-economic characteristics	Freq	%	Mean
Age(years)			
≤30	120	50.0	
31-40	45	18.7	35±10.5
41-50	57	23.7	
51-60	15	6.3	
61 and above	3	1.3	
Sex			
Male	156	65.0	
Female	84	35.0	
Marital status			
Single	117	47.5	
Married	120	2.5	
Widow	6	2.5	
Education (Years spent in school)			
<6	36	15.0	
7-10	24	10.0	
13 and above	180	75.0	
Religion			
Muslim	102	42.5	
Christian	138	57.5	
Household size (persons)			
≤5	192	80.0	**2**±0.6 persons
6 and above	48	20.0	
Primary occupation			
Farming	135	56.3	
Civil servant	9	3.8	
Trading	42	17.5	
Artisan	51	21.3	
Students	3	1.3	
Annual income (000)			
<500	63	26.3	
501-1,000	171	71.2	
1,001-and above	6	2.6	
Social organization			
Yes	103	42.5	
No	138	52.5	

Source: Field Survey, 2021.

Awareness level on GAP technologies by the respondents

Table 2 indicate the awareness level of different GAPs technologies in the study area. (75.0%) indicate indigenous soil testing, (60.0%) claimed modern soil testing, (77.5%) claimed avoid use of refuse dumping site for cropping, (72.5%) claimed to purchased seed from trusted seller, (93.8%) claimed looking for varieties which are pest and disease resistance, (82.5%) claimed healthy seedling are selected for transplanting, (63.7%) claimed preference for organic fertilizer against inorganic, (77.5%) ensured site free from toxic element, (72.5%) claimed water source is not contaminated, (77.5%) claimed appropriate use of chemical, (78.8%) claimed container for harvesting tomato are clean, (83.8%) claimed storage area are clean.

Table 2. Distribution of respondent according to their awareness in Good Agriculture practices (GAP) technologies

GAP technologies Awareness*	Freq	%	Rank
Look for varieties which are pest and disease resistant	225	93.8	1st
Ensure storage area kept clean	201	83.8	2nd
Ensure storage area protected from insect and rodents	201	83.8	3rd
Healthy seedlings are selected for transplanting	198	82.5	4th
Ensure accident and emergency procedure exist	195	81.3	5th
Ensure worker equipped with suitable protective clothes	189	78.8	6th
Ensure containers for harvesting tomato are clean	189	78.8	7th
Ensure site free from toxic element	186	77.5	8th
Ensure appropriate use of chemicals	186	77.5	9th
Avoid use of refuse dump site for cropping	186	77.5	10th
Soil testing (indigenous)	180	75.0	11th
Purchase seed from trusted seller	174	72.5	12th
Ensure water source is not contaminated	174	72.5	13th
Preference for organic fertilizer against inorganic	153	63.7	14th
Soil testing (modern)	144	60.0	15th

Source: Field survey, 2021.

Also, 83.8% claimed storage area protected from insect and rodents, 78.8% claimed worker equipped with suitable protective clothes and 81.3% ensured accident and emergency procedure exist.

This implies that looking for varieties which are pest and disease resistance is the most aware GAP technologies by the respondents.

Level of utilization on GAPs technologies by the respondents

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Table 3 shows the level of utilization on GAPs technologies by the respondent. It indicated that look for varieties which are pest and disease resistance is most utilized GAP technologies with a weighted mean score (WMS) of 2.30 and was ranked 1st ,followed by avoid use of refuse dumping site for cropping with (WMS) of 2.21 and was ranked 2nd ,ensure storage area kept clean with (WMS) of 1.96 and was ranked 3rd ,healthy seedling are selected for transplanting with (WMS) of 1.86 was ranked 4th ,ensure site free from toxic element with (WMS) 0f 1.85 was ranked 5th, ensure storage area protected from insect and rodents with (WMS) of 1.85 was ranked 6th, purchase seed from trusted seller with (WMS) of 1.78 was ranked 7th., ensure appropriate use of chemical with (WMS) of 1.77 was ranked 8th, ensure container for harvesting tomato are clean with (WMS) of 1.66 was ranked 9th, ensure water source is not contaminated with (WMS) of 1.64 was ranked 10th, ensure worker equipped with suitable protective clothes with (WMS) of 1.58 was ranked 11th, indigenous soil testing with (WMS) of 1.54 was ranked 12th, ensure accident and emergency procedure exist with (WMS) of 1.32 was ranked 13th.

Table 3. Distribution of respondents according to their level of utilization in GAP technologies

GAP technologies	Always	Occasionally	Utilized before discontinued	Not Utilized	WMS	Rank
Look for varieties which are pest and disease resistance	150(62.5)	36(15.0)	30(12.5)	24(10.0)	2.30	1st
Avoid use of refuse dumping site for cropping	87(36.3)	75(31.3)	21(8.8)	54(22.5)	2.21	2nd
Ensure storage area kept clean	90(37.5)	90(37.5)	21(8.8)	39(16.3)	1.96	3rd
Healthy seedlings are selected for transplanting	99(41.3)	60(25.0)	30(12.5)	51(21.3)	1.86	4th
Ensure site free from toxic element	96(40.0)	63(26.3)	30(12.5)	51(21.3)	1.85	5th
Ensure storage area protected from insect and rodents	87(36.3)	72(30.0)	39(16.3)	42(17.5)	1.85	6th
Purchase seed from trusted seller	111(46.3)	39(16.3)	15(6.3)	75(31.3)	1.78	7th
Ensure appropriate use of chemicals	96(40.0)	51(21.3)	36(15.0)	57(23.8)	1.77	8th
Ensure that the containers for harvesting tomato are clean	63(26.3)	90(37.5)	30(12.5)	57(23.8)	1.66	9th
Ensure water source is not contaminated	81(33.8)	60(25.0)	30(12.5)	69(28.7)	1.63	10th
Ensure worker equipped with suitable protective clothes	48(20.0)	93(38.8)	48(20.0)	51(21.3)	1.58	11th
Soil testing (indigenous)	63(26.3)	72(30.0)	36(15.0)	69(28.9)	1.54	12th
Ensure accident and emergency procedure exist	36(15.0)	78(32.5)	54(22.5)	72(30.0)	1.32	13th
Soil testing (modern)	60(25.0)	45(18.8)	24(10.0)	111(40.3)	1.22	14th
Preference for organic fertilizer against inorganic	36(15.0) 36(15.0) 72(30.0)	72(30.0)	39(16.3)	93(38.8)	1.21	15th

Source: Field Survey, 2021. *Multiple response.

Also, modern soil testing with (WMS) of 1.22 was ranked 14th and preference for organic fertilizer against inorganic with (WMS) of 1.21 was ranked 15th.

This implies that look for varieties which are pest and disease resistance is most utilize.

Hypothesis testing

Pearson Product Moment Correlation analysis of the relationship between the socio-economic characteristics of the respondents and level of utilization of technologies in GAPs.

The result in Table 4 shows that two of the selected socio-economic characteristics were significant which were age (r=0.531; P=0.003), education qualification (r=0.460; P=0.020) and level of utilization of GAPs technologies. This implies that increase in their age, leads to increase in their level of utilization of GAPs technologies. Also, increase in education qualification leads to increase in their level of utilization of GAP technologies. The null hypothesis which stated that there is no significant relationship between the selected socio-economic characteristics of the respondent and level of utilization in Good Agricultural Practices technologies is thereby rejected and alternative hypothesis is hereby accepted.

Table 4. Pearson Product Moment Correlation analysis of the relationship between the socio-economic characteristics of the respondents and level of utilization of technologies in GAPs.

Socio-economic characteristics	Correlation coefficient (r)	p-value	Remark
Age	0.531**	0.003	Sig
Education	0.460*	0.020	Sig
Household size	0.193	0.087	Non-sig.
Annual income	0.141	0.211	Non-sig.

Source: Field survey, 2020.
**correlation is significant at the 0.01 level (2-tailed).
*correlation is significant at the 0.05 level (2-tailed).

CONCLUSIONS

Based on the findings, farmers gathered their information mostly from relatives and co-farmers. Tomato farmers in the study area were faced with various challenges on the use of GAPs technologies in the study area ranges from inadequate knowledge of GAPs, high cost of technology, lack of awareness about technology and lack of credit facility. Study further concluded that most GAPs technologies adopted by the farmers are to look for varieties which are pest and disease resistance and avoid use of dumping site for cropping. It is therefore recommended that extension agents should extend training of tomato farmers in Oyo state to other non-participating local governments to ensure others benefitted from GAPs technologies.

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METROFOOD-RI UNSTOPPABLE IN THE PURSUIT OF BECOMING A FULLY OPERATIONAL RESEARCH INFRASTRUCTURE ADDRESSING KEY CHALLENGES IN THE AGRI-FOOD SECTOR

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Abstract

The purpose of this article is to provide an insight of a distributed research infrastructure and its roadmap in the pursuit of becoming fully operational. The article presents an overview of the stages in which IBA Bucharest was involved in the creation of METROFOOD-RI. METROFOOD-RI is a distributed pan-European research infrastructure listed in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap in 2016 as an Emerging Project and subsequently, in ESFRI Roadmap in 2018 as an Active Project, sustained in this way, to make progress in legal, technical and financial terms so that it could reach the maturity level necessary to be implemented. METROFOOD-RI fits perfectly in the ESFRI domain of Health & Food, tackling the pressing societal challenges, especially in the agri-food sector by providing high-quality metrology services in food and nutrition. The document describes the path that METROFOOD-RI had to follow so far, its structure, vision, mission, and objectives, as well as the infrastructure architecture and its role in the research landscape. At present, METROFOOD-RI has completed the Preparatory Phase and its partners are about to submit the 1st application form for becoming a legal entity METROFOOD ERIC (European Research Infrastructure Consortium).

Key words**:** *research infrastructure, agriculture, agri-food, metrology, food safety*

INTRODUCTION

METROFOOD-RI "Infrastructure for Promoting Metrology in Food and Nutrition" was created as a distributed research infrastructure (RI) aimed to promote scientific excellence in the field of food quality and safety. It provides high-quality metrology services in food and nutrition, comprising an important cross-section of highly interdisciplinary and interconnected fields throughout the food value chain, including agri-food, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health.
At present, 48 partners from 18 countries (IT - Italy, BE - Belgium, CH - Switzerland, CZ – Czech Republic, DE - Germany, ES - Spain, FI - Finland, FR - France, GR - Greece, HU - Hungary, MO – Moldova, MK – Republic of North Macedonia, NL - Netherlands, NO - Norway, PT - Portugal, RO - Romania, SI – Republic of Slovenia and TR - Turkey) are involved, bringing their contribution in the preparation of METROFOOD-RI upon the H2020-INFRADEV-2019-2 METROFOOD-PP project (GA 871083) (Fig. 1).
The construction of such a large and complex RI takes time (up to 10 years) and it is made in several subsequent steps according to the lifecycle of a RI under the ESFRI approach [2] which consists in passing through the following phases: concept development, design, preparation, implementation, operation, and termination (at some point, in the future, if the case).
Each phase corresponds to the status of a RI in terms of research landscape needs, mission, strategy, targets, costs and so on.
The RI can move from one phase to another subject to the ESFRI evaluation and its decision to include it in the ESFRI Roadmap depending on the gaps identified in the landscape analysis and the so-called maturity

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level of the RI from a legal, technical and financial point of view (Emerging/ Projects/ Landmarks) [2].

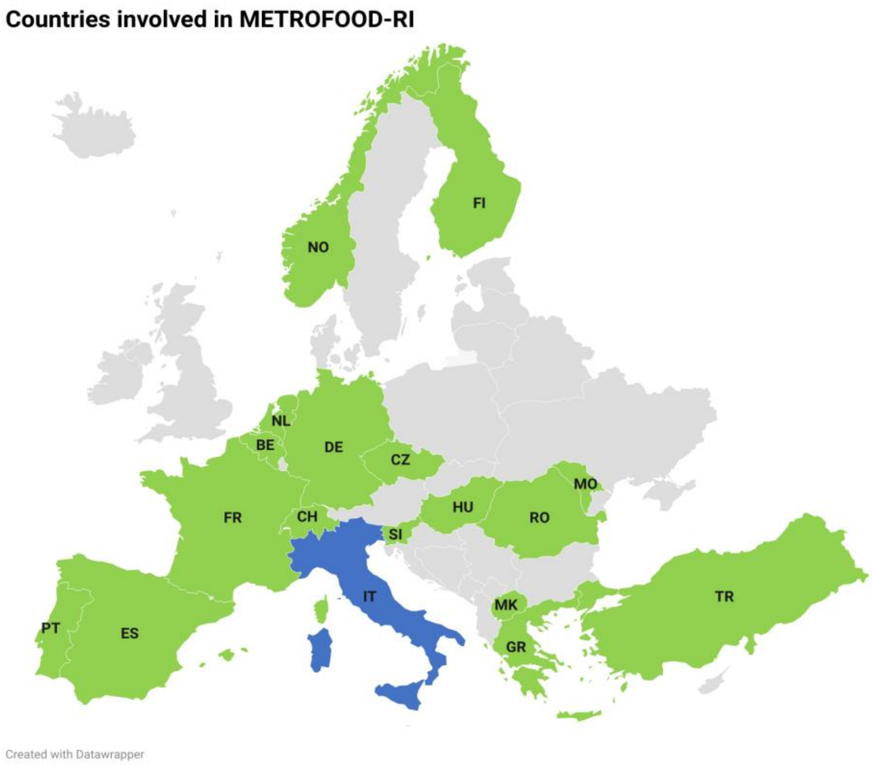

Fig. 1. Countries involved in METROFOOD-RI
Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, www.metrofood.eu, Accessed on 30.05.2022 [9].

Once a RI is included in the ESFRI Roadmap, it has the opportunity to access funds under the European Commission funding programs (e.g., Horizon 2020, Horizon Europe) which include dedicated calls for such RIs about the RI's development stage, i.e., design, preparation or construction phase. Consequently, ESFRI supports the development of such RIs in different key domains that it considers a top priority for action, as follows: energy (EN), environment (ENV), health & food (H&F), physical sciences & engineering (PHSC & ENG), social & cultural innovation (S&C INNOV) and digitalization (DIG) [5, 6].

Most of the RIs sustained by ESFRI are distributed-RIs because the aim is to enhance collaboration and integration among various research institutions/organizations, so pushing forward scientific excellence and also, in this way, generating a wider impact, not only at the European level but also worldwide.

Timeline of METROFOOD-RI

The concept of METROFOOD-RI has started to be developed step-by-step, more than 7 years ago and at present, it finally completed the Preparation Phase, which means that it is entitled to prepare the application for the next phase, i.e., the Implementation Phase.

The timeline of METROFOOD-RI [9] can be summarized as displayed in the below diagram (Fig. 2).

PRO-METROFOOD (Progressing towards the construction of METROFOOD-RI - GA 739568) [13] represented the first step in shaping METROFOOD-RI. The project started after the inclusion of METROFOOD-RI as an "Emerging project" in the ESFRI Roadmap 2016, Domain "Health & Food" [2]. During that phase (2017), METROFOOD-RI performed a detailed design and feasibility study, including a detailed inventory of the pre-existing facilities (physical and electronic), an analysis of the potential services, and an analysis of users and stakeholders, cost book analysis, etc.

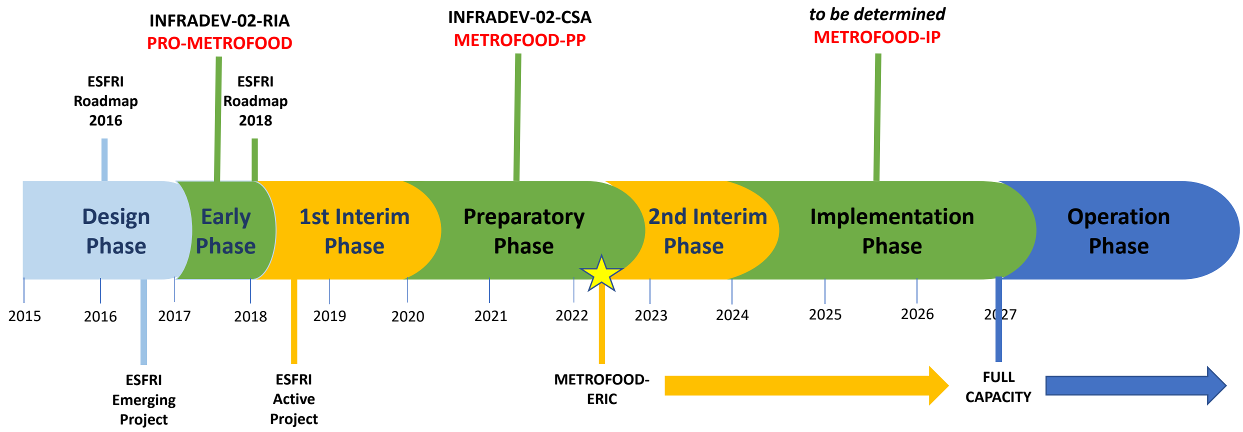

Fig. 2. Timeline of METROFOOD-RI
Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, www.metrofood.eu, Accessed on 30.05.2022 [9].

Subsequently, in 2018, METROFOOD-RI was included in the ESFRI Roadmap 2018 [4], as the evaluation panels (ESFRI Strategy Working Group and Implementation Group) stated that it clearly fills a gap in the Health & Food domain and it was mature enough to proceed with the next steps for its implementation. As such, in 2020 METROFOOD-RI moved forward to the next stage, i.e., the so-called METROFOOD-PP which was specifically dedicated to the realisation of the Preparatory Phase of METROFOOD-RI. Under this phase, a wide consortium of 48 institutions/organizations have worked further, over a 30 month-period, to organize the infrastructure as a ready-to-implementation and ready-to-operation service-oriented organization [10].

MATERIALS AND METHODS

The presentation of the global stringent challenges and the research landscape relies on the ESFRI reports, as well as on official webpages and documents from the EC, FAO, Eurostat, and other relevant organizations, networks, and initiatives active in the Health and Food domain and cross-domain, including relevant stakeholders of the agri-food system.
The description of METROFOOD-RI (history, vision, mission, structure, architecture) is based on the publicly available data and insights from the METROFOOD-PP project.
Diagrams were created for a visual representation of the key aspects related to METROFOOD-RI.

RESULTS AND DISCUSSIONS

Key challenges and gaps
Grand societal challenges represent very complexly, multi-level (macro, meso and micro levels) and interdisciplinary problems that the global society faces including environmental, economic and social problems. All actions and efforts of the EU and other various actors are focused on dealing with these major constraints to successfully mitigate them.
Agri-food, comprised of agriculture and food processing, is a significant economic driver for many EU countries. It emerged as one of the most prominent domains with the EU region's smart specialization strategies. According to the Europe 2020 strategy for smart, sustainable, and inclusive growth, the objective is to make the agri-food sector more competitive while also striving toward more sustainability.
According to the Food and Agriculture Organization of the United Nations (FAO), to meet the increasing food demand, global food production must be increased by 70% by 2050 [8].
Besides this increase in food production, there is a need for more food controls and testing to pass the strict regulations on food safety and their possible evolutions according to

emerging and new food products, new processing techniques and new environmental conditions.

According to the European Cluster Observatory - Priority Sector Report: Agrofood, issued in February 2017, food remains a central need of all human societies. Key global trends are shaping the demands that modern agriculture and food production have to meet: a rising global population requires access to safe and reliable sources of nutrition.

To meet the challenges of the coming years, the EU and the Member States require ambitious policies that unlock the great potential of the European agri-food chain and maintain its place as a world leader. The main challenges are:

-Providing food security as Europe is a major global food importer and exporter and it has some of the world's most fertile arable land. It must use these advantages to play its part in feeding the growing population in Europe and the world as a whole.

-Ensuring food safety - ensuring the highest standards of food safety, all along the chain from farm to fork is essential.

-Creating jobs and growth as the agri-food sector accounts for about 30 million jobs (13.4% of total employment) and 3.5% of total Gross Value Added in the EU-28.

-Safeguarding the environment as agriculture is closely linked with nature and the environment. Innovative technologies, products and practices can help make the most efficient and sustainable use of natural resources, and thereby improve farming's environmental footprint [1].

Agriculture contributed 1.3% to the EU's GDP in 2020 (Eurostat) and, according to Data & Trends 2020 (Food Drink Europe, 2020), the EU food and drink industry employs 4.82 million people, generates a turnover of 1,205 billion euros and 266 billion euros in value-added, making it the largest manufacturing industry in the EU and the biggest manufacturing employer in half of the EU's 28 the Member States plus the UK [12].

Agroecological transition plays an essential role in sustainable agriculture and food systems that enhance food security and nutrition.

Current research landscape at the EU level

RIs in the Biological, Agri-food and Medical Sciences – i.e., Health & Food domain – continue to be established as a key driver for economic impact.

Food-related diseases are increasing and very costly. The EU national health systems are the most under pressure. Regulatory demands relating to health and novel foods impose comprehensive safety assessment procedures and scientific evidence.

In this context, ESFRI Roadmap 2018 clearly states that new infrastructure efforts are needed at the EU level in the field of food, nutrition and processing. There is a need to connect RIs across the EU and globally, and across the entire food chain.

At present, at the EU level, 16 RIs are related to the "Health & Food" domain, including METROFOOD-RI, which is also connected to ENE, ENV, PSE, SCI and DGI.

Relevance

METROFOOD-RI aims at providing high-quality metrology services in food and nutrition all along the whole food processing and supply chain. Such a comprehensive approach along the supply chain, and the central focus on Metrology as an element of objectivity and impartiality, represent distinctive features of METROFOOD-RI giving it an element of uniqueness in the Landscape of RIs.

METROFOOD-RI will support the needs of the food industry, by establishing a strategy to allow reliable and comparable analytical measurements in the whole food value chain, starting from primary producers until consumers, combined with having access to advanced food metrology and safety testing labs.

Measurements related to food quality, safety, traceability, and authenticity are necessary for many purposes: for official control, quality control, research activities and for evaluating exposure through diet or prevent food contamination, as well as to promote sustainability of agri-food systems and circular bioeconomy.

Metrology is the foundation of any measurement system and provides the tools to make the measurement results reliable and comparable. Reliability of measurements is obtained through Reference Materials and methods and reference laboratories. A lot of standardization bodies dealt with this matter and the authorities at the National and European levels fix method performances and analytical procedures. Although in the last year many efforts have been made to harmonize and share standards and procedures, is still a long way to go. Quality of measurements plays an increasingly key role in technological and socio-economic development. To have a Metrological Infrastructure able to allow trade, demonstrate the quality of products and services and strengthen the knowledge base for decision-making in the environmental, health and forensic sectors is an essential factor [7].

Vision, mission and objectives

The **vision** of METROFOOD-RI is to become a distributed Research Infrastructure of Global Interest, using which it will be possible to find comprehensive, integrated and reliable measurement data on food products and processes and to carry out different activities supporting data collection and measurement reliability, as well as basic and frontier research in food and nutrition.

METROFOOD-RI **mission** (Fig. 3) is to promote metrology in food and nutrition & harmonization on a European and gradually global scale by enhancing quality and reliability at the measurement level and making available and sharing data, information and metrological tools, enhancing scientific excellence in the field of food quality and safety and strengthening scientific knowledge, promoting scientific cooperation and integration [11].

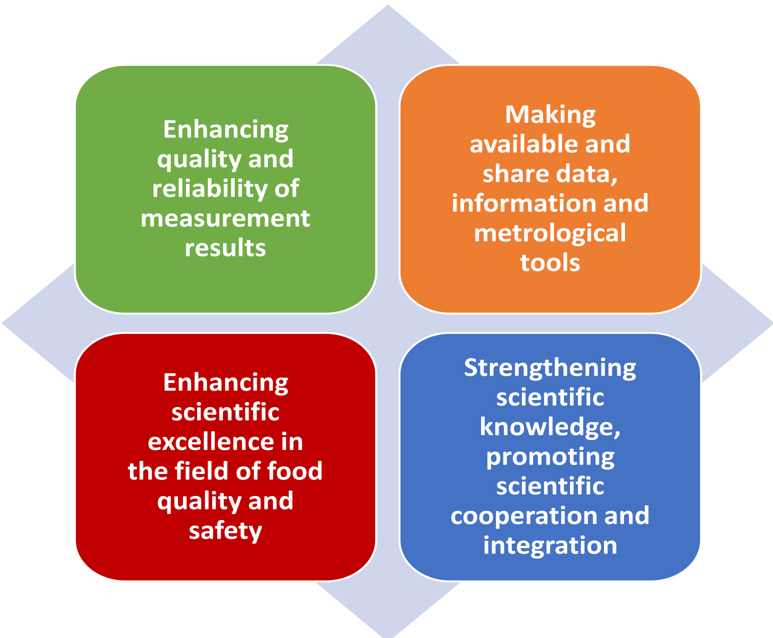

Fig. 3. Mission of METROFOOD-RI
Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, Mission, https://www.metrofood.eu/about-us/mission.html, Accessed on 30.05.2022 [11].

The **general objective** is to enhance scientific excellence in the field of food quality & safety by promoting metrology in food and nutrition, allowing coordination on a European and increasingly Global scale [11].

The **specific objectives** are:

-Providing high-level metrology services in support of the agri-food

-Promoting excellent science, research and innovation on metrology in food and nutrition and support to the agri-food

-Developing the facilities owned by METROFOOD ERIC together with all facilities made available by the National Nodes (NNs)

-Integrating research, training, technology transfer and information dissemination activities.
-Promoting the digitalisation of the agri-food systems, open data and the application of FAIR principles
-Establishing connections with international initiatives relevant in the field
-Synchronising investment and operational funds, in a way to optimise national, European and international resources.
The research activities of METROFOOD-RI cover the whole food chain and related services, from agri-food production up to final consumption, too:
-Support sustainability of food production and consumption;
-Improve food quality and safety;
-Achieve food traceability and authenticity demonstration;
-Optimize all steps from farm to fork with a holistic approach;
-Foster the digitalization of the agri-food systems.

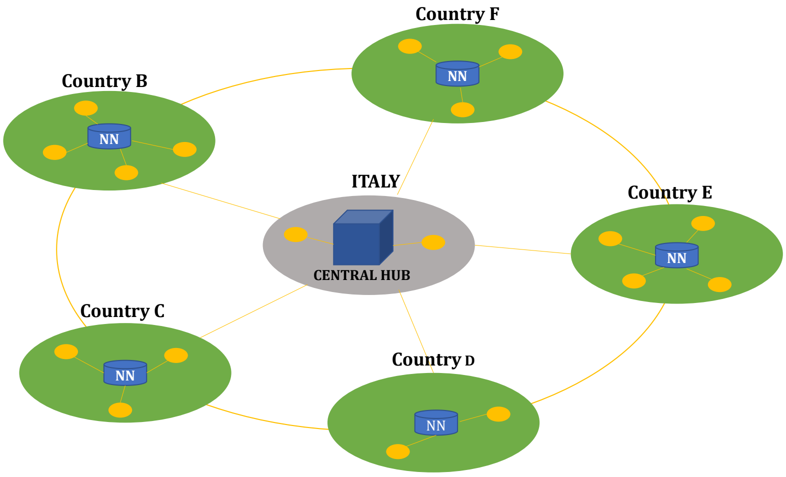

Fig. 4. METROFOOD-RI's structure as distributed-RI
Source: Based on the ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [3].

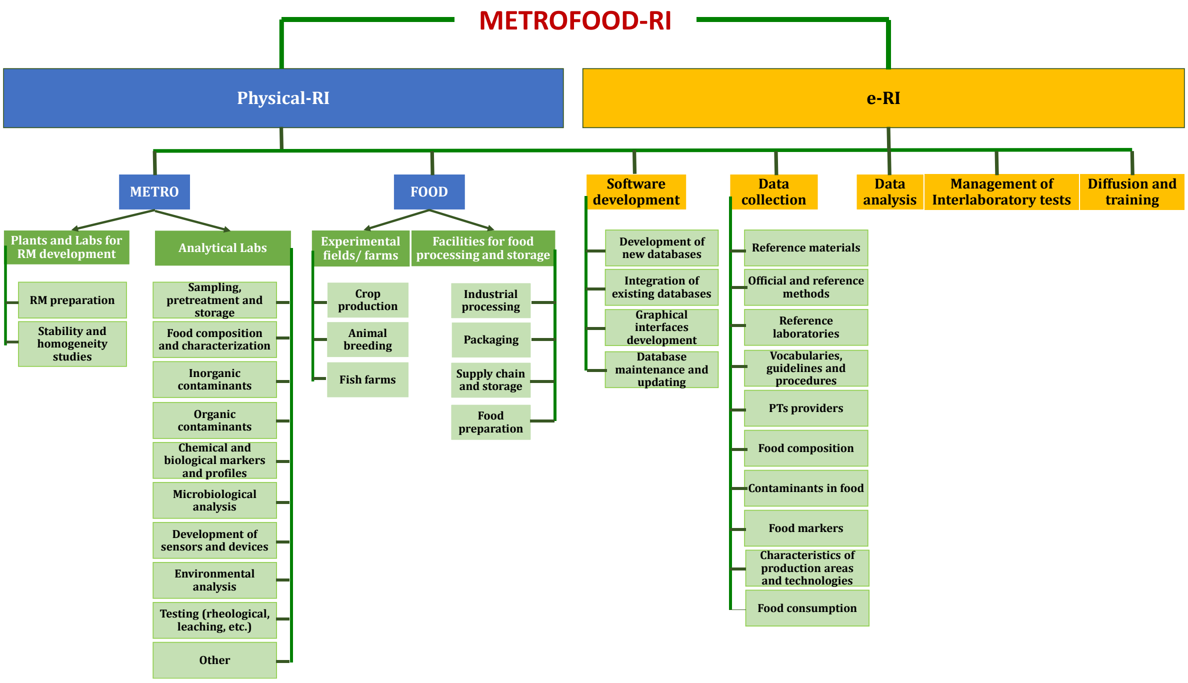

Fig. 5. Physical-RI and electronic-RI of METROFOOD-RI
Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, https://www.metrofood.eu/about-us/infrastructure.html, Accessed on 30.05.2022 [10].

Structure

As a distributed-RI, METROFOOD-RI will be built on a Hub and Node model, formed by a Central Hub in Italy and a network of National Nodes, one for each country involved. Some National Nodes (NN) – typically those of the Countries with more Partners (e.g.: Italy, Romania, Republic of Macedonia, Slovenia), will be in turn organized in a network of Centres.

Infrastructure architecture

METROFOOD-RI includes a physical (P-RI) and electronic component (e-RI), as showcased in Fig. 4.

Physical-RI

METROFOOD-RI mainly counts on pre-existing facilities, its "Implementation" relies on the upgrading of the pre-existing facilities that each partner owns and the implementation of the Central Hub.

The physical infrastructure of METROFOOD-RI can be described in two main components, the "Metro side" and the "Food side", depending on the different physical facilities. The "Metro side" consists of:

-plants for the development and production of new reference materials for the agri-food sector;

-analytical labs for the development and validation of new methods for the chemical, physical-chemical and (micro)biological characterisation of foods and any matrix of interest for the agri-food system,

while the "Food side" consists of:

-facilities for primary production of food (e.g., agricultural fields, greenhouses, livestock breeding, aquaculture, agricultural (by)products for bioenergy production, biotechnological production of foods/ingredients, etc.)

-experimental plants related to food processing, food storage, food packaging, treatment/reduction of food losses and waste, production of aids in food production/storage up to kitchen labs for reproducing and studying the effects of consumers' domestic habits on food quality and safety.

e-RI

The objective of METROFOOD-RI is to create a unique platform providing access to a worldwide distribution network of scientific facilities and state-of-the-art services, data, information and metrological tools for the measurement and assessment of food quality and safety, covering the entire food chain from agri-food primary production up to final consumption.

The METROFOOD e-RI will cover two major areas, that is:

-The public resources (i.e., digital tools, services, and datasets) for external and internal users,

-Digital tools for internal management and administration of the Central Hub and its relationship with the National Nodes.

CONCLUSIONS

Agriculture has a vital mission in securing crop production and increasing crop yield to face the growing population fast pace. The agri-food sector faces growing concerns as the market demands more and more healthy, sustainable and safe products, made of natural ingredients, so that is another important reason for paying particular attention to the whole food value chain to ensure food quality, food safety, authenticity and traceability.

In this context, METROFOOD-RI aims to tackle consumers' needs and expectations, help policymakers and local authorities in the decision-making process, as well as to help scientists and food business operators make excellent research related to food and nutrition, but also develop complex innovation ecosystems where industry plays an increasingly significant role. Improving the collaboration between the RI and industry is crucial in boosting competitiveness and innovation. RIs "constitute a powerful resource for the industry" as expressed in the ESFRI White Paper 2020 [11, 6].

METROFOOD-RI represents a cornerstone in the research ecosystem and not only, with a focus on the Health & Food domain and a look to cross-domain activities, covering a broad area of research activities and business sectors, with a high potential of widening at the global level, bringing multiple long-term benefits to various stakeholders, addressing global complex challenges that need urgent solutions, all of these aspects highlighting METROFOOD-RI's relevance and imperativeness for an indefinite period.

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IMPACT OF THE COVID-19 PANDEMIC ON ABACA FARM HOUSEHOLDS: A CROSS-SECTIONAL SURVEY

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Abstract

This research study examined the impact of the COVID-19 pandemic on abaca farming, a fiber crop in the Philippines. To accomplish the study's aims, both descriptive analysis and mean comparisons by paired t-test were performed. Based on the results, abaca farmers have seen a decrease in their farm incomes as transportation expenses and agricultural input prices have risen. To cope with the pandemic, various coping techniques such as borrowing money, selling of assets, and usage of savings are being practiced. To help revive the agricultural portion of the abaca industry, loans exclusive for abaca growers must be made accessible.

Key words**:** *Covid-19, abaca farming, fiber crop*

INTRODUCTION

The coronavirus disease or COVID-19, which is caused by severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2 [10], has brought disruptions all over the world specifically in various sectors of the economy [3]. The agricultural sector across the provinces in the Philippines is not exempted from the pandemic's unfavorable effects during the appearance of COVID-19 virus [4]. The government imposed lockdowns, community quarantines, and curfews to prevent the coronavirus disease from spreading, and health measures were implemented [5].

These various announcements have corresponding consequences on the agricultural sectors that had a negative impact on the incomes of farmers [8]. As a result, appropriate responses at all levels to support them in the aftermath of the crisis is essential. This study was conceptualized to assess the impact of the COVID-19 pandemic mainly on abaca farming, a fiber crop in the Philippines. Abaca is native to the Philippines and is considered the “strongest natural fiber in the world” by the Philippine Department of Science and Technology and the Philippine Fiber Industry Development Authority [6]. Abaca is a herbaceous plant, originally from the Philippines, whose fibre has a high content of lignin and cellulose that provide a big resistance to traction, putrefaction, abrasion, and UV rays and salt water degradation [7] Abaca has a variety of uses [1], it is used for specialty papers such as currency notes, tea and coffee bags, vacuum bags, cigarette filter paper, sausage casing paper, and high-quality writing paper. It is also used to make twines, ropes, fishing lines, and nets. Abaca has a high potential to substitute glass fibers in multiple automotive parts.

This study was designed to collect evidence as a prerequisite for policy response considerations so that abaca farmers can recover their agricultural income and lessen their vulnerabilities. This research study's primary beneficiaries include abaca growers, government agencies, and researchers.

MATERIALS AND METHODS

The data for this study was collected from the abaca farmers in Baybay City, Leyte, Philippines, at Amguhan and Villa Mag-aso, two of the abaca farming areas in Baybay City (Map 1).

Data Collection

Primary data was collected in November and December 2021 through the use of pretested

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survey questionnaire. Proper health protocols such as wearing masks and physical distancing were observed during the face-to-face interview to prevent the spread of the Covid-19 virus. The literature review was also made in the collection of data.

Map 1. Map of the study sites
Source: [2].

Data Analysis

To answer the objectives of this study, statistical methods such as descriptive analysis (e.g. means and frequency counts) and comparison of means by paired t-test were used. Statistical Packages for Social Sciences (SPSS) v. 21 was used to analyze the data. Microsoft excel was also utilized to facilitate the construction of graphs and charts.

RESULTS AND DISCUSSIONS

Abaca farmer respondents are on average 47 years old. Males make up the majority (55.6%), and more than three-quarters (3/4) of the respondents are married (Table 1). With seven (7) years of formal education, roughly half of them have completed elementary school. A family's average number of members is four (4), the size of a typical Filipino family.

Almost all of the farmer respondents (92.6%) considered abaca farming as their primary source of living (Fig. 1).

About 41% of them looked for alternative sources of income to supplement their family's daily necessities (e.g. food, clothing, medication, and education), such as starting a business, working as a service worker, working in labor and production, and working as health workers in their local *barangay*, native Filipino term for a village [9].

Table 1. Profile of the abaca farmer respondents

Profile	Category	Percentage
Sex	Female	44.4
	Male	55.6
	Total	*100*
Age (in years)	20 to 29	7.4
	30 to 39	29.6
	40 to 49	29.6
	50 to 59	7.4
	60 to 69	18.5
	70 and above	7.4
	Total	*100*
Civil status	Single	3.7
	Married	88.9
	Separated/Divorced	3.7
	Live-in	3.7
	Total	*100*
Educational attainment	Elementary level	18.5
	Elementary Graduate	25.9
	High School level	33.3
	High school Graduate	22.2
	Total	*100*
Household size	0 to 2	11.1
	3 to 5	59.2
	6 to 8	25.9
	9 and above	3.7
	Total	*100*
Number of children	0 to 2	25.9
	3 to 5	44.4
	6 to 8	14.8
	9 and above	14.8
	Total	*100*

Source: Author's calculation and analysis (2022).

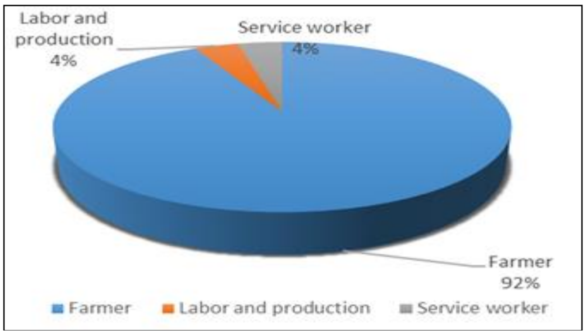

Fig. 1. The primary occupation of the abaca farmer respondents
Source: Author's calculation and analysis (2022).

Abaca farmers with more than 12 years of experience make up nearly half of the respondents (Table 2).

However, the average number of years spent in farming abaca is 15, and the average area of an abaca plantation is 1.7 hectares (17,000 sq. m.).

The majority of the abaca farmer respondents are the sole owners of the farms they are cultivating and there are about 44% of them who planted less than 100 abaca plants only.

Table 2. Abaca farming-related characteristics

Abaca farming-related characteristics	Category	Percentage
Years in abaca farming	0 to 2 years	14.8
	3 to 5 years	11.1
	6 to 8 years	11.1
	9 to 11 years	11.1
	12 years above	51.8
	Total	*100*
Size of abaca farm (in ha)	< 1 ha	33.33
	1 to 2 ha	44.44
	3 to 4 ha	14.81
	5 to 6 ha	3.7
	> 6 ha	3.7
	Total	*100*
Ownership of farm	Individual	59.3
	Partnership	11.1
	Communal	11.1
	Tenant	18.5
	Total	*100*
Number of abaca planted	< 100 plants	44.44
	100 to 200 plants	18.52
	300 to 400 plants	18.52
	500 to 600 plants	14.81
	> 600 plants	3.7
	Total	*100*

Source: Author's own calculation and analysis (2022).

Many farmers, particularly abaca growers, are experiencing changes in terms of revenue and costs in their farming activities as a result of the Covid-19 pandemic (Fig. 2). Approximately 44% of abaca farmers have reported that their farming capital has dropped while agricultural costs have also risen (55.5%) as the cost of farming inputs has risen dramatically. This has resulted in a decrease in family income (51.9%) and increased in household spending (59.3%).

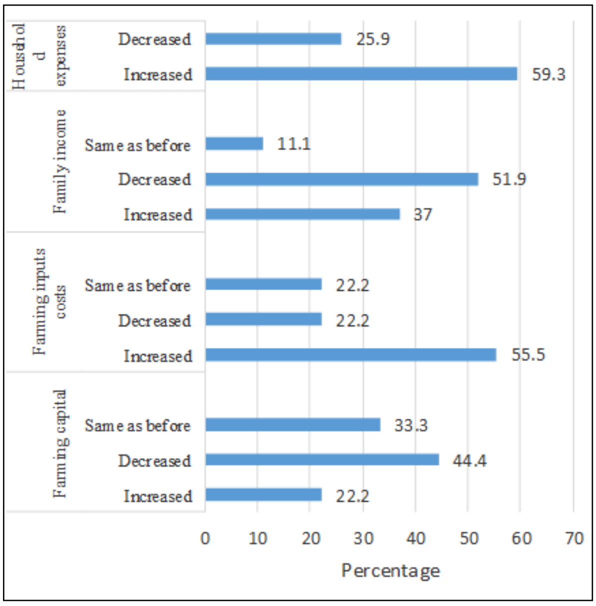

Fig. 2. Impact of Covid-19 on abaca farming
Source: Author's calculation and analysis (2022).

In Fig. 3, the majority of people have issues with accessing inputs (59.2%) primarily because of border restrictions, but they have no issues with labor availability (74.1%) since most of the abaca farmer respondents do not hire laborers.

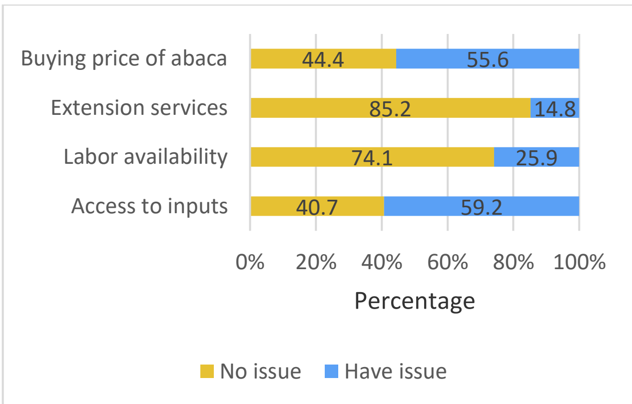

Fig. 3. Challenges in agricultural inputs
Source: Author's calculation and analysis (2022).

They also don't have any problems with access to extension services (85.2 %) since it is available through the internet. On the other hand, many people have complained about difficulties in obtaining abaca fiber at a reasonable price (55.6 %) since its prices varies from time to time.

As displayed in Table 3, there are changes in the costs of transportation due to the pandemic making even higher (70.4%) with *habal-habal* as the most used mode of transport (48.1%) in bringing the fiber crop to the buyer. Most of the abaca farmers preferred traders as their primary source of the marketing outlet (77.8%) since they usually can borrow money from them whenever they needed it.

Table 3. Marketing related variables in abaca

Marketing related variables	Category	Percentage
Increase in transport costs?	None	29.6
	Yes	70.4
	Total	*100*
Primary outlet	Traders	77.8
	Buying Station	22.2
	Total	*100*
Reason for market choice	High buying price	40.7
	Regular buyer	51.8
	Lots of buyer within barangay	7.4
	Total	*100*
Mode of transport	Truck	11.1
	Tricycle	11.1
	Habal-habal	48.1
	Hand carry/walking	29.6
	Total	*100*

Source: Author's own calculation and analysis (2022).

During the pandemic, various coping mechanisms are being employed (Fig. 4). In managing their household expenses almost half of the farmer respondents sell their assets (44.4%) while only a few make use of their savings (33.3%) and pursued credit (22.2%). When borrowing money is being practiced, usually, they go to their family and friends (59.2%) were without or low-interest rates are being charged to the borrowers with no collaterals are being required.

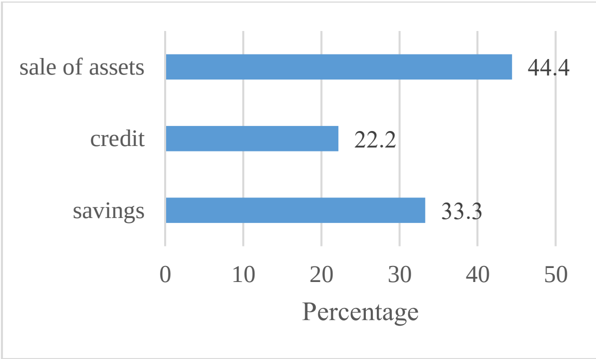

Fig. 4. Coping mechanisms of the abaca farmer respondents during the pandemic
Source: Author's calculation and analysis (2022).

Figure 5 shows that the majority have received cash assistance from the government (70.4%) and non-cash assistance (63%). Many respondents haven't received cash (81.5%) and non-cash (85.2%) assistance from non-government organizations.

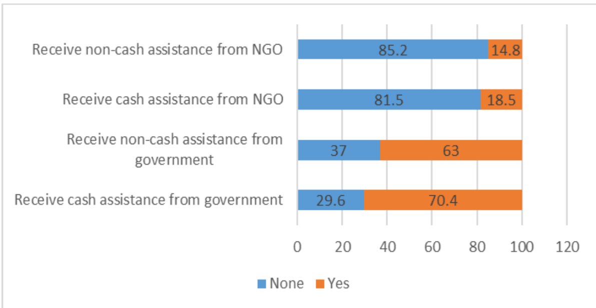

Fig. 5. Cash and non-cash assistance received by the abaca farmer respondents
Source: Author's calculation and analysis (2022).

Abaca farming capital was higher prior to the Covid-19 outbreak, but there isn't enough data to verify its statistical significance (Table 4). Farm revenue is marginally greater during the pandemic due to volatile agricultural buying prices, particularly for the abaca fiber crop. With this, the buying price of abaca fiber is significantly higher, at 1%. Due to establishment closures during the epidemic as a result of strict controls being implemented, non-farm income was lesser during the Covid-19 pandemic. In addition, job losses have forced people to stop sending money to their family, which has resulted in a drop in remittances.

Table 4. Results of mean comparison by paired t-test

Variables	Mean (before pandemic)	Mean (during pandemic)	Mean difference	SE	t	p-value
Capital	6,723.53	4,817.65	1,905.88	1,800.87	1.058	0.306
Farm income	10,079.17	10,504.17	425	1,577.64	-0.27	0.79
Non-farm	11,385.71	9,900	1,485.71	2,121.93	0.7	0.51
Remittances	5,664.29	3,342.86	2,321.43	1,342.26	1.729	0.10
Buying price	40.1053	57.7368	17.63	4.40	-4.01	.001***

Note: *** significant at 1%,
Source: Author's own calculation and analysis (2022).

CONCLUSIONS

The abaca farmer respondents sought extra sources of income to meet their daily household needs. As a result of the pandemic, agricultural input prices and transportation costs have all risen, resulting in lower farming incomes. Farmers have also been hampered by the general increase in the prices of other commodities, which resulted in higher family spending. Due to this, the government must keep a close eye on the rising prices of a variety of goods. Access to farming inputs is a big challenge in abaca farming during the pandemic because of border restrictions. To address this problem, the local government will need to pass new border limitations exemptions, which might include the purchase of agricultural inputs. As one of the coping mechanisms, most of the abaca farmers borrowed money from their relatives and friends during the pandemic. With this, low-interest loans must be made available for abaca farmers to revitalize the abaca agricultural industry.

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ASSESSMENT OF ABACA FIBER PRODUCTION IN EASTERN VISAYAS PROVINCES, PHILIPPINES

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Abstract

This paper examines the production of abaca fiber in the Eastern Visayas region. The buying prices of abaca fiber and the agricultural land area planted with abaca were also assessed. The goal of this study is to identify abaca production gaps and develop policies to improve the abaca sector in the region. According to the findings, abaca fiber production varies across Eastern Visayas provinces starting from 2010 to 2020. Natural disasters like typhoons and the bunchy top virus damaged the abaca fiber production. The agricultural land area cultivated with abaca is decreasing with time and there has been a considerable difference in the buying price of abaca fiber across the provinces. With this, the local government units must conduct proper monitoring on the buying prices of abaca fiber, improved extension services must be made available, provision of incentives and partnerships must be strengthened to enhance the quantity of abaca fiber production in the region.

Key words*: *abaca, fiber, Eastern Visayas, assessment

INTRODUCTION

The Philippine abaca industry was a key player in the global abaca market. The Philippines supplies 80 percent of the world's abaca need [8]. It has become a source of employment for more than 1.5 million Filipinos who rely on it for a living, either directly or indirectly [4]. Although there is a growing demand for abaca on the worldwide market, current productivity levels are insufficient to supply this need. The demand-supply gap in 2019 is 25,000 metric tons [11].

The low productivity of abaca is attributed to several reasons. First, with abaca as an agricultural crop, it is subject to weather conditions and since the Philippines is located in the typhoon belt, it is visited by an average of 20 typhoons every year, five of which are destructive [1]. Another threat is the abaca bunchy top virus or ABTV, which has significantly wiped out the abaca plantation [6].

Eastern Visayas produces 33.15 percent of the country's abaca [2]. As the Philippines' second-largest abaca producer [9], it is important to evaluate the status of abaca production in the provinces of Eastern Visayas. This assessment would go back several years, as studying the abaca industry's past performance helps plan for future investment in abaca. The gaps along the years will be investigated, providing enough information for policymakers to formulate strategies to strengthen the abaca sector in Eastern Visayas. Generally, the objective of this study is to assess the status of the abaca industry in the provinces of Eastern Visayas starting from 2010 to 2020. Specifically, this study aims to examine the buying prices of abaca fiber, the area planted, and the production quantity of fiber across the provinces in Eastern Visayas; and to provide policies for the improvement of the abaca industry in Eastern Visayas. On the researcher's side, this will add to the growing literature about abaca. The private sectors, government agencies, future investors on abaca, and researchers are the target beneficiaries of this research study.

MATERIALS AND METHODS

The Study sites

Eastern Visayas, or Region VIII, is made up of three major islands: Samar, Leyte, and

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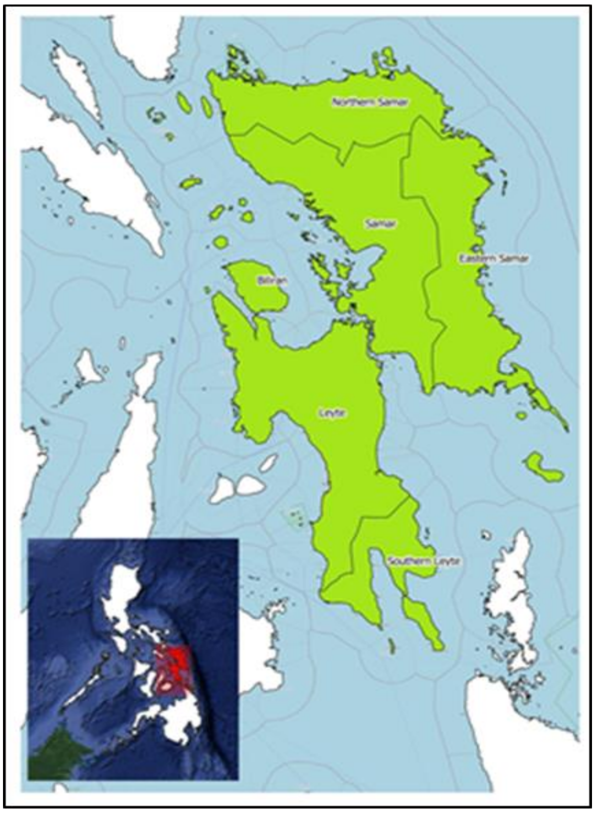
Biliran. It is located in the Philippine archipelago's east-central region. The six provinces of Eastern Visayas are Biliran, Leyte, Southern Leyte, Eastern Samar, Western Samar, and Northern Samar (Map 1). It covers 2,156,285 hectares, accounting for 7.2 percent of the country's total land area [12].



Map 1. Eastern Visayas Region
Source: [5].

The data

The data being used in this study was taken from Philippine Statistics Authority, or PSA [10]. The above mentioned government agency provided data on abaca production (in metric tons) in the six provinces of Eastern Visayas and other related variables (e.g. prices and land area). The data was collected during a ten-year period, starting from 2010 until 2020. A literature review was also made in the collection of data.

Statistical Analysis

To facilitate the data analysis of this study, descriptive analysis such as means, variances, standard deviation, minimum and maximum values was computed describing the status of abaca fiber production in the provinces of the Eastern Visayas Region. Statistical Packages for Social Sciences (SPSS) was used to analyze the data. Microsoft Excel facilitates the construction of graphs.

RESULTS AND DISCUSSIONS

By mean values, the year 2010 produced the most abaca fiber in the Eastern Visayas region, totaling 1,012.57 metric tons (see Table 1). As indicated in Table 1, abaca fiber output in the Eastern Visayas began to decline until 2015, when the abaca bunchy top virus disrupted the abaca plants, causing them to die. Several farmers incurred losses on their farms and had to cope with the loss of income. In addition to the threat of the virus, the region was also threatened by the catastrophic typhoon Yolanda, internationally known as "Haiyan" [7], which damaged numerous provinces in the Eastern Visayas region including the abaca plantation that resulted in a considerable decrease in abaca fiber production with only 638.97 MT and 631.49 MT of abaca fiber in 2014 and 2015. Abaca production began to climb again in 2016 when farmers began replanting abaca with the encouragements from the agriculture sector in local government units. Planting materials were provided and virus-fighting training sessions were done to fight the devastating effect of the virus.

Table 1. Descriptive analysis of abaca fiber production in metric tons (2010-2020)

Year	Mean	Variance	Std. Dev	Min	Max
2010	1,012.57	541,737.43	736.03	63.47	2,455.36
2011	994.82	602,142.93	775.98	64.19	2,198.45
2012	954.60	565,655.18	752.10	66.55	2,120.00
2013	825.80	539,920.20	734.79	44.10	2,081.24
2014	638.97	479,240.45	692.27	40.20	2,154.08
2015	631.49	483,301.14	695.20	3.72	2,160.00
2016	960.06	1,761,025.10	1,327.03	3.62	7,241.25
2017	911.86	1,510,541.93	1,229.04	0.66	7,234.90
2018	905.48	1,479,703.77	1,216.43	2.40	7,149.15
2019	911.45	1,486,061.35	1,219.04	2.00	7,150.65
2020	877.13	1,440,177.1	1,200.07	.77	6,974.25

Source: [10].

Leyte has the highest abaca fiber production among the provinces in the Eastern Visayas region in 2010 and 2011, whereas Northern Samar produced the most abaca fiber starting from 2012 to 2020 (Fig. 1). Abaca fiber production has been declining in Southern Leyte, although it has increased slightly from 2017 until 2020. On the other hand, Eastern Samar, Samar, and Biliran produced the least amount of abaca fiber throughout the ten-year period.

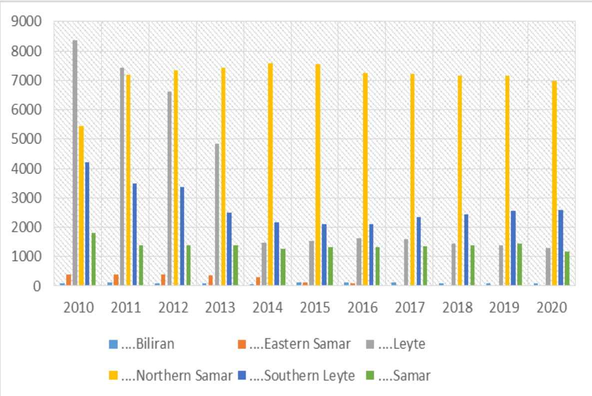


Fig. 1. Abaca fiber production among provinces in Eastern Visayas provinces (2010-2020).
Source: [10].

As seen in Fig. 2, from 2018 to 2020, farm gate prices in Eastern Visayas provinces fluctuate. The average farm-gate price of abaca fiber in Southern Leyte in 2020 was PHP 76.02 (USD 1.48) per kilogram, the highest buying price in three years. Biliran is consistent with the lowest buying farm gate price reaching an average of PHP 51.76 (PHP 1.01) per kilogram. Other provinces in Eastern Visayas, such as Leyte and Northern Samar, charge around PHP 60 (USD 1.17) per kilogram, on average. For Samar's farm gate price, there has been a significant dropped in price from PHP 63.69 (USD 1.24) in 2018 to PHP 58.48 (USD 1.14) in 2019 and in 2020 it was PHP 58.48 (USD 1.14).

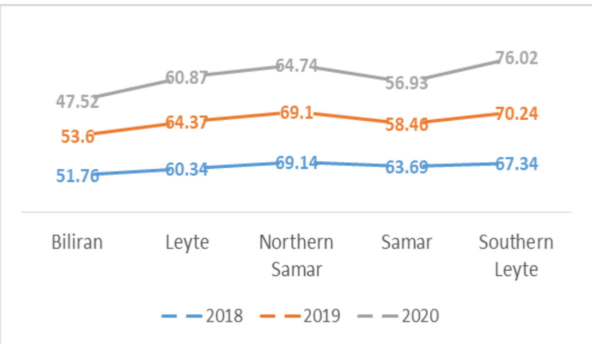


Fig. 2. Mean values of farm gate prices of abaca fiber (2018-2020)
Source: [10].

In 2010, Leyte had the largest agricultural area planted with abaca, though this has been decreasing over time. However, from 2015 to 2020, the same size of land was planted with abaca at around 8,000 ha (Fig. 3). During the three-year period, the area planted with abaca in Northern Samar (12,000 ha), Western Samar (2,000 ha), and Biliran (18,000 ha) did not vary significantly.

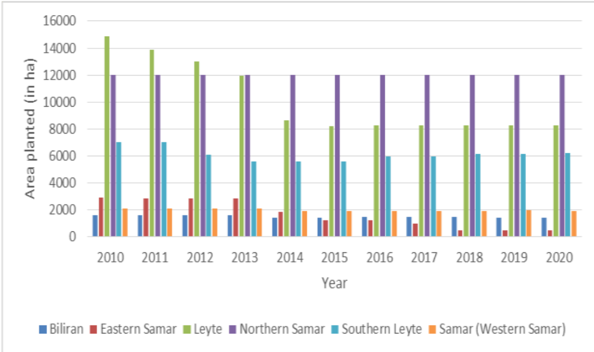


Fig. 3. Agricultural land area planted with abaca in Eastern Visayas provinces (2010-2020)
Note: 1 USD = PHP 51.30
Source: [10].

Table 2 indicates the proportion of abaca-planted agricultural land. Among the provinces in the Eastern Visayas region, Southern Leyte has the smallest agricultural land area (90,673 ha), but has the highest fraction of abaca plantation (6.85%). With 27,239 ha of agricultural land, Biliran was next to have the biggest portion of abaca-planted agricultural land (5.14%).

Table 2. Agricultural land area planted with abaca (ha)

Eastern Visayas Provinces	**Agricultural area (ha)**	**Area planted with abaca (ha)- 2020**	**Area planted with abaca (%)**
Biliran	27,230	1,400	5.14
Leyte	332,018	8,250	2.48
Southern Leyte	90673	6,210	6.85
Samar	154,906	1,935	1.25
Eastern Samar	170,995	500	0.29
Northern Samar	976,385	12,040	1.23

Source: [3].

Leyte has the second largest agricultural land next to Northern Samar (332,018 ha), however, only a small percentage of it was planted with abaca (2.48%). Northern Samar, on the other hand, has the region's largest agricultural land area, but has the smallest percentage being planted with abaca (1.23%), nearly the same percentage in Samar (1.25%). Eastern Samar has the least part of abaca grown (0.29%), with approximately 170,995 ha of agricultural area.

CONCLUSIONS

Within the ten-year assessment period, there are variations in the quantity of abaca fiber production between provinces in the Eastern Visayas region. The agricultural area utilized for abaca farming is decreasing over time and the quantity of abaca fiber production has been reduced due to natural calamities (e.g. typhoons) and the bunchy top virus. With this, abaca farming must be promoted by the agricultural sector in local government units and the government may incentivized planting materials or labor cost to encourage the start-up of farming activity. The buying price of abaca fiber, on the other hand, fluctuates with time. This needs the government's strict supervision of abaca fiber buying prices. Extension services must be offered or expanded, particularly as farmers fight the abaca bunchy top virus disease in order to increase abaca yield in the region. Finally, partnerships and regional collaboration must be strengthened as they share best practices to revitalize the abaca industry in the region.

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WOMEN'S PARTICIPATION IN ABACA FARMING: A CASE IN BAYBAY LEYTE, PHILIPPINES

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Abstract

This study examines the involvement of women in abaca farming activity at various phases. Selection of the respondents was done by simple random sampling, and the data were collected using survey questionnaire. The data were analyzed using descriptive analysis, which included frequency counts, percentages and mean. According to the findings, women participated in all aspects of abaca farming, however men are more heavily involved than women because it is a labor-intensive livelihood. Women were commonly involved in abaca-related decision-making, as well as in the sale of abaca fiber and the management of abaca farm earnings.

Key words: *women, abaca farming, gender roles*

INTRODUCTION

In the global abaca market, the Philippine abaca industry was a major player. The Philippines provides 80% of the world's abaca demand [14]. It has become a source of income for more than 1.5 million Filipinos who rely on it either directly or indirectly for a living [6]. Women have important contributions to agriculture, according to numerous studies. Many studies have been done to detect the trends of working female labor in agriculture, but none looks at the role of women in abaca farming. As a result, this research was carried out to fill the gap. Thus, this study was conducted to determine the function of women in abaca farming and to comprehend the roles of men and women at various phases of the abaca farming process.

MATERIALS AND METHODS

Location of the study

The study took place at Baybay City, Leyte, Philippines. It is situated at approximately 10°41' North, 124°48' East, in the island of Leyte. Elevation at these coordinates is estimated at 2.0 meters or 6.5 feet above mean sea level [13]. City of Baybay has a total land area of 46,050 hectares, and is known to be one of the largest in terms of land area in the Eastern Visayas region. It is divided into ninety-two (92) barangays, composed of 24 urban barangays and 68 rural barangays [3]. The climate is often humid, with no identifiable seasons and its topography is generally mountainous in the eastern portion as it slopes down west towards the shore line. Farming and fishing are the most frequent sources of income in this predominantly agricultural community [18].

Data collection and sampling technique

The abaca farmer respondents were selected using simple random sampling, with each abaca farmer in Baybay City having the same chance of being selected as samples for the study [9].

The survey instrument was pre-tested prior to the collection of the respondent's profile, and other farming related activities.

The collected data were analyzed using descriptive statistics, which included frequency counts, percentages, and mean. Covid-19 virus protection was observed using health standards such as wearing of masks and keeping a 2-meter distance while doing the interview.

Data analysis was made using Statistical Packages for Social Sciences (SPSS) v.20

while Microsoft Excel 2017 was used in the construction of charts and graphs.

RESULTS AND DISCUSSIONS

Profile of the abaca farmer respondents

Men worked in abaca farms for a longer period of time than women; men worked for an average of 19 years, while women worked for about 11 years (Table 1). This translates that men have been farming abaca since they were younger, but women joined them later due to pregnancy, childbirth, and child raising [4]. Male farmers are 55 years old on average, whereas female farmers are 36 years old. Women farmers, on the other hand, have higher level of education than men. Women, on average, completed second year high school with eight (8) years of formal education, whereas men had only primary education with six (6) years of formal schooling and none of the respondents had even reached tertiary education.

Table 1. Profile of the abaca farmer respondents, by sex

Variables	Female	Male
Years in abaca farming	11.27	18.55
Age	36	55
Years of education	8.42	6.33

Source: Author's calculation and analysis (2022).

Role of men and women in abaca farming

Agricultural trainings are relevant in any farming activity. It allows the farmers to incorporate the latest scientific advances and technology tools into their day to day operation [8]. These trainings may improve farmers' skills and knowledge in areas such as planting techniques, irrigation, pesticides, crop rotation, and crop storage after harvest. These skills enable farmers to improve yields, and protect their crops against weather-related shocks [11]. Based on the findings, it appears in Fig. 1 that men (48.1%) are more likely to take abaca related trainings than women (44.4%). Men chose to take part in this activity because they were mostly involved in the abaca planting tasks. In their training sessions, farmers were taught some measures on how to be more productive in their farms like eradication of abaca bunchy top virus or ABTV that had wiped away abaca plantation [12]. Also, men become more responsible in the decision-making about abaca farming (81.5%) since men performed the majority of abaca farming related activities.

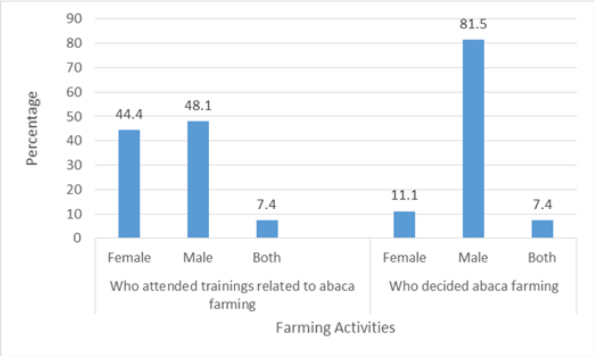

Fig. 1. Attendance to trainings and decision-making in abaca farming, by gender
Source: Author's calculation and analysis (2022).

As reported in Fig. 2, male abaca farmers primarily took charge in planting the abaca seedlings (66.7%) while seldom it is done by both male and female (33.3%). Women are involved in various stages in abaca farming such as planting (3.7%), plowing the soil (3.7%), and weeding (3.8%). The initial harvest of abaca fiber takes place between 18 and 24 months after planting [5]. During this period, the abaca fiber will go through several stages such as fiber extraction, drying, grading, and baling where men frequently assume responsibility on these stages (69.2%) [1].

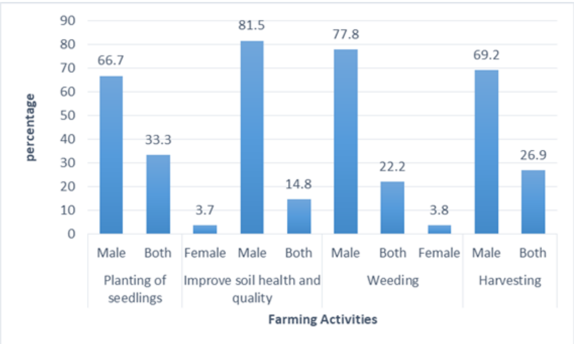

Fig. 2. From planting to harvesting related activities
Source: Author's calculation and analysis (2022).

After harvesting and getting the fiber ready for sale, the choice of buying station is considered. Selection of buying station for abaca fiber is essential in the every farm household since it leads to an impact in their earnings. Different buying outlets have varied buying prices, some of which are low while others have higher buying price. As presented in Fig. 3, male abaca growers usually decides where to sell the fiber (81.5%), seldom female (7.4%) take part on this decision making, whether to sell it to licensed traders in the city or in buying stations within their community or barangay. Meanwhile, the men (76.9%) will usually bring the fiber to the abaca buying station since this is a labour intensive activity.

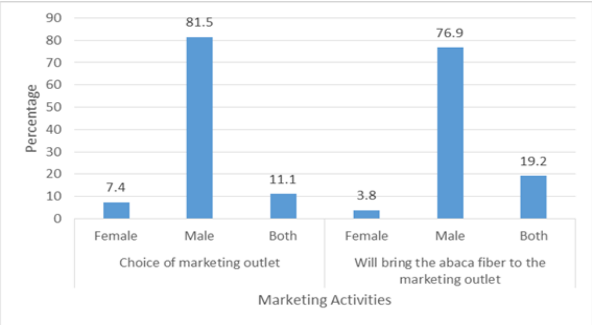

Fig. 3. Marketing related activities in abaca farming
Source: Author's calculation and analysis (2022).

In farming, one of the first steps to be successful is keeping well-maintained, accurate records and establishing a sound record-keeping system. Keeping accurate records has its benefits, like helping farmers plan for his/her future farming activity [15]. Based on the results of the study, men do the majority of the record keeping since they are more actively involved in abaca farming activities (62.5%). After the fiber is being sold, women, keep the earnings (57.7%) for they take charge in managing the household incomes [16] (see Fig. 4).

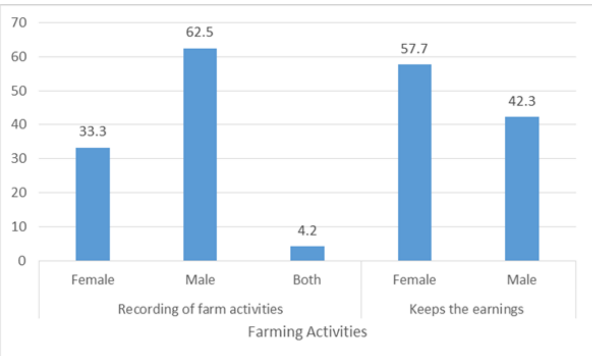

Fig. 4. Record keeping and managing the earnings
Source: Author's calculation and analysis (2022).

Women's participation in abaca farming

Market outlet selections for abaca fiber are household-specific decision and various factors have to be considered as a basis for such decision. As shown in Fig. 5, licensed trading stations are the choice outlet for abaca fiber of nearly three-quarters of women abaca farmers (70%). Baybay has two (2) licensed abaca trading stations: Ching Bee Trading Corporation (CBT) and Specialty Pulp Manufacturing, Inc. (SPMI) [2]. Women farmers preferred selling their fiber to these licensed traders because it offers them higher buying price than other stations. However, they would have additional expenditures for labor and transportation since abaca farms are located very distant from the trading station. Farmers usually have to travel for over an hour, on average, to reach the city where these trading stations are situated. Other women farmers said that they are discouraged from selling their fiber to these licensed traders due to added costs, despite the fact that it will make them more income. With this, they preferred selling their abaca fiber to the buying stations within their community or *barangay* (30%).

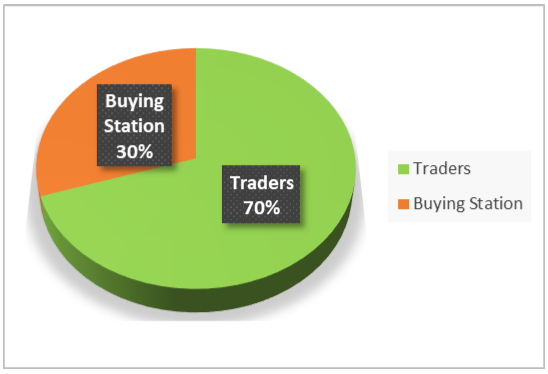

Fig. 5. Women's choice of buying station for abaca fiber
Source: Author's calculation and analysis (2022).

Various reasons were cited by the abaca farmer respondents in choosing where to sell their fiber however only two (2) are discussed in this section. As illustrated in Fig. 6, women's main motivation for choosing a marketing outlet for their abaca fiber is the buying price (60%), they prefer bringing the fiber to buying stations with high buying price. Even though it will cost them time, money, and effort, they will do so. Other women abaca farmers said that they will bring their fiber to their regular buyer or *suki* (40%). As an advantage of being the frequent buyers, they can go to them whenever they are in financial need as long as they agree to sell their fiber to them but of slightly lower price. At times, other farmers who owed money to those buying stations may be forced to sell their fibers to them.

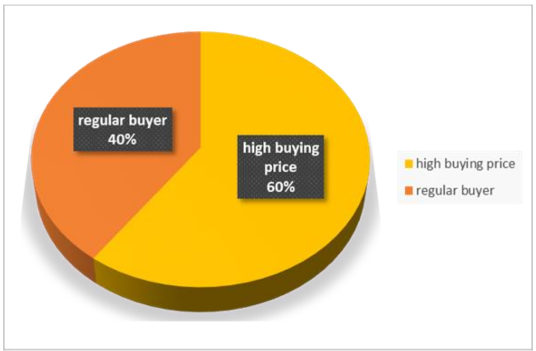

Fig. 6. Women's reasons for the choice of marketing outlet
Source: Author's calculation and analysis (2022).

In managing the abaca farm households during crisis (Fig. 7), women preferred using savings (55%), and they pursue credit as their second option (36%) while their last resort is selling of assets (9%). Examples of the assets of the family are appliances, farming tools and equipment and vehicles (e.g. motorcycle).

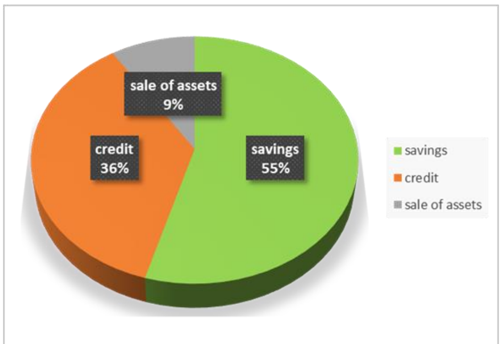

Fig. 7. Distribution of how women manages their household expenses
Source: Author's calculation and analysis (2022).

There is a variety of expenditures that may apply to any agricultural operation such as agricultural inputs, equipment rental, transportation charges, and many other [7]. However, farmers' access to funds can be challenging at times, and borrowing money may be their only alternative. In this section, borrowing sources are described where women abaca farmers preferred to borrow from their family and friends (56%) because they may get the money without paying interest and without having to put up any collateral, as long as they promise to pay back the money in a specified period of time. This condition can sometimes lead to relationship problems when failing to pay the debt on time. Meanwhile, roughly 22% of women abaca farmers have taken out loans from banks. Informal money lenders are rarely chosen because of their high interest rates, these interest rates may vary depending on the lender (11%). Banks' strict collateral requirements and long loan processing times encourage people to turn to the informal sector, where loan approvals are based more on trust and personal relationships [10]. Lastly, digital lenders were also considered, although only a small number of them have chosen this option (11%). Digital lending is a technology that allows financial institutions to increase productivity and loan profits while providing quicker service at the point-of-sale (POS) [17].

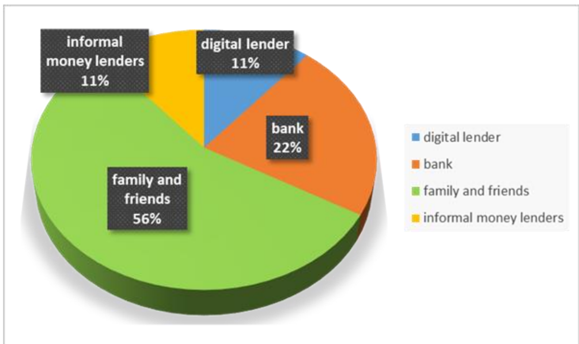

Fig. 8. Distribution of women's preferred source for borrowing money
Source: Author's calculation and analysis (2022).

CONCLUSIONS

Abaca farming is a labour-intensive activity, hence men are more extensively involved in it. However, women play an important role in abaca farming at various phases. Women are typically involved in decision-makings, particularly when it comes to marketing outlets and financial resources needed for farming. They also participate in the selling of abaca fiber and they take charge in managing the earnings since women are known to be household managers.

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LIVESTOCK DECLINE AND ANIMAL OUTPUT GROWTH IN THE EUROPEAN UNION IN THE PERIOD 2012-2021

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Abstract

The paper analyzed the EU's livestock and animal production in the decade 2012-2021 using the Eurostat data which were statistically processed using dynamics and structural indices and regression equations. The results pointed out that the EU livestock declined by about 9%, so that in 2021, it numbered 77.54 million bovines, 142.73 million pigs, 63.23 million sheep and 12.45 million goats. EU had 5.7 million animal holdings in 2016, by -37.6% less than in 2005, representing 54.28% of the total number of the EU farms. The highest number of bovines are reared in France, Germany, Ireland, Spain, Poland, Italy, Netherlands, Belgium, Austria and Romania. While their number decreased in France, Germany, Netherlands, Belgium, Austria and Romania, in Ireland, Spain, Poland and Italy it increased. Pigs are mainly grown in Spain, Germany, Denmark, France, Netherlands, Poland, Italy, Belgium and Romania. While in Spain and Denmark it recorded an upward trend, in Germany, France, Netherlands, Poland, Italy, Belgium and Romania pig number declined. Sheep are especially reared in Spain, Greece, Romania, France, and Italy. The sheep number increased by 14% only in Romania, while in the other countries it decreased. Goats number increased in Italy, Romania and France, while in Greece and Spain it registered a downward tendency. Animal output volume and value registered an increasing trend. Milk production increased by +10.3% reaching 160.14 million tonnes in 2020, of which 70% is produced by Germany, France, Poland, Italy, Spain, Ireland, Romania and Austria. Meat production accounted for 43.92 million tonnes in 2021, being by 11.50% higher than in 2012. In its structure, 52.3% is pork, 31% is poultry meat, 15.5% is beef and veal and 1.2 % comes from sheep and goats. France and Germany are the largest meat producing countries. Beef is mainly produced in France, Germany and Spain, poultry in Poland and France, pork in Germany, Spain and France, sheep meat in Spain, France, Ireland and Greece and goat meat in Greece and Spain. In 2021, the animal output value accounted for Euro 162.81 million being by 7.1% higher than in 2012. France, Germany, Spain, Italy, Netherlands, Ireland and Denmark contributes by 70%. In the future it is expected to continue the decline in livestock, the increase of yield and its quality, farmers paying more attention to organic farming, animal health and welfare, food quality and security and also to environment protection and biodiversity conservation.

Key words: *livestock, animal production, dynamics, trends, European Union*

INTRODUCTION

Agriculture is the main source of food which sustains the globe population. It does not assure only food security, but also it has a more complex economic, social and environmental impact. It stimulates economic growth, contributing to GDP, it assures jobs and income, sustaining the living standard [32, 40].

It is no doubt that crop and animal farming systems play an essential role in assuring food security, providing raw materials for the processing industry, jobs and incomes for the rural population and in maintaining biodiversity, the ecological balance of agro-eco systems and the beauty of the landscapes [23, 49].

Animal sector is dealing with livestock growing for agricultural goals as defined by FAO (2017) [16].

Livestock brings its contribution to food diversity providing a large range of products rich in high value protein, fats, vitamins and minerals needed for a harmonious growth of the human body [22, 48].

And this is possible due to the existence of animal sector in agriculture where farmers, grace to the specificity of their job, utilize land, fixed assets and working capital, labour force and technologies for animal rearing to attain the goals of their business to get income from providing food to cover their needs and market requirements.

Cultivating forages and utilizing the secondary products from vegetal production, and valorizing pastures and meadows, animal farming provides milk and dairy products, meat, and other products which contribute to the economic and social development as well as to the maintenance of habitats and landscapes. For the disadvantaged regions, animals growing diminish the migration of the population, maintain the traditional way for achieving natural food products as an expression of the local culture and life style [1, 19].

The resulting manure from animal husbandry is a high value organic fertilizer helping crop production to grow and also an alternative source of renewable energy [18].

Food products of animal origin are successfully exported stimulating international trade, contributing to a better cover of the internal markets of many countries and also assuring currency flows in payment balance of the supplying states [24, 25, 28, 31, 34].

Despite the advantages and benefits of animal rearing, its development involves risks which have to be taken into account regarding the following aspects:

-the increased competition in using agricultural land between the forage and crop sector;

-the increased competitiveness between humans and animals regarding the consumption of vegetal resources, especially cereals;

-the high intensive systems utilized in animal husbandry require additional costs for assuring animal health and welfare;

-the high risk of zoonoses whose spread could diminish livestock number and production;

- the risk to increase human diseases caused by a high consumption of food of animal origin;

-the risk of an increased environment pollution as animal growing is responsible of about 65% of the global nitrous oxide emissions which could determine a global warming impact 296 time higher than carbon dioxide; the statistics proved that 15% of global greenhouse gas emissions is generated by livestock reared for human consumption [2, 21].

Analyzing the advantages and disadvantages of animal rearing, the EU issued a new orientation in its reformed PAC, paying more attention to the sustainability of the viability of the animal sector for a long run and increasing the quality of the products destined to consumption. This means a harmonized combination between assuring the animal health and welfare and achieving high quality food produced in organic livestock farming which is environmentally friendly [17].

Stimulating production by increasing yield, livestock number could be diminished. However, the performance in animal sector of the EU differs from a country to another depending on farm structure, technical endowment, genetic potential of the biological material, rearing systems and natural conditions where animal farming is practiced [42, 43].

As a response to climate change, the EU Green Deal emphasizes the need to increase food production and its quality by extending and practicing technologies friendly with the environment which are destined "to cut green gas emissions by 55% by 2030 and to transform the European area in a net-zero emitter of greenhouse gases by 2050" [3].

In this context, the paper aimed to analyze the dynamics of livestock, animal density per 100 ha utilized agricultural area, animal output volume and value in the EU during the last

decade, 2012-2021 by species pointing out the differences from a country to another.
The idea started from the supposition that the decline of livestock is required but this does not affect production level as long as yield performance and product quality is increasing.

MATERIALS AND METHODS

This study is based on the Eurostat data for the period 2012-2021 regarding livestock number: bovines, pigs, sheep and goats, animal density index per 100 ha utilized agricultural area (UAA), distribution by main animal rearing countries, animal output volume evolution (milk and meat) and also animal output value, the share of animal output in total agricultural output, pointing out the differences between various states.
Dynamics and structural indices, as well as regression equations were used to emphasize the general tendencies. The results are synthetically shown in tables and the graphics which offer an illustrative image for a better understanding of the dynamics of the selected indicators. The main ideas resulting from this statistical research are exposed at the end of the study in conclusions.

RESULTS AND DISCUSSIONS

Dynamics of the EU's livestock

During the last two decades, 2001-2020, the EU livestock decreased by about 8.9%. This was the result of the review of the Common Agricultural Policy which in 2003 established to pass to the decoupling subsidies [20].
The decrease of the livestock affected almost all the EU countries and almost all the farm species in different proportions from country to another [26, 27, 29, 30, 33, 35, 36, 41]. This process was more intensified during the decade 2012-2021. The data from Table 1 show that at the end of December 2021, the EU livestock consisted of: 77.54 million bovines, 142.73 million pigs, 63.23 million sheep and 12.45 million goats, meaning by -2%, -0.76%, -4.97% and, respectively, -8.36% less than in 2012. The dynamics by year in the analyzed period is reflected by Fig. 1.

Table 1. The EU's livestock in 2021 versus 2012 (Million heads)

	2012	2021	2021/2012 %
Bovines	77.54	76.0	98.00
Swine	142.73	141.65	99.24
Sheep	63.23	60.09	95.03
Goats	12.45	11.41	91.64

Source: Own calculations based on Eurostat, 2022 [9].

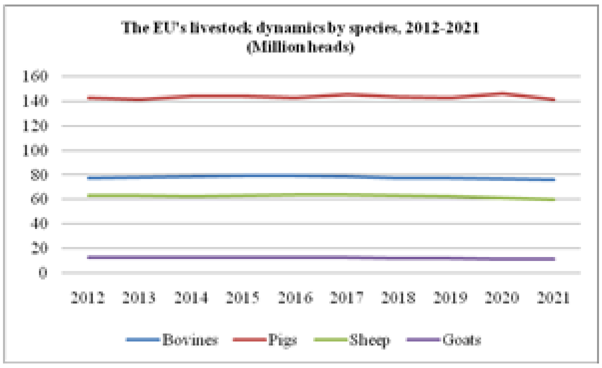

Fig. 1. Dynamics of the EU's livestock by species in the period 2012-2021
Source: Eurostat, 2022, [9].

Three EU countries rear the largest number of farm animals

The largest number of farm animals is reared in three EU member states: Spain, France and Germany, whose share in the total number of animal by species is presented in Table 2.

Table 2. Share of the top EU countries rearing farm animals in the EU's livestock in 2021(%)

	Spain	France	Germany
Bovines	9	23	15
Swine	24	9	17
Sheep	25	12	3
Goats	23	12	1

Source: Own calculations based on Eurostat, 2022 [9].

Therefore, Spain comes on the 1st position for the highest share for sheep, pigs and goats and on the 3rd position for the number of bovines.
France is ranked the 2nd for the number of pigs, also the 2nd for the number of sheep and goats and the 3rd for the number of pigs. Germany is on the 2nd position for the number of pigs, also on the 2nd position for the number of bovines and on the 3rd place for the number of sheep and goats.

Specialization in animal farming

More than this, in the EU, we can distinguish a specialization in animal farming among the member states as follows:

-Denmark is specialized in pig farming, rearing 9% of the EU's swine population;
-Netherlands is also profiled on pig growing, keeping 8% of the EU's swine;
-Ireland is specialized in bovine husbandry as it keeps 9% of the EU's cattle livestock;
-Romania is profiled on sheep growing, keeping 17% of the EU's sheep population;
-Greece is specialized in goat farming as it rears 25% of the EU's goats livestock.

The EU's livestock in livestock units (LSU)

In terms of livestock units (LSU), in 2016, the EU-28 had 131 million LSU, of which 49% bovines, 25.2% pigs, 15.8% poultry. That time, the EU countries with the highest LSU, in the decreasing order, were: France 22.1 million heads, Germany 18.2 million, Spain 14.4 million and United Kingdom 13.3 million, while the lowest LSU belonged to Malta (32,470 heads) [15].

Livestock density in the EU

Table 3. Livestock density index (LDI) by EU country in 2016 (LU/100 ha UAA)

EU-28 average density index = 0.8 LU/100 ha UAA		
LDI over 3	LDI	Dif. from LDI aver.
Netherlands	3.8	+3
LDI between 2 and 3		
Malta	2.9	+2.1
Belgium	2.8	+2.0
LDI between 1 and 2		
Denmark	1.6	+0.8
Cyprus	1.5	+0.7
Luxembourg	1.3	+0.5
Ireland	1.3	+0.5
Germany	1.1	+0.3
Slovenia	1.0	+0.2
LDI below 1		
Austria	0.9	+0.1
United Kingdom	0.8	0.0
France	0.8	0.0
Italy	0.8	0.0
Poland	0.7	- 0.1
Spain	0.6	- 0.2
Portugal	0.6	- 0.2
Sweden	0.6	- 0.2
Hungary	0.5	- 0.3
Czechia	0.5	- 0.3
Croatia	0.5	- 0.3
Finland	0.5	- 0.3
Greece	0.5	- 0.3
Romania	0.4	- 0.4
Slovakia	0.3	- 0.5
Lithuania	0.3	- 0.5
Estonia	0.3	- 0.5
Latvia	0.3	- 0.5
Bulgaria	0.2	- 0.6

Source: Eurostat, 2019 [15].

In terms of livestock density, measured in livestock units per 100 utilized agricultural area (UAA), in 2016, the average density in the EU-28 accounted for 0.8 LU/100 ha UAA, varying between the top level 3.8 registered by Netherlands and the lowest level of 0.2 LU belonging to Bulgaria.
Table 3 shows the livestock density by each member state in the year 2016.
Therefore, 10 EU member states had a LDI higher than the EU average, 3 countries had a LDI equal to the EU average and 15 counties had a LDI lowers than the EU mean.

The situation of the animal holdings in the total number of agricultural holdings in the EU

In 2005, the EU had 14.72 million agricultural holdings, but along the years their number decreased while farm size increased for assuring a higher productivity and profitability. In 2016, the EU-28 had 10.5 million farms by -28.6% less than in 2005.
In 2005, the EU had 9.13 million animal holdings, accounting for 625 of the total agricultural holdings. But in 2016, there were only 5.7 million holdings with animals, that is by -37.6% less than in 2005 and representing 54.28% of the total number of the EU farms (Table 4).

Table 4. Dynamics of the animal holdings in the EU in the years 2005, 2010, 2016 (million)

	2005	2010	2016	2016/2005 %
Total number of agricultural holdings	14.72	12.24	10.5	71.33
Number of animal holdings	9.13	6.92	5.7	62.43
Share of animal holdings in the total agricultural number of holdings (%)	62	56.5	54.28	-

Source: Own calculations based on Eurostat, 2019 [15].

Therefore, both the number of holdings rearing animals and its share in the total number of agricultural holdings declined year by year in the period 2005-2016 for which Eurostat offers data from Farm Structure Survey [42, 43].

This process has continued in the period 2016 till present and will continue in the future as the EU policy aims to grow production performance per animal by increasing farms size, improving animal rearing technologies and diminishing the number of holdings growing animals as long as it is possible to assure a higher profitability in animal sector and to cover the market requirements.

Dynamics of bovine livestock in the EU

In the year 2012, the EU had 77,548 thousand bovines, but in 2021 it registered by -1.31% less, that is 76,534 thousand. In the analyzed interval, the maximum number of bovines was recorded in the year 2016, but starting from this year the decline continued year by year (Fig. 1).

The countries rearing the highest number of bovines in the year 2021 were: France, Germany, Ireland, Spain, Poland, Italy, Netherlands, Belgium, Austria and Romania (Fig. 2).

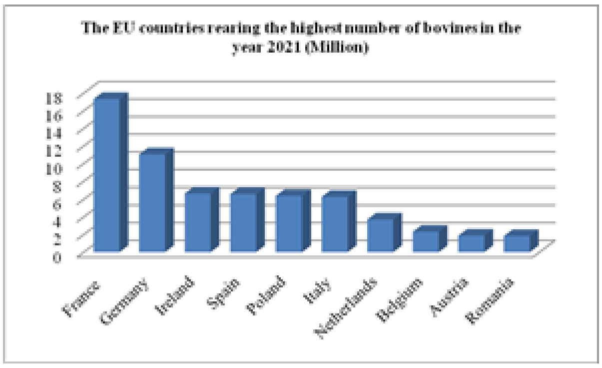

Fig. 2. The EU member states rearing the highest number of bovines in the year 2021 (Million heads)
Source: Own design based on Eurostat, 2022 [5].

Compared to the bovine livestock in the year 2012, in 2021, France registered a decline by -9.04%, Germany -11.73%, Netherlands -7.03%, Belgium - 5.26%, Austria -4.4% and Romania - 9.46%. In the same interval, the bovine livestock increased in Ireland by +6.33, Spain +13.14%, Poland +15.56% and weak growth of +0.44 in Italy (Table 5).

Table 5. Bovine livestock in the year 2021 versus 2012 in the top 10 EU countries rearing these species (Thousand heads)

Country	2021	2012	2021/2012 %	Increase/Decrease %
France	17,300	19,052	90.96	-9.04
Germany	11,040	12,507	88.27	-11.73
Ireland	6,649	6,253	105.33	+6.33
Spain	6,579	5,812	113.14	+13.14
Poland	6,379	5,520	115.56	+15.56
Italy	6,280	6,252	100.44	+0.44
Netherlands	3,705	3,985	92.97	-7.03
Belgium	2,310	2,438	94.74	-5.26
Austria	1,870	1,956	95.60	-4.40
Romania	1,819	2,009	90.54	-9.46

Source: Own calculation based on Eurostat, 2022 [5].

A declining trend was noticed in Denmark and Sweden of -7% and, respectively, -3.7%, while in Portugal the number of bovines increased by +9.6%.

Dynamics of pig livestock in the EU

In the year 2012, the EU had 142,737 thousand pigs, but in 2021 it registered by -0.8% less, that is 141,655 thousand. In the analyzed interval, the maximum number of pigs was 145,843 recorded in the year 2020, but then, in 2021, it declined by 2.88% (Fig. 1). The countries rearing the highest number of pigs in the year 2021 were: Spain, Germany, Denmark, France, Netherlands, Poland, Italy, Belgium and Romania (Fig. 3). Compared to the pigs livestock in the year 2012, in 2021, Germany registered a decline by -12.13%, France -6.08%, Netherlands -10.2%, Poland - 8%, Italy -2.94%, Belgium -6.3% and Romania -30.86%, the highest loss. In the same interval, the pig livestock increased in Spain by +36.4%, and Denmark by +7.09% (Table 6).

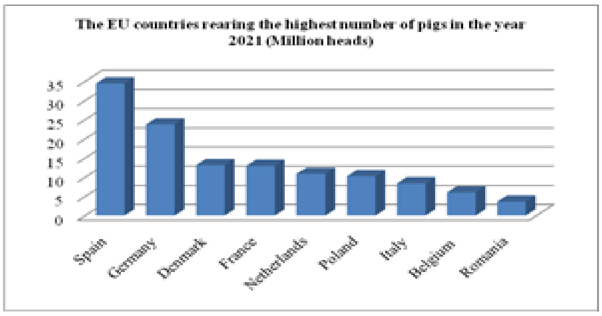

Fig. 3. The EU member states rearing the highest number of pigs in the year 2021 (Million heads)
Source: Own design based on Eurostat, 2022 [6].

Table 6. Pigs livestock in the year 2021 versus 2012 in the top 9 EU countries rearing swine (Thousand heads)

Country	2021	2012	2021/2012 %	Increase /Decline %
Spain	34,454	25,250	136.45	+36.45
Germany	23,762	28,331	83.87	-12.13
Denmark	13,152	12,281	107.09	+7.09
France	12,941	13,778	93.92	-6.08
Netherlands	10,870	12,104	89.80	-10.20
Poland	10,242	11,132	92.00	-8.00
Italy	8,407	8,661	97.06	-2.04
Belgium	6,042	6,447	93.7	-6.3
Romania	3,619	5,234	69.14	-30.86

Source: Own calculation based on Eurostat, 2022 [6].

A declining tendency was noticed in Austria and Hungary where the pigs number decreased by 6.6%, and, respectively, by 8.8%, while in Portugal the number of pigs increased by +9.7%.

Dynamics of sheep livestock in the EU

In the year 2012, the EU had 63,237 thousand sheep, but in 2021 it registered by -4.98% less, that is 60,094 thousand (Fig. 1).

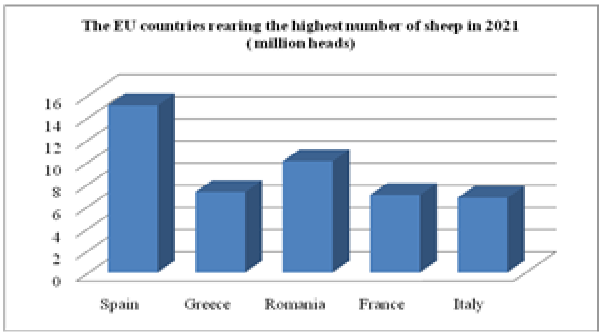

Fig. 4. The EU member states rearing the highest number of sheep in the year 2021 (Million heads)
Source: Own design based on Eurostat, 2022 [7].

The countries rearing the highest number of sheep in the year 2021 were: Spain, Greece, Romania, France, and Italy (Fig. 4).

Compared to the sheep livestock in the year 2012, in 2021, Spain registered a decline of -7.7%, Greece -21.28%, France - 6.2%, and Italy -4.1%. In the same period, Romania increased it sheep livestock by 13.77% (Table 7).

Table 7. Sheep livestock in the year 2021 versus 2012 in the top 5 EU countries rearing this species (Thousand heads)

Country	2021	2012	2021/2012 %	Increase/ Decline %
Spain	15,081	16,339	92.30	-7.7
Greece	7,253	9,213	78.72	-21.28
Romania	10,050	8,833	113.77	+13.77
France	6,994	7,453	93.84	-6.16
Italy	6,728	7,015	95.90	-4.1

Source: Own calculation based on Eurostat, 2022 [7].

In 2021 versus 2012, Ireland and Portugal also registered an important growth of the sheep number by + 16.3% and, respectively by + 6.9%, but their livestock was much smaller compared to the other top EU countries rearing this species (3,991 thousand heads and, respectively 2,238 thousand heads.

Dynamics of goats livestock in the EU

In the year 2012, the EU had 12,455 thousand goats, but in 2021 it registered by -8.39% less, that is 11,411 thousand (Fig. 1).

The countries rearing the highest number of goats in the year 2021 were: Greece, Spain, Romania, France, and Italy (Fig. 5).

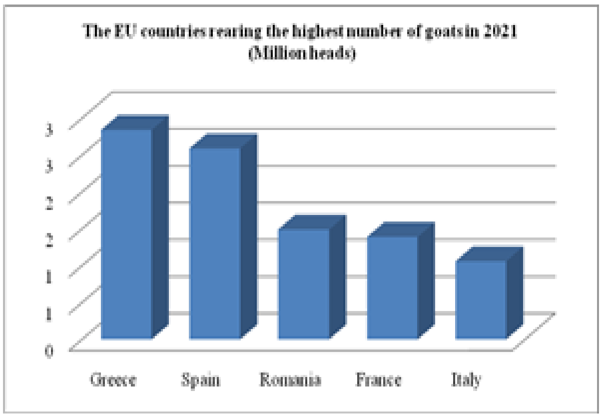

Fig. 5. The EU member states rearing the highest number of goats in the year 2021 (Million heads)
Source: Own design based on Eurostat, 2022 [8].

Compared to the goats livestock in the year 2012, in 2021, Greece recorded a decline of -33.8% and Spain -1.8%, while Romania registered an increase by 17.37%, France by +6.27% and Italy by +18.94% (Table 8).

Table 8. Goats livestock in the year 2021 versus 2012 in the top 5 EU countries rearing this species (Thousand heads)

Country	2021	2012	2021/2012 %	Increase/ Decline %
Greece	2,844	4,293	66.2	-33.8
Spain	2,590	2,637	98.2	-1.8
Romania	1,486	1,266	117.37	+17.37
France	1,388	1,306	106.27	+6.27
Italy	1,061	892	118.94	+18.94

Source: Own calculation based on Eurostat, 2022 [8].

Animal production volume in the EU

Animal production was deeply influenced by the changes in livestock and also in yield for each farm species [25, 26, 27, 29].

Animal output increased both regarding milk and meat in the period 2012 -2020, for which Eurostat provided data.

Milk production and its utilization on the farm increased by +10.3% from 145.08 million tonnes in 2013 to 160.14 million tonnes in 2020 (Table 9).

The contribution of different species to milk production in 2020 was: cows' milk 154.5 million tonnes (96.4% of the total milk), ewes' milk 3 million tonnes (1.8%), goats' milk (1.6%) and buffalos milk (0.2%) [10].

Table 9. Animal production volume in the EU in 2020 versus 2012 (Million tonnes)

	Milk production Million tonnes	Meat production Million tonnes	Of which:			
			Pork	Poultry	Bovine	Sheep and goat
2012	145.08	39.39	21.4	11.0	6.69	0.3
2020	160.14	43.92	23.0	13.6	6.82	0.5
2020/2012 %	110.3	111.50	107.5	123.6	101.9	166.6

Source: Own calculation based on Eurostat, 2022 [10, 11].

The dynamics of milk production in the period 2012-2020 is shown in Fig. 6.

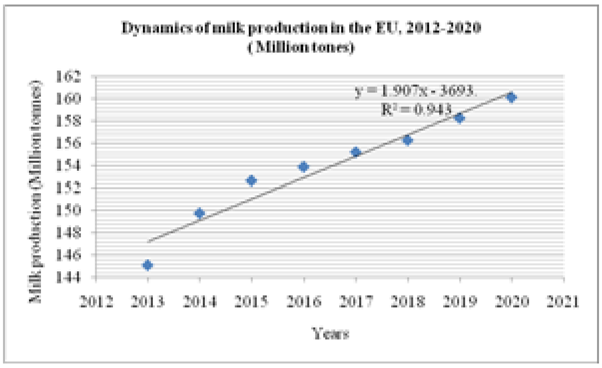

Fig. 6. Dynamics of milk production in the EU in the period 2012-2020 (Million tonnes)
Source: Own design based on Eurostat, 2022 [10].

In 2020, the main milk producing countries in the EU and their share in milk production were: Germany (20.7%), France (16,3), Poland (9.3%), Italy (8.4%), Spain (5.4%), Ireland (5.3%), Romania (2.7%) and Austria (2.4%).

Despite that cattle livestock declined, milk yield increased, so that milk production registered an upward, the main source being cows [39, 44], but also buffalos [44], sheep [36, 45] and goats [30, 36, 45, 46].

Meat production increased by 11.50% from 39.39 million tonnes in 2012 to 43.92 million tonnes in the year 2021.

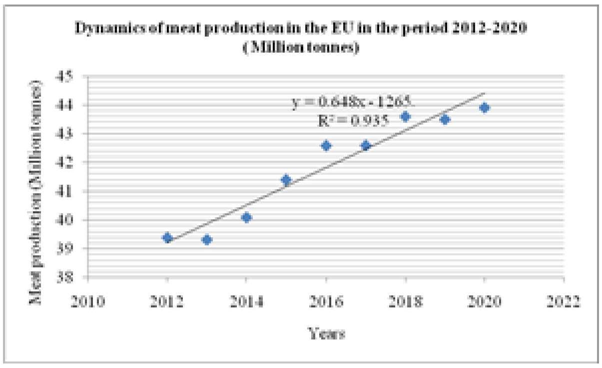

Fig. 7. Dynamics of meat production in the EU in the period 2012-2021 (Million tonnes)
Source: Own design based on Eurostat, 2022 [11].

The contribution of various species to meat production in 2021 was: 52.3% from pigs, 31% from poultry, 15.5% from bovines and 1.2 % from sheep and goats (Table 9). The dynamics of total meat production in the EU in the period 2012-2021 is presented in Fig. 7.

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The largest producing countries of meat in the EU are France and Germany. By meat type, France, Germany and Spain produce the big amount of beef. More than 50% of poultry meat is produced by Poland and France. The largest producers of pig meat are Germany, Spain and France. Sheep meat is mainly produced by Spain, France, Ireland and Greece. Goat meat is produced by Greece and Spain [11].

The largest exporters of meat in the EU are Netherlands, Spain, Germany, Poland and Denmark [47].

Pork production was influenced by the variation in the number of slaughter animals by species and their live weight at slaughter [25, 33, 35, 36, 37, 38, 46].

Animal output value in the EU

The value of animal output reached Euro 162.81 million in the year 2021 being by 7.1% higher than in 2012.

In 2021, the highest contribution to the EU animal production value was given by the following EU countries as reflected by their shares: France (16.5%), Germany (16%), Spain (12.8%), Italy (10%), Netherlands (6.6%), Ireland (4.6%), Denmark (4%), Belgium (3%), Austria (2.3%) and Hungary (1.9%) (Table 10).

The changes in animal output value and also in output of agricultural industry in the EU in the analyzed decade have led to variations in the share of animal production value in the total value of agricultural output, from 39.2% in the year 2012 to 36.7% in the year 2021, reflecting a decrease by -2.5 percentage points.

In the major of the EU countries, the share of animal output value decreased in 2021 compared to its level in the year 2012. Only two countries, Germany and Ireland registered a growth by +2.1%, and, respectively, +5.2%.

The EU member states having the highest share of animal output value in the value of agricultural output in 2021 were: Ireland (74.4%), Denmark (56.3%), Belgium (50.1%), Finland (49.3%), Germany (48.9%), Austria (44.2%), Spain (37.1%), Netherlands (35.6%), Czechia (33.9%), France (32.8%), and Hungary (32.2%) (Table 10).

Table 10. Animal output value and its share in agricultural output value, at basic and producers' prices in the EU in 2021 versus 2012

	Agricultural Output value Euro Million			Animal Output value Euro Million			Share of animal output value in agricultural output value (%)		
	2012	2021	2021/2012 %	2012	2021	2021/2012 %	2012	2021	Difference 2021-2012
EU-27	387.45	443.36	114.4	151.91	162.81	107.1	39.2	36.7	-2.5
France	76.57	81.59	106.5	25.98	26.82	103.2	33.9	32.8	-1.1
Germany	57.02	59.35	104.1	26.71	26.04	97.5	46.8	48.9	+2.1
Spain	41.95	56.43	134.5	16.24	20.91	128.7	49.8	37.1	-12.7
Italy	54.38	60.02	110.3	16.84	16.30	96.7	30.9	27.2	-3.7
Netherlands	26.97	30.31	112.4	10.64	10.80	101.5	39.4	35.6	-3.8
Ireland	6.83	10.04	146.9	4.73	7.48	158.1	69.2	74.4	+5.2
Denmark	11.81	11.53	97.6	7.06	6.49	91.9	59.8	56.3	-3.5
Belgium	8.80	9.78	111.1	4.77	4.90	102.7	54.2	50.1	-4.1
Austria	7.24	8.45	116.7	3.33	3.74	112.3	46.0	44.2	-1.8
Hungary	7.50	9.42	125.6	2.64	3.04	115.1	35.2	32.2	-3.0
Greece	10.83	11.86	109.5	2.49	2.47	99.1	23.0	20.8	-2.2
Finland	4.85	4.46	91.9	2.64	2.20	83.3	54.5	49.3	-5.2
Czechia	4.86	6.05	124.4	1.79	2.05	114.5	36.8	33.9	-2.9

Source: Own calculation based on the data from Eurostat, 2022 [12, 13].

The output prices in animal sector

In the last half of the analyzed period, more exactly in 2015-2020, the output prices in animal sector of the EU remained relatively constant for most of animal species, except pigs whose price declined in 2018, then they recovered in 2019 and fell again in 2020 discouraging the farmers.

A slight downward was registered in the output price of cattle in the year 2019 and

2020, after a period of relatively unchanged level.

The prices for output coming from sheep and goats were smaller than in the year 2015 in the interval 2016-2019, but in 2020, they had an upward encouraging the breeders [4, 14].

The last PAC reform aims to green the agricultural systems in livestock farming as well, so that the farmers are required to adapt the animal rearing technologies so that to preserve their income and at the same time to practice environmentally friendly animal farming in order to supply high quality products and cover better market needs [20].

CONCLUSIONS

Animal sector plays an important role in agriculture enlarging agro-food offer, satisfying market needs and consumer's demand, assuring food security, economic growth, deliveries to export, jobs and income, a better living standard, preserve biodiversity and the beauty of the landscapes.

In the last two decade, and especially in the analyzed period 2012-2021, the EU livestock declined by about 9%, so that in the year 2021, there were 77.54 million bovines, 142.73 million pigs, 63.23 million sheep and 12.45 million goats. The largest number of farm animals is reared in three EU member states: Spain, France and Germany.

In terms of livestock units (LSU), in 2016, the EU-28 had 131 million LSU, of which 49% bovines, 25.2% pigs, and 15.8% poultry. The highest LSU is in France and Germany, the lowest one in Malta.

In average, the EU animal density is 0.8 LU/100 ha UAA, ranging between 3.8 in Netherlands and 0.2 LU in Bulgaria.

In 2016, in the EU, there were 5.7 million holdings rearing animals, by -37.6% less than in 2005 and representing 54.28% of the total number of the EU farms. The reduction of the number of farms will continue to favour farm size, production performance per animal, modern rearing technologies, profitability and food quality.

In 2021, the highest number of bovines was in: France, Germany, Ireland, Spain, Poland, Italy, Netherlands, Belgium, Austria and Romania. In the last decade, the number of bovines decreased in France, Germany, Netherlands, Belgium, Austria and Romania, while it increased in Ireland, Spain, Poland and Italy.

The highest number of pigs is in Spain, Germany, Denmark, France, Netherlands, Poland, Italy, Belgium and Romania. While in Germany, France, Netherlands, Poland, Italy, Belgium and Romania pig number decreased, in Spain and Denmark it recorded an upward.

Sheep are especially reared in Spain, Greece, Romania, France, and Italy. While in Romania the sheep number increased by about 14%, in the other countries it declined.

Goats are grown in Greece, Spain, Romania, France, and Italy. Goats number increased in Italy, Romania and France, while in Greece and Spain it registered a downward.

Despite that the livestock declined, animal output volume and value registered an increasing trend.

Milk production increased by +10.3% reaching 160.14 million tonnes in 2020, the major contributor being cows (96.4%), but also buffalos, sheep and goats.

About 70% of the EU milk is produced by Germany, France, Poland, Italy, Spain, Ireland, Romania and Austria.

In the year 2021, meat production was by 11.50% higher than in 2012, accounting for 43.92 million tonnes, of which 52.3% pork, 31% poultry meat, 15.5% beef and veal and 1.2 % from sheep and goats.

France and Germany are the largest producing countries. However, France, Germany and Spain are specialized in beef, Poland and France in poultry, Germany, Spain and France in pork. Also, Spain, France, Ireland and Greece produce sheep meat, and goat meat is produced by Greece and Spain.

In 2021, the animal output value accounted for Euro 162.81 million being by 7.1% higher than in 2012. About 70% of animal output value is achieved by France, Germany, Spain, Italy, Netherlands, Ireland and Denmark.

The value of animal output was influenced in a smaller proportion by price level than the volume of animal output, except pork.

The general trend remains a declining one regarding livestock, and an upward trend is expected to continue for animal yield especially produced in organic farming as long as the EU PAC reform points out that the sustainability and the viability of the animal sector requires more attention to animal health and welfare, food quality and security using environmentally friendly technologies.

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LIVESTOCK AND MILK AND MEAT PRODUCTION IN THE TOP FIVE EU COUNTRIES REARING SHEEP AND GOATS, 2012-2021

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Abstract

The paper aimed to analyze the dynamics of livestock and milk and meat production in the top five EU countries growing sheep and goats: Spain, Romania, Greece, France and Italy. The empirical data from Eurostat and Faostat for the period 2012-2021 were processed using usual methods and procedures like fixed basis and structural indices, trend regression equation, determination coefficient and points method. The comparison between these five countries pointed out the decline of sheep number in four countries, except Romania and the decrease in goats number in Greece and Spain, but an increase in Romania, France and Italy. Ewe milk production increased in three countries, except Spain where it remained relatively constant and Romania where it declined. Goat milk production raised in three countries, except Greece and Romania. Sheep meat output increased in France and Spain, but in the other countries went down, while goat meat output increased only in Spain, the other four states recording a decline. In the year 2021,these five countries all together counted 46.1 million sheep, representing 76.% of the EU sheep livestock, and also they had 9.4 million goats, meaning 82.1% of the EU goats livestock. In 2020, all these countries produced 2.73 million tonnes sheep milk and 1.87 million tonnes goat milk, accounting for 1.7% and respectively 1.16% in the EU milk output. These counties also contributed by 85% to the EU sheep and goat meat production. This reflects the importance of small ruminants in the EU animal livestock and production. These species have to help the EU for greening agriculture, as they could valorize natural resources from the mountains and less favored areas and also could be grown in organic farming system, assuring jobs and income to the local population, food security and at the same time contributing to the biodiversity preservation and production of renewable energy.

Key words: *livestock, milk, meat, European Union, top five countries rearing sheep and goats, trends*

INTRODUCTION

The need to cover milk and meat market needs at the global level, but also in the EU has determined a more specific orientation to the economic, social and environment importance of the small ruminants [26, 30, 45].

Even thou their contribution is smaller than from other farm species, they offer benefits regarding production diversification with natural products, traditionally obtained mainly in the mountain areas, improving the income and living standard and satisfying better the population needs [42, 47].

Of over 70 million small ruminants existing in the EU, 85% are sheep and 15% are goats.

The EU main countries dealing with sheep and goats rearing are Spain, Romania, Greece, France and Italy, but also other countries like Ireland, Netherlands, Portugal, Poland etc pay a special attention to these species.

Geographically, the EU countries with sheep and goats could be divided into Northern member states and Southern states situated in the Mediterranean area. In the Northern countries, sheep and goat milk production is small, while in the Southern states has a higher volume.

In the EU, 14 countries have more than 500,000 sheep and only five member states rear more than 500,000 goats [13].

Sheep and goats are mainly reared in the regions where agricultural land is not suitable for cropping, like the mountain areas, semi-mountain zones, semi-arid regions and less favored areas [7].

For these reasons, sheep and goats have an important role in sustaining the local economy, offering jobs and income to the local population, valorizing the natural resources, assuring food security, preserving biodiversity and the beauty of the landscapes, diminishing environment pollution and assuring a valuable resource for renewable energy [12].

However, profitability in sheep and goat farming is not high and this depends on a large range of factors: the geographical location of the farm, farm size, genetic material and its production potential, technologies applied regarding reproduction, feeding, milking, and farm management as a whole, farmer's experience and training etc. [27].

Sheep and goats are reared in a large variety of farm sizes, farm structures and production systems which differ from a country to another and even from a region to another.

About 50% of sheep livestock is reared in flocks over 500 heads, while a little over 51% goats livestock is grown in flocks of over 200 heads.

Sheep and goat milk contribute by 3% to the EU milk output, while meat production from these species represents 1.4 % of the total EU agricultural output.

Milk produced by ewes and goats are special milk sorts of high nutritional value and also with hygienic qualities. They have a higher digestibility than cow milk and for this reason they are a suitable alternative for the consumers who have no tolerance to cow milk. The explanation is related to the existence of small globules of fat which are able to favor digestion, and in addition, in case of infants to stimulate brain development and immunity [18].

Ewes and goats are an exceptional source of natural milk as they are reared on pastures and meadows where fertilization is naturally sustained by manure and where organic farming system is practiced on larger and larger surfaces.

Their milk is mainly destined for producing cheese, but also other dairy products like yogurts and chilled desserts on the farm and also in small manufacturing dairies, where the artisan processes are practiced contributing to the preservation of culinary traditions and production of natural tasty products in the regions where sheep and goats are grown [22, 46, 48].

In the major EU ewe and goat's milk producing countries, cheese and other milk products are carried out under organic technologies and are protected by the EU regulation concerning Protected Designation of Origin (PDO) and Protected Geographic Indication (PGI), designation which assure the protection of biodiversity regarding: regions of origin, animal species from which they are achieved, farming practices, production systems, microbiological characteristics of cheeses.

In the five EU main producing countries, sheep and goat cheese is already recognized by its well-known names:

-"Feta" cheese which is a white and salty cheese made of ewes' milk 70% and of goats' milk per PDO in Mainland Greece and Lesbos island, Greece [49].

-"Pecorino" Romano cheese which is a hard and salty cheese produced of ewe's milk in Lazio, Sardinia and Tuscany in Italy [51].

-"Roquefort" cheese is produced by Roquefort sheep breed reared in the South of France, and it is well-known for one of the best blue cheeses. Its technology imposes the natural maturation in the Combalou caves of Roquefort-sur-Soulzon [52].

-"Manchego" cheese is made of ewes' milk and has its origin in La Mancha region of Spain [50].

- "Romanian Telemea" is a white salty cheese prepared in Romania either from cow milk or from ewe's milk or goats' milk or a mixture of these milk types [2, 21, 48].

However, in this study it was not analyzed cheese production, but only sheep and goats livestock, ewe and goat's fresh milk production achieved on farm and which also represent a source of high value raw material for dairies and finally sheep and goat meat production.

Meat production from these species depends on the category of animals destined to be slaughtered, the number of slaughtered animals and their live weight.

Lambs are not fattened in Greece and Italy, while in Spain, France and Romania, lambs delivered to the market are both fattened and not fattened. In Ireland, lambs are fattened having more than 13 kg at slaughter.

The EU offers financial support to sheep and goats breeders by subsidies per income named direct payments" which are justified as the average agricultural income is always behind the average income at the EU economy level.

There are many types of direct payments like: basic payments, payments for greening, payments for young farmers, and other sorts of payments, but in the prospect 2023-2027 there are expectations of changes adapted to the new PAC reform [9].

Production level is below the consumption requirements of lamb, mutton and goat meat and that's why about 20% of consumption is covered by imports, the main suppliers being New Zealand, Australia and the countries included in Mercosur agreement [28].

However, regarding sheep and goat meat, there are two categories of consumers: the ones who like these types of meats knowing their unique taste, appreciating that they are natural and healthy foods and the second category who dislike the smell and taste of these meats [19, 31].

The EU exports accounts for about 10% of total meat output from these species, but also the EU sells live sheep in the countries of the Middle and Far East and also in the Northern Africa [10].

Therefore, the products obtained from sheep and goats are subject of international trade called to cover better the needs of the internal markets, to improve the trade and payment of the suppliers [28].

In this context, the paper aimed to analyze the dynamics of sheep and goats livestock and milk and meat production in the EU top five countries rearing these species, in the last decade 2012-2021 emphasizing the main trends and changes across the time and the differences among these countries.

The idea started from the supposition that the decline of livestock is required but this does not affect production level as long as yield performance and product quality is increasing.

MATERIALS AND METHODS

The research work required the study of the literature background in the field, the collection of the empirical data in the selected EU countries rearing sheep and goats: Spain, Romania, Greece, France and Italy and the data processing. The sources of statistical data have been Eurostat and FAOSTAT and the period of reference was 2012 and 2021 for livestock and 2012-2020 for milk and meat output for which the official data were available. The studied indicators were: sheep and goats number, ewe's' and goat's fresh milk production and sheep and goat meat production. The main trends were displayed in graphics, being sustained by regression equations and coefficient of determination.

Fixed indices were calculated for showing the percentage increase/decrease between the performance recorded in the year 2020 or 2021 versus the level of the year 2012.

The results are synthesized in tables and illustrated in graphics for a better understanding of the variations in time of the selected indicators.

Finally, the conclusions summarized the main ideas resulting from this statistical research.

RESULTS AND DISCUSSIONS

Dynamics of the livestock

Sheep livestock

Sheep farming represent an important agricultural animal sector in Spain, Romania, Greece, France and Italy. In the year 2021, the

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sheep number of all these five countries accounted for 46,106 thousand heads, representing 76.7% of the EU sheep livestock (60,094 thousand heads).
Compared to 45,853 thousand sheep in the year 2012, this means a slight growth of +0.55%.
However, in the analyzed decade 2012-2021, important changes took place varying from a country to another.
While in Romania the number of sheep registered a continuous upward trend and growth rate accounted for +13.77% compared to the 2012 level, in the other four countries, the sheep livestock declined by -21.28% in Greece, -7.7% in Spain, -6.16% in France and -4.10% in Italy.
In Spain, the sheep number started to decrease even from the year 2012 when it was 16,339 thousand heads and reached 15,431 thousand heads in 2015. Then, it increased to 16,026 thousand heads in the year 2016, but after that year it has continuously recorded a downward trend to 15,081 thousand heads in the year 2021.
In Romania, the sheep livestock was 8,833 thousand heads in the year 2012 and since that time it recorded an upward trend till the year 2020, when it reached the maximum level, accounting for 10,464 thousand heads, but in 2021, it declined to 10,050 thousand heads, meaning a loss of -4%.
In Romania there are many types of sheep breeds, a part of them being specialized on milk production, other breeds on meat and the third category are for a dual purpose like meat and wool [29].
In Greece, the reduction of sheep number attained the highest percentage accounting for -21.28% in the last decade. The largest number of sheep was registered in the year 2013 and accounted for 9,356 thousand heads. Then, the sheep number declined up to the lowest level of 7,253 thousand heads in the year 2021.
In France, the sheep livestock recorded a continuous downward trend from 7,453 thousand heads, the peak recorded in 2012 to 6,877 thousand heads in 2017, the lowest level. In 2018, a slight recovery was noticed, the livestock increasing to 7,166 thousand heads, but then, it declined to 6,994 thousand heads in 2021.
In Italy, the number of sheep had an up and down variation across the time, with the peak of 7,215 thousand heads in 2016 and the lowest level of 6,728 thousand heads in 2021 (Fig. 1).

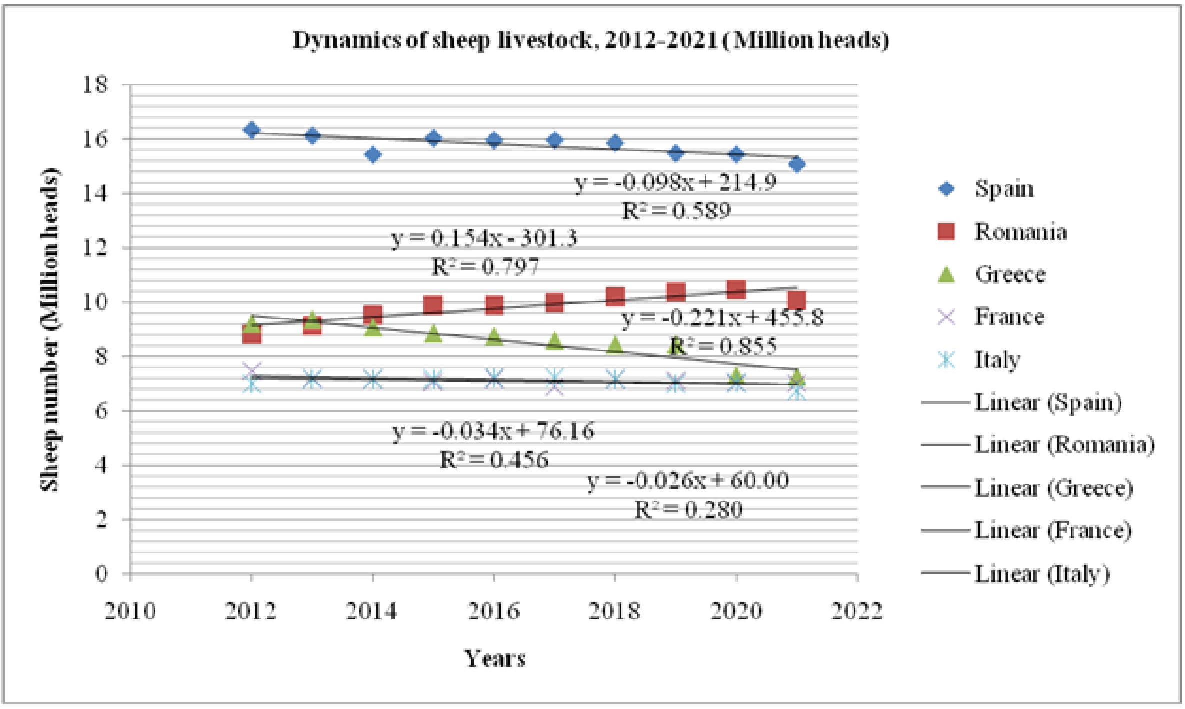

Fig. 1. Dynamics of sheep number in the period 2012-2021 in the EU top rearing countries (Million heads)
Source: Own design based on the data from Eurostat, 2022 [15].

The evolution of the sheep number has determined a change in the year 2021 compared the level of the year 2012 and also in the share of the EU sheep livestock as presented in Table 1.

Table 1. Sheep livestock in 2021 versus 2012 in the selected countries and its changes in the EU sheep number

	MU	Spain	Romania	Greece	France	Italy
2012	Million heads	16.34	8.83	9.21	7.45	7.01
2021	Million heads	15.08	10.05	7.25	7.00	6.73
2021/2012	%	92.30	78.72	113.77	93.84	95.90
Share in the EU sheep livestock						
-in 2012	%	25.83	13.96	14,56	11.78	11.09
-in 2021	%	25.09	16.72	12.06	11.63	11.20
Difference 2021-2012	pp	-0.74	+2.75	-2.50	-0.15	+0.11

Source: Own calculations based on the data from Eurostat, 2022 [15].

Goats livestock

Taking into account the number of goats, the five EU member states rearing the largest livestock are: Greece, Spain, Romania, France and Italy.

In 2012, all these five countries had 10,394 thousand goats representing 83.45% of the EU goats livestock, in 2021, they registered 9,409 thousand heads, meaning 82.45% of the EU level. Despite that in the EU, the number of goats is not so high compared to the livestock of other farm species and in the analyzed decade it decreased by 8.4%, accounting for only 11.41 million heads in the year 2021, in the four of these five countries the number of goats increased, except Greece.

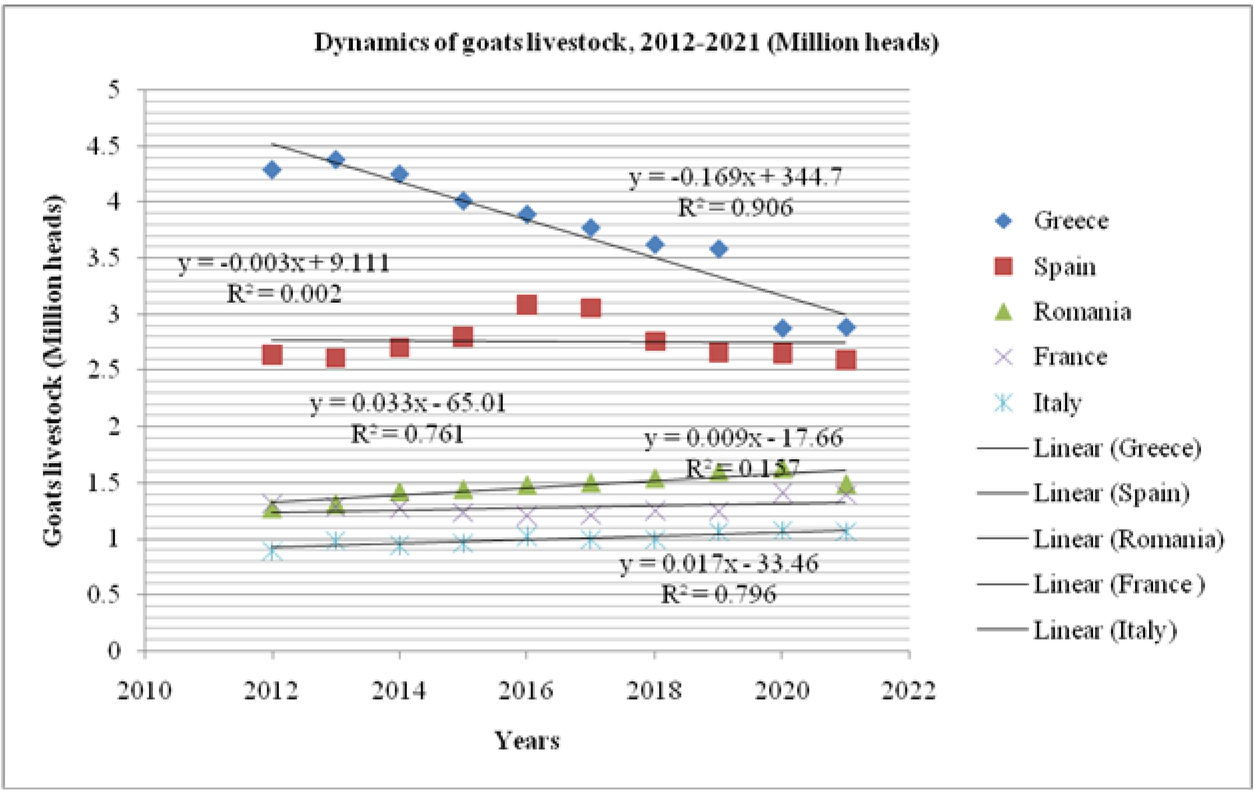

Fig. 2. Dynamics of goats number in the period 2012-2021 in the EU top rearing countries (Million heads)
Source: Own design based on the data from Eurostat, 2022 [14].

Greece registered a high decline in goats number, accounting for -32.83%, from 4,293 thousand heads in 2012 to 2,884 thousand heads in 2021. The maximum livestock was registered in the year 2013, but after that year, the goats number declined year by year.

Spain recorded a decrease in goats number from 2,637 thousand heads in 2012 to 2,590 thousand heads in 2021, meaning -1.79% less. The maximum number of goats was 3,088 thousand heads in the year 2016, but then, it started a downward from a year to another.

In Romania, the goats number increased by 17.335 in the analyzed interval from 1,266 thousand heads in 2012 to 1,486 thousand heads in 2021. However, the maximum number was 1,630 thousand heads, achieved in the year 2020, being by +28.75% higher than in 2012. But, in 2021, a loss of 144 thousand heads was noticed, meaning -8.84% compared to the previous year.

In France, the goats number declined from 1,306 thousand heads in 2012 till the year 2016, when it registered the lowest level of 1,204 thousand heads, but then, it increased so that in the year 2020, it reached the highest level accounting for 1,414 thousand heads, being by +8.26% higher than in 2012. But, in 2021, the number declined to 1,388 thousand heads, meaning by -1.84% less compared to the level of the previous year. Therefore, in 2021, the number of goats in France was by +6.27% higher than in 2012.

Italy increased its goats livestock from 892 thousand heads in 2012 to 1,061 thousand heads in 2021, reflecting +18.74% growth in the whole decade. However, the record number of 1,066 thousand heads was attained in the year 2020, but in the year 2021, there were lost 5,000 heads (-0.01%) (Fig. 2).

Taking into account the evolution of the goats livestock, the share of the goats number in the EU goats livestock changed in 2021 compared to the 2012 level as shown in Table 2.

Table 2. Goats livestock in 2021 versus 2012 in the selected countries and its changes in the EU goats number

	MU	Greece	Spain	Romania	France	Italy
2012	Million heads	4.29	2.64	1.27	1.31	0.89
2021	Million heads	2.88	2.59	1.49	1.39	1.06
2021/2012	%	67.17	98.21	117.37	106.27	118.94
Share in the EU goats livestock						
-in 2012	%	34.46	21.17	10.16	10.48	7.16
-in 2021	%	25.27	22.69	13.02	12.16	9.29
Difference 2021-2012	pp	-9.19	+1.52	+2.86	+1.68	+2.13

Source: Own calculations based on the data from Eurostat, 2022 [14].

Despite that Greece registered a decline of -9.19 percentage points in 2021 versus 2012 or -32.83% in goats number, it remained the major EU country growing sheep.

Dynamics of milk production

Sheep milk production

In 2020, the milk produced in the EU farms accounted for 160.1 million tonnes. The milk coming from cows represented 154.4 million tonnes (96.4%), and the milk provided by ewes accounted for 3 million tonnes (1.87%), by goats 2.5 million tonnes (1.56%) and by buffalos 0.3 million tonnes (0.17%).

Of the total milk output, 149.4 million tonnes (93.31%) were delivered to dairies, of which 145.2 million tonnes were represented by cows' milk (90.6%). This means that the difference of 4.2 million tonnes (9.4%) was provided by ewes, goats and buffaloes [16].

These figures reflect how important are small ruminants in producing milk in the EU. More than this, at the global level, the EU's contribution to the world sheep milk is about 50%, which reflect the high performance in milk production of this species.

In the year 2021, five countries: Greece, Spain, Italy, Romania and France, all together, produced 2,735 thousand tonnes sheep milk by +2.89% more than 2,658 thousand tonnes in the year 2012. This means that these five countries are able to carry out over 90% of the EU's sheep milk output.

In Greece, despite that the sheep livestock has substantially declined in the last decade, ewes' milk production increased by + 21.52% from 777.97 thousand tonnes in 2012 to 945.43 thousand tonnes in the year 2020, when production achieved its peak level.

From a geographical point of view, Greece, as a Mediterranean country has a high share of the rural areas in its territory, especially mountainous regions, semi-mountainous and semi-arid areas and sheep and goats are adapted to these conditions and successfully sustain farming in large parts of the less favored regions, maintain people's work, and living standard by producing feta and other specific sorts of cheeses, most of them having protected designation of origin (PDO) [21].

The sustainable development of agriculture in Greece is based on small ruminants sector where traditional producing systems are supported by milk processing on farm, the use of short supply chain (SSC) and qualitative labels [48].

However, in the last three years, Greek sheep and goats breeders were facing the reduction in the milk sale price due to the milk amounts imported at a lower price than the production cost. This was a terrible challenge for the Greek farmers to sustain their business and avoid failure [11].

Spain also was facing the decline of sheep livestock, but sheep milk production remained at a relatively stable level and even registered a slight increase of only +0.67% in the analyzed decade.

The peak of production was 600.56 thousand tonnes recorded in the year 2013, but since that time, sheep milk production started to decrease reaching 544.10 thousand tonnes in 2017, the lowest level, but in 2020 it recovered a little.

Like Greece, Spain pays a special attention to small ruminants which are able to sustain the rural areas and to give an important contribution to the gross animal production.

Spanish paste cheeses like Manchego, Zamorano and Calabozo are the most famous Spanish cheeses.

But, as milk production is not enough, Spain imports cheese and yogurt and fermented milk products [53].

In Italy, sheep number declined, but milk production increased by +18.66% from 406.17 thousand tonnes in 2012 to the maximum level of 495.91 thousand tonnes, attained in the year 2019, but then it declined to 481.97 thousand tonnes in 2020, meaning about -3% compared to the previous year.

Of the total milk production delivered to dairies, sheep milk represents about 3.47% and goat milk about 0.25%.

Around 43.3% of total milk utilization is destined for producing PDO cheese. In Italy, pecorino cheese with controlled origin is well-known and intensively used by consumers.

In 2016, of the total cheese production in Italy, accounting for 1,232.230 tonnes., the cheese made of cow milk accounted for 89.56%, the cheese made of ewe's milk had 5.89% and cheese made of goat's milk represented only 0.5% [3, 22].

In Romania, despite the high contribution of dairy cows to milk production, sheep and goats have an increasing number in the last period of time and their contribution to milk output went up [37, 44].

The farms rearing sheep and goats are numerous in Romania, but they have a small size and production system is more extensive than intensive and that is why profitability is not high [41].

Despite of the high growth rate of +13.77% in sheep livestock in the analyzed decade, sheep milk production registered a serious decrease, accounting for -34.66% from 650.91 thousand tonnes in 2012 to 426 thousand tonnes in the year 2020 [34]. The main causes are related to the low milk price at farm gate and the high price of farm inputs [36, 39].

In Romania sheep and goats rearing is a traditional activity, from these species there is obtained a large range of products with a reduced energy consumption and forages used in feeding which do not compete with humans like other farm species [35].

Sheep and goats farming assures the sustainability of milk and meat sector in Romania, but also in the EU. Romania 's exports of live sheep could bring important income to the breeders [20, 38, 43].

France with almost 7 million sheep livestock in the year 2021, by -6.16% smaller than in 2012, has succeeded to sustain milk production which in the analyzed decade increased by + 20.24%, the highest growth rate among the five these important EU countries rearing sheep.

If in 2012, sheep milk output was 270.7 thousand tonnes, in 2020, it reached 325.5 thousand tonnes, the maximum level.

This performance is based on the efforts made in the field of sheep breeding to increase milk yield. The Lacaune breed is well known for its high milk yield obtained by a long selection process. For its high record, this breed is imported in many counties to improve yield of the local breeds [1].

As mentioned before, sheep milk is successfully utilized for producing tasty yogurts, chilled desserts and cheese. The French local breeds from different regions were genetically improved in Roquefort area, Manech region, Pyrennees and Corsican island which led to various crossbreds and new breeds wearing the name of the region of origin [8, 46].

The dynamics of sheep milk production in the EU five main producing countries is shown in Fig. 3.

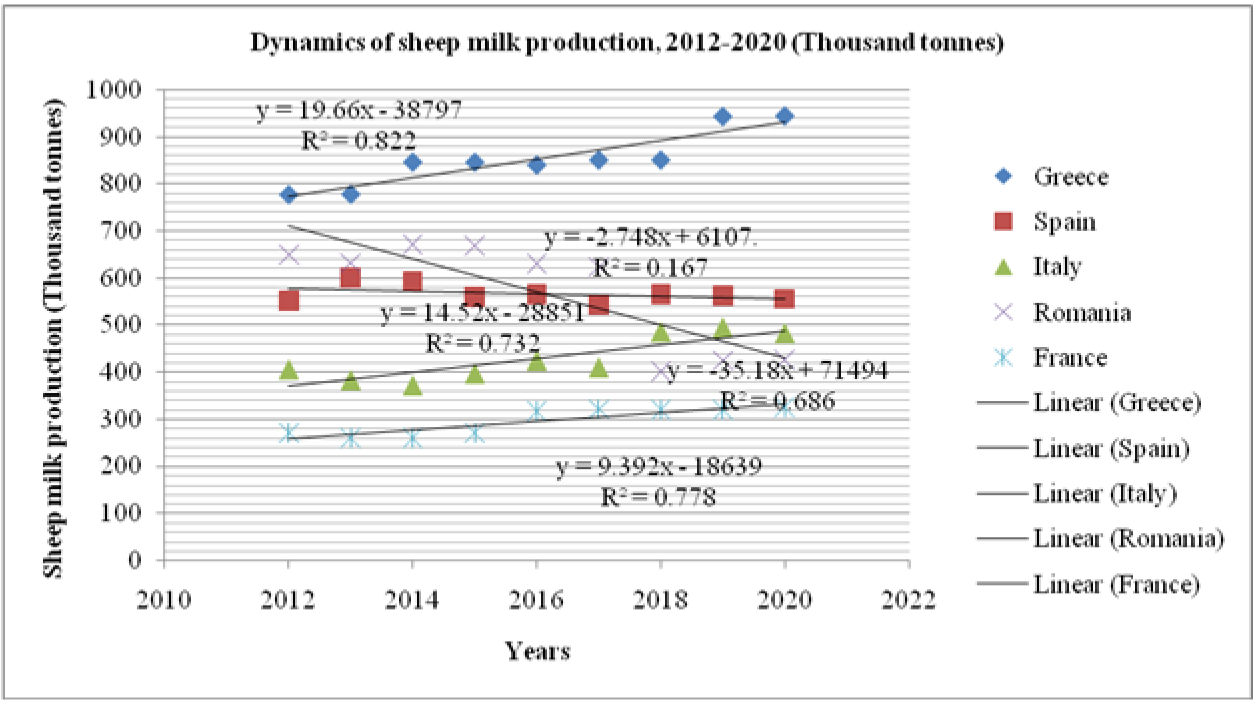

Fig. 3. Dynamics of sheep milk production in the EU five main producing countries, 2012-2020 (Thousand tonnes)
Source: Own design based on the data from [17].

Table 3. Sheep milk production in 2020 versus 2012 in the selected countries countries

	MU	Greece	Spain	Italy	Romania	France
2012	Thousand tonnes	777.97	552.52	406.18	650.91	270.71
2020	Thousand tonnes	945.43	556.25	481.97	426.00	325.50
2020/2012	%	121.52	100.67	118.66	65.44	120.24

Source: Own calculations based on the data from [17].

The production level in 2020 versus 2012 level is shown by selected country in Table 3.

Goat milk production

As mentioned before, goat milk output represents 2.5 million tonnes in the EU, meaning 1.56% of the EU total milk production [16].

Apparently, it is looks to be a small contribution to milk output, but goats produce a very special milk of high nutritive and hygienic value.

Taking into account the level of goat milk production achieved by the five selected countries, their decreasing order is the following one: France, Spain, Greece, Romania and Italy.

In France, goat milk output increased by +10.68% from 613.71 thousand tonnes in the year 2012 to 679.30 thousand tonnes in 2020. If we look at the statistical data, France produces more goat milk than sheep milk. In 2020, goat milk output accounted for 679.3 thousand tonnes and sheep milk production was 325.5 thousand tonnes, that is by more than 2 times smaller, reflecting the importance that French farmers allocate to this species in milk production to better satisfy consumer preferences and protect their health. Goat milk price had a continuous upward tendency in the last years raising from Euro 73.72/100 lt in 2019 to Euro 79.24/100 lt in 2021 [4].

In Spain, goat milk production increased by +18.09% from 443.62 thousand tonnes in 2012 to the peak of 535.79 thousand tonnes in 2019, but then it declined in 2020 to 523.9 thousand tonnes.

In Spain, goats' milk production is almost equal to sheep production, which in 2020 accounted for 523.90 thousand tonnes, and, respectively, 556.25 thousand tonnes.

In Spain, goats milk sale price is smaller than sheep milk price. If in 2016, average sheep milk price accounted for Euro 0.891/liter, in 2021, it reached Euro 1.002/liter, while average goat milk price ranged from Euro 0.579/liter in 2021 to Euro 0.776/lt in 2021 (Fig. 4).

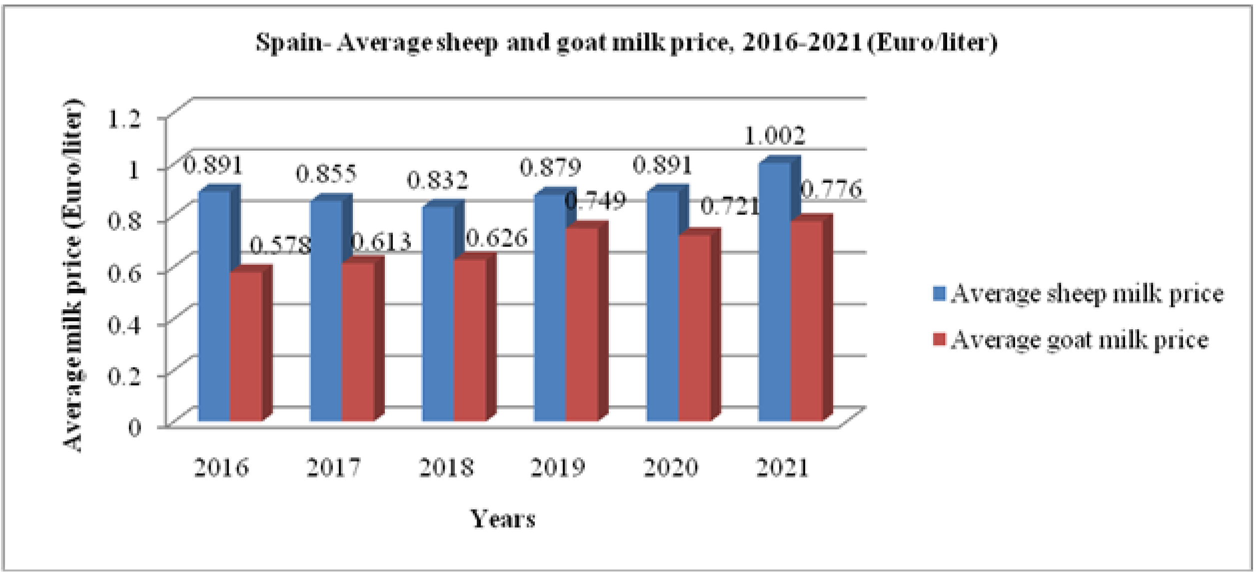

Fig. 4. Average sheep and goat milk sale price in Spain, 2016-2021 (Euro/liter)
Source: Own design based on the data from [5, 6].

In Greece, goats milk production is 2.6 times smaller than sheep production. In 2020, Greece produced 361.35 thousand tonnes goats milk and 945.43 thousand tonnes sheep milk. In the analyzed period, while sheep milk output increased by +21.52%, goats milk production decreased by -21.94%.

If for sheep milk production growth it is an explain, that the farmers paid more attention to the improvement of milk yield per ewe by selection and breeding, in case of the decline of goat milk output the main cause is the decrease of the goats livestock by -38.83% and the lack of interest to improve yield.

In Romania, goats milk production is about 2 times smaller than sheep production. In 2020, Romania achieved 426 thousand tonnes sheep milk and 240.80 thousand tonnes goats milk. It is normal to be so taking into account the sheep livestock is much higher than the number of goats. In 2020, goats milk output recorded a decline of -33.94% compared to 364.51 thousand tonnes in 2012 [34].

Italy registered 61.24 thousand tonnes goat milk in the year 2020, a level 2.19 times higher than in 2012.

However, sheep are more important than goats in Italy, as long as, sheep milk

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production is 7.87 times higher than goats milk production and the goats livestock is also much smaller (Fig. 5).

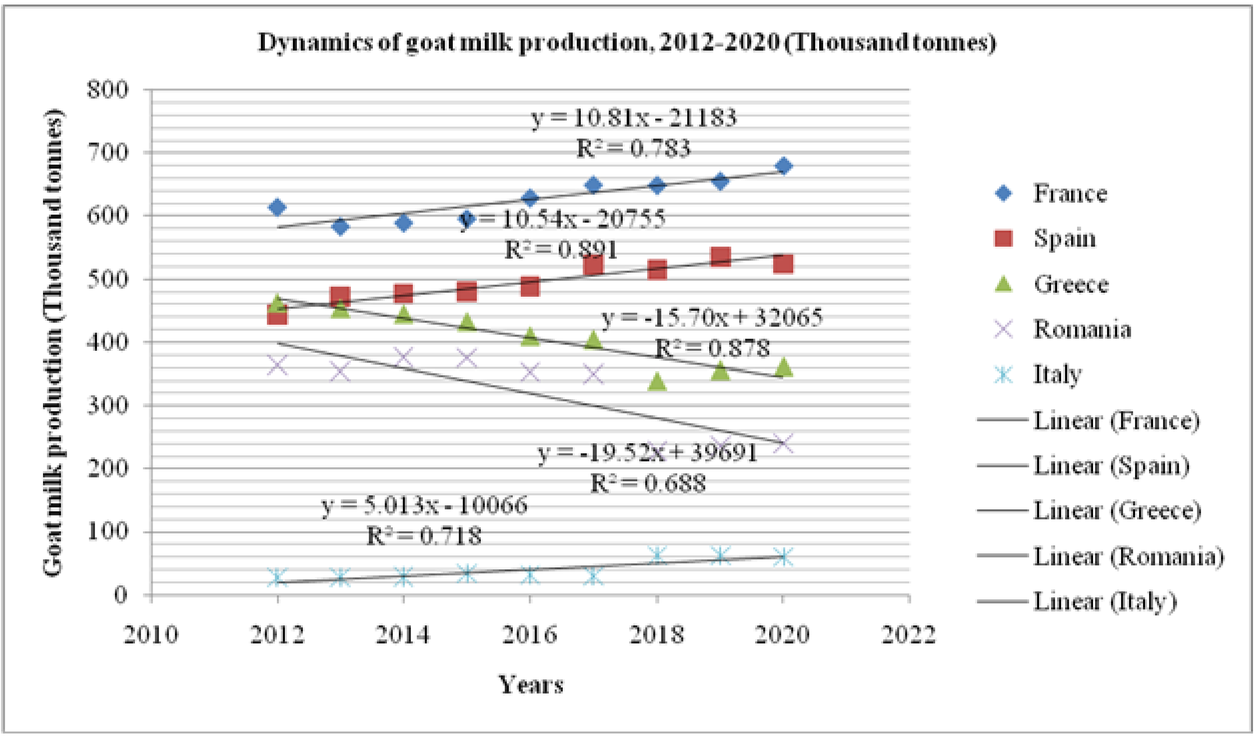

Fig. 5. Dynamics of goats milk production in the EU five main producing countries, 2012-2020 (Thousand tonnes)
Source: Own design based on the data from [17].

Table 4. Goats milk production in 2020 versus 2012 in the selected countries

	MU	France	Spain	Greece	Romania	Italy
2012	Thousand tonnes	613.711	443.62	462.87	364.51	27.94
2020	Thousand tonnes	679.30	523.90	361.35	240.80	61.24
2020/2012	%	110.68	118.09	78.06	66.06	219.15

Source: Own calculations based on the data from [17].

The production level in 2020 versus 2012 level is shown by selected country in Table 4.

Dynamics of meat production

Sheep meat production

From this point of view, the hierarchy of the EU top countries producing sheep meat is: France, Spain, Greece, Romania and Italy.

France comes on the 1st position showing an increasing trend in sheep meat output starting from 777.97 thousand tonnes in 2012 to 945.43 thousand tonnes, the maximum level attained in the year 2020. The growth rate for the whole interval accounts for +21.52%.

In the other four producing countries, sheep meat production decreased as specified below.

In Spain, sheep meat production registered the highest level of 122 thousand tonnes in 2021, but then it varied from a year to another. The minimum production was 114.22 thousand tonnes achieved in the year 2014. In the coming years, a slight recovery was noticed reaching the peak of 121.34 thousand tonnes in 2019, but in 2020, it declined to 115.12 thousand tonnes, meaning by -5.65% less than in 2012.

In Greece, the maximum sheep meat production was registered in 2012, accounting for 91.99 thousand tonnes and since that year, it recorded a continuous descending trend so that in 2020, it accounted for only 60.62 thousand tonnes, the minimum level, being by -34.1% lower than in 2012.

In Romania, sheep and goat meet have a low share in meat production and consumption.

However, the rural population dealing with sheep and goat rearing in the hilly and mainly in the mountain areas, consume a high amount of mutton along the year and lamb meat especially at Easter, as lamb is traditional at that holly fest [37].

In 2012, sheep meat output was 68.50 thousand tonnes and after two years of decline, in 2015 and 2016, it was noticed a slight recovery with the peak of production of 77.37 thousand tonnes in 2016. After that, production decreased by -35.31% in 2018 and then it registered again a slight recovery in 2020, accounting for 50.57 thousand tonnes, but this level was by -26.18% smaller than in 2012 [32, 33, 40].

In Italy, the maximum sheep meat production was achieved in 2012 when it accounted for 45.56 thousand tonnes. In the coming years, it varied between 34.83 thousand tonnes in 2018 and 25.31 thousand tonnes. In 2020, the level of sheep meat production accounted for 29.21 thousand tonnes, being by -35.89% less than in 2012 (Fig. 6).

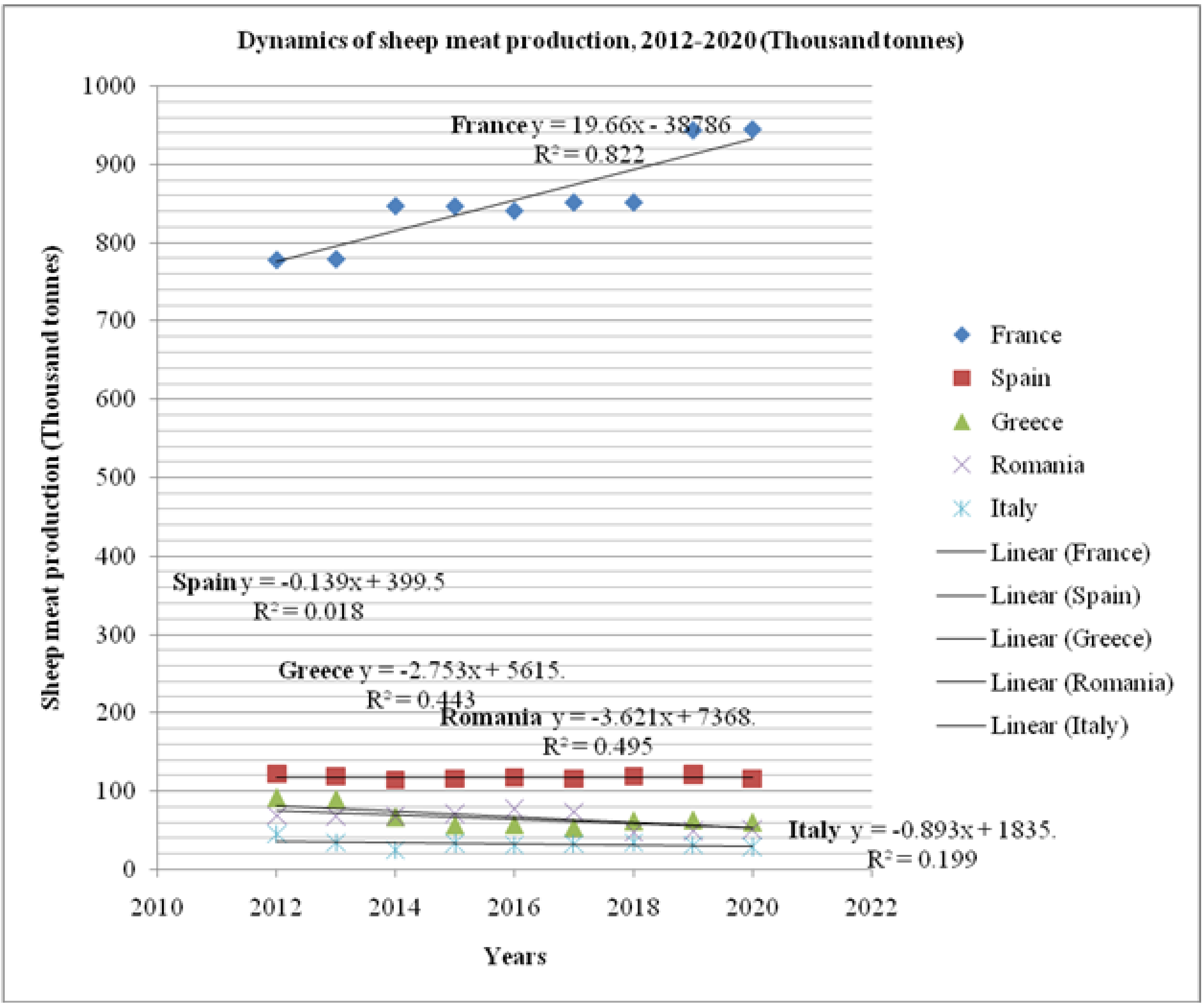

Fig. 6. Dynamics of sheep meat production, 2012-2020 (Thousand tonnes)
Source: Own calculations based on the data from [17].

Fig. 6 and Table 5 show the huge discrepancy between France and all the other countries producing sheep meat. In 2020, the production carried out by France was 8.21 times higher than in Spain, 15.59 times higher than in Greece, 18.69 times higher than in Romania and 32.36 times higher than in Italy.

Table 5. Sheep meat production in 2020 versus 2012 in the selected countries
countries

	MU	France	Spain	Greece	Romania	Italy
2012	Thousand tonnes	777.97	122.00	91.99	68.50	45.56
2020	Thousand tonnes	945.43	115.12	60.62	50.57	29.21
2020/2012	%	121.52	94.35	65.90	73.82	64.11

Source: Own calculations based on the data from [17].

Goat meat production

Compared to sheep meat production, goat meat output is much smaller in all the selected countries, as this species is mainly used for its high value milk suitable for preparing cheese and its livestock is less numerous than the sheep number.

Based on the performance in goat meat output, the top five EU countries have to be considered in the following order of importance: France, Greece, Spain, Romania and Italy.

If in 2012, these five countries all together produced 534.35 thousand tonnes goat meat, in 2020 they achieved only 399.88 thousand tonnes, meaning by -25.17% less and this was caused by the decreasing trend registered in France, Greece, Romania and Italy, except Spain where goat meat production increased.

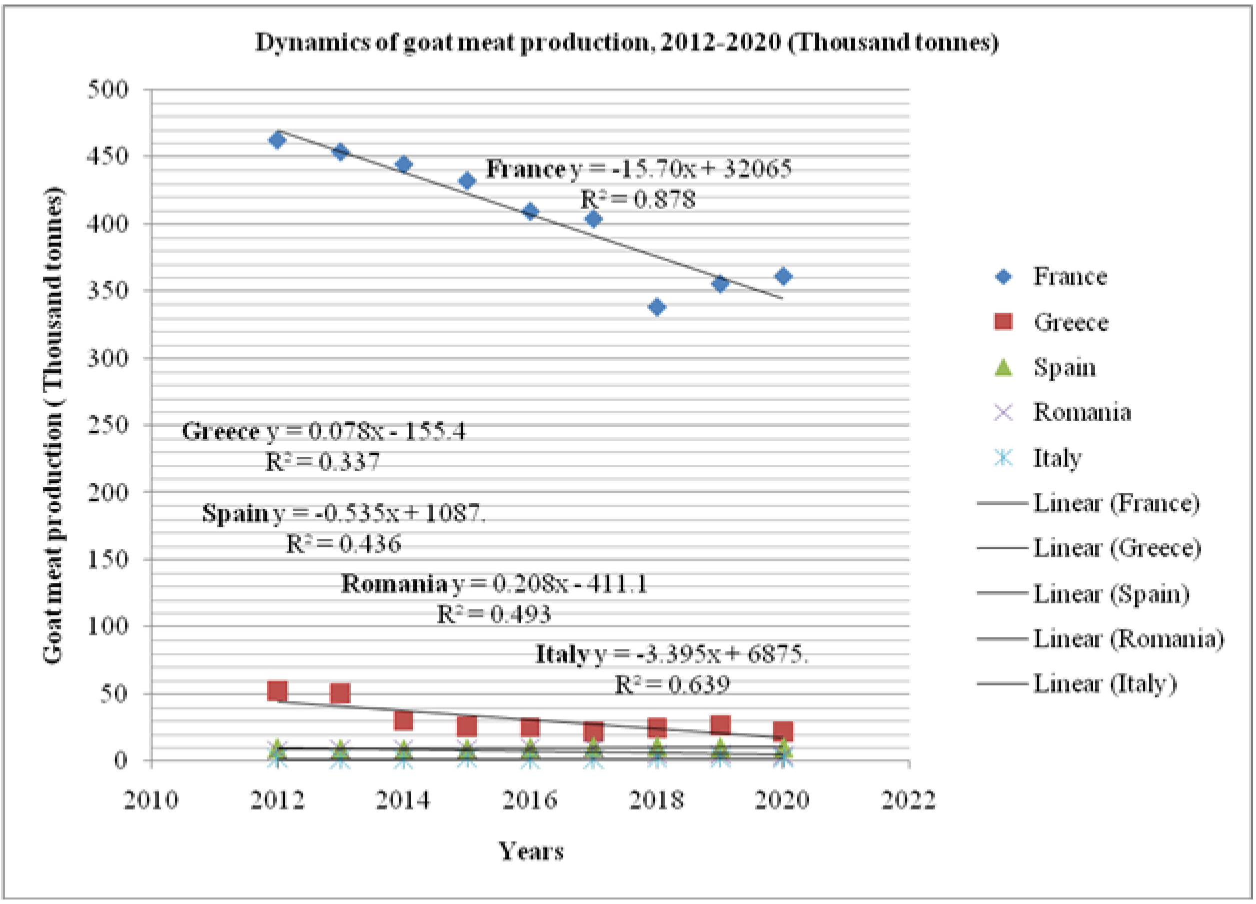

Fig. 7. Dynamics of goat meat production, 2012-2020 (Thousand tonnes)
Source: Own calculations based on the data from [17].

In France, goat meat output declined from 462.87 thousand tonnes, the maximum level registered in 2012, to 361.35 thousand tonnes in 2020, reflecting a reduction by -22.27%.

In Greece, goat meat production also decreased starting from 51.96 thousand tonnes in 2012 to 22.25 thousand tonnes in 20202, when it was by -57.19% smaller than at the beginning of the analyzed decade.

In Spain, in 2012, there were produced 9.7 thousand tonnes goat meat. In 2014, production was smaller, but after that it started to grow so that in the year 2018 it was achieved the maximum level of 10.97 thousand tonnes. In the coming years, it declined a little, reaching 10.15 thousand tonnes, but this level was by +4.68% higher than in the year 2012.

In Romania, goat meat production started from 7.73 thousand tonnes in 2012 and registered an ascending tendency till the year 2017, when it reached the highest performance, accounting for 9.73 thousand tonnes. But, in the coming three years it deeply declined and in 2020, it recorded the minimum level of 4.07 thousand tonnes, meaning by -47.37% less than in 2012.

However, in the analyzed decade, sheep and goat meat production in Romania is much higher than it was in the previous two decades 1990-2010 [23].

In Italy, at the beginning of the decade, goat meat production was 2.08 thousand tonnes, but in 2013 it decreased and reached the minimum level of 1.31 thousand tonnes. Since 2014, it recorded up and down variations and in 2019 it registered the peak accounting for 2.29 thousand tonnes. In 2020, it declined by -10% compared to the previous year and reached 2.06 thousand tonnes, a level by -1.3% lower than the one recorded in 2012 (Fig.7 and Table 6).

Table 6. Goat meat production in 2020 versus 2012 in the selected countries

	MU	France	Greece	Spain	Romania	Italy
2012	Thousand tonnes	462.87	51.96	9.69	7.73	2.09
2020	Thousand tonnes	361.35	22.25	10.15	4.07	2.06
2020/2012	%	77.73	42.81	104.68	52,63	98.70

Source: Own calculations based on the data from [17].

France is again in the top position, this time for goat meat output, far away from the level of the other four main producing countries.

A synthetic overview on each country regarding the development of sheep and goat sector

In order to rank each country based on its performance regarding the number of animals and their records in milk and meat production, it was used the Point Method and the obtained results are presented in Table 7.

The data show the following aspects:

Regarding livestock:

-Spain comes on the 1st position for the number of sheep, being followed by Romania, Greece, France and Italy;

- Greece is in the top for the number of goats, being followed by Spain, Romania, France and Italy;

- Taking into consideration the sheep and goats livestock, the hierarchy remains: Spain, Romania, Greece, France and Italy.

Regarding milk production:

-the highest ewe's milk output is obtained by Greece, followed by Spain, Italy, Romania and France;

-the highest goat milk output is achieved by France, followed by Spain, Greece, Romania and Italy;

-for ewe's and goat's milk production, on the top position is France, followed by Greece, Spain, Romania and Italy.

Concerning meat production:

- the highest sheep meat production is obtained by France, followed by Spain, Greece, Romania and Italy;

-the highest goat meat production is achieved by France, also followed by Spain, Greece, Romania and Italy;

- for sheep and goat meat output, it is obvious that France comes on the 1st position, being followed by Spain, Greece, Romania and Italy.

Table 7. The rank of the EU main countries rearing sheep and goats in the year 2021

	Spain	Romania	Greece	France	Italy
Sheep number	1	2	3	4	5
Goats number	2	3	1	4	5
TOTAL POINTS FOR Sheep and goats number	1	2	3	4	5
Ewe's milk production	2	4	1	5	3
Goat's milk production	2	4	3	1	5
TOTAL POINTS FOR Sheep and goats' milk production	3	4	2	1	5
Sheep meat production	2	4	3	1	5
Goat meat production	2	4	3	1	5
TOTAL POINTS FOR Sheep and goat meat production	2	4	3	1	5

Source: Own conception and calculation based on the performance recorded by each country.

Therefore, the differences regarding the position occupied by each country for livestock and for production are given by the changes of performance in yield.
The countries having a lower livestock have recorded a better performance in milk or meat production which have been sustained by the efforts done to increase yield using genetic factors, selection and breeding, a better feeding, reproduction, animal health and welfare and farm management.

CONCLUSIONS

In the year 2021, the study pointed out that Spain, Romania, Greece, France and Italy have all together the largest number of sheep in the EU, accounting for 46,106 thousand sheep, meaning 77% of the EU sheep livestock (60,094 thousands heads) and the largest number of goats, summing 9,369 thousand heads, accounting for 82.1% of the EU goats livestock.
In the year 2020, taking into account milk production, Greece produces the highest amount of sheep milk, being followed by Spain, Italy, Romania and France, while the largest amount of goats milk is achieved by France, whose position is far away from Spain, Greece, Romania and Italy/
Regarding sheep and goat meat, the highest production is carried out by France, followed with smaller amounts by Spain, Greece, Romania and Italy.
In the countries with the highest production, the livestock declined was justified and the efforts to improve yield have led to a higher performance.
However, the profitability per head is smaller in sheep and goat farming as it is practiced in regions with a limited agronomic potential like mountain area, semi-mountain, semi-arid and less favored areas.
To increase milk yield or meat per head it is important to grow the flock size or reorienting the farm on dairy production.
The diversification of the activity on farm is also an alternative to increase breeders' income and help rural areas to develop.
In this respect, the valorization of fresh milk and meat in products with high value added obtained by traditional processing technologies and certified for their origin and geographical designation is a guarantee of quality and could satisfy consumer's preferences.
Rural policy has to sustain sheep and goat farmer by direct support, but the lack of subsidies for the product and for animals have to complete the list of support measures.

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GAPS IN THE EDUCATION LEVEL BETWEEN RURAL AND URBAN AREAS IN THE EUROPEAN UNION

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Abstract

The paper aimed to analyze the education level in the EU rural areas and identified the gaps exiting between different member states compare to the EU average according to ISCED 2011classification mainly for the population aged 15-64 years. The Eurostat data were processed determining the differences in percentage points registered in the year 2021. The results showed that, in more than 50% EU member states, the share of the rural population is over the EU mean of 22.3%. With 44.9% and 44.7%, Slovakia and Romania could be considered rural countries. The demographic changes in the rural areas have had a deep influence on enrollment and future labor force reserve. The early school-leaving rate is the highest in the rural areas, while tertiary education has lower percentages, on the last position being situated Bulgaria and Romania (below10%). The EU rural population aged 15-64 years has a higher share than the EU average of 25.5% for "Less primary, primary and lower secondary education (level 0-2)" in only 9 countries: Portugal, Spain, Italy, Greece, Malta, Bulgaria, Romania, Denmark and Hungary. Compared to the EU mean of 74.5% for "Upper secondary, post secondary non-tertiary education (level 3-8)", a lower level was registered in only in 9 countries: Hungary, Denmark, Romania, Bulgaria, Malta, Greece, Italy, Spain and Portugal. The EU average for "Upper secondary and post secondary non-tertiary education (level 3 and 4)" accounted for 53% and this rate was higher in only 7 states: Czechia, Slovakia, Poland, Croatia, Romania, Hungary and Germany. For "Tertiary education (levels 5-8)", the EU-27 average is 21.4% and a higher rate was found only in 14 countries: Ireland, Belgium Luxemburg, Slovenia, Sweden, Cyprus, France, Estonia, Lithuania, Malta, Spain, Netherlands, Finland, Austria. The large variation of education level in the rural areas from a country to another has a deep impact on economic and social development. For this reason, besides the EU strategy, each country has to adapt its policy and strategy to the local situation and needs. Education and work force crises in the rural areas should be solved by a better infrastructure, more and highly competent teaching staff, a modern endowment in rural schools and a competence oriented curricula, extend of IT skills and digitalization, creation of partnerships and networks, exchange of experience and good practices, educational platforms and internet connections to ensure the permanent interlinks in the community and in the territory, and a proper financing for the field of education from the budget and access of the EU financial support provided by CAP 2021-2027, European Regional development Fund (ERDF), European Social Fund (ESF), EaSIF- European and Social Innovation Fund, ERASMUS Programme and Horizon 2020.

Key words: *education level, rural areas, discrepancies versus urban areas, European Union*

INTRODUCTION

Education and training are part of life and enable the people to get knowledge and better understand what is happening around them, to develop thinking capacity, to stimulate creativeness, acquire skills and experience and increase job performance [9].

Well-educated people have a chance to a more stable life, to benefit of better opportunities in their career, to be independent and free ensuring their financial security, to be more confident in attaining the goals of their lives [48].

Also, a higher level of education could bring nonmaterial benefits such as: health, social involvement and cultural participation, well-being and a high life quality and expectancy, higher chances of marriage etc. [24].

At the society level, the education and training enable the work force to increase productivity and assure economic growth and social development [8, 21].

Labor productivity depends not only the fixed capital performance and technologies applied but also on human capital, in terms of qualification and specialization [1]. A higher education and training level stimulates production, productivity and product quality in the non tradable sector [2, 28]. But, a higher productivity also favors a better wage in the labor market [4].

Education is an important factor contributing to the economic growth, to the increase of GDP, value added [23, 26, 32, 37].

[26] affirmed that education is key determinant of economic well-being and increases in human capital inherent in labour force.

GDP level is deeply conditioned on fixed capital, labor force, employment, professionalism and qualification of labor force [25, 29, 30, 31].

Employers are interested to used high qualified labor in all the sectors, including agriculture and rural services contributing to the sustainable development of the rural areas [3, 5, 6, 7, 36].

In the rural areas education and training has a lower level than in the urban areas, and the agriculture being the main activity run in the rural areas requires labor force of high qualification able to apply modern technologies and raise productivity, sustain rural development, and GDP created in this economic sector [33, 34, 35].

Education level is different from a country to another and for allowing comparisons, at the international level there were set up classification standards. ILOSTAT provides aggregate levels of education established by International Standard Classification of Evaluation - ISCED, designed by United Nations Educational, Scientific and Cultural Organization- UNESCO [25].

The ISCED-2011 Classification applied since 2014 includes five aggregate educational levels as follows:

(a)*Less than basic education* consisting of NS- No schooling, and ECE- Early childhood education;

(b)*Basic education* comprising: (i) PE- Primary education; (ii) LSE- Lower secondary education;

(c)*Intermediate education* which regards: (i) USE- Upper secondary education; PSNTE- Post secondary non tertiary education;

(d)*Advanced education* or Tertiary education, including: (i) SCTE-Short-cycle tertiary education; (ii) BSc- Bachelor's or equivalent; (iii) MSc- Master's or equivalent level and (iv) PhD- Doctoral or equivalent level.

Tertiary education confers levels of higher complexity and specialization provided by academic institutions as well as by vocational and professional units.

(e)*A not stated level*, which is not classified [25].

The educational level of the population is influenced by a large range of factors among which the most important are: legal background, education system organization, education policy and strategy, economic factors (the budget allocation for the field of education, infrastructure in the education units, income level of the teaching staff etc), social factors (education and training level of teaching staff, possibilities to improve the competence and quality of the educational process, family climate and the parents' model of education, community climate regarding education etc), psychological factors (the power of models which deserve to be followed, self-awareness regarding the importance of educational level in life etc).

The large number of factors existing in various countries have determined differences from a state to another and also from a region to another and from rural communities to urban ones [45].

It is unanimously recognized that, in general, education in rural areas has a lower level than in the urban area. This is because of the gaps in infrastructure, the existence of a fewer number of educational units and their endowment which is not updated like in the urban areas, the long distance to travel from home to school or a library, non sufficient teaching staff, the limited opportunities to get a higher educational level etc.

For this reason, young people move to the cities to find better chances to study especially in high schools and universities.

Sometimes, the access to education is restrained by the family possibilities to financially sustain the children' education. The lower income per household in the rural areas than in the urban zone is a restraining factor regarding the increase of education level [39, 45]. In the rural areas, work in the households, gardens, field and farms is of a high complexity and parents are accustomed to involve their children in various agricultural works which diminish the time allotted to studying and learning.

The number of pupils in the rural communities is smaller than in the urban localities and the relationship with the family is closer and stronger. Demographic changes in the rural area have a deep impact on the enrollment in various educational units and also on the future labor force of the local communities [38].

In this context, rural schools needs a specific educational strategy to overcome the difficulties they are facing and connect equally to the opportunities offered by urban localities.

The local authorities have to be much involved in helping rural schools to develop in the benefit of the community. The young generation has to be educated and trained to be able to get knowledge and skills so that its general educational background to be helpful for becoming the reserve of the work force in the local community, to be able to understand policies, procedures, rights and duties, legislation, local economy, to be conscious that education is a vital element and a tool to perform yourself and develop your career and standard of life and also to contribute to the economic development and prosperity of the local community.

However, the gap between the education level in the rural areas and in the urban ones continues and economic returns to education for rural areas continue to lag those for cities and towns and suburbs. More than this, the loss of potential work force in the rural areas due to the migration of the young generation to cities looking for a higher education level, better paid jobs and a higher income and living standard cannot be stopped and this depletes local resources because communities have invested in the future workers' education and are expecting to get a return on that investment. Therefore, outmigration could diminish school effects [22].

Therefore, education plays a critical role in the development of the rural communities and areas. That is way schools are facing new challenges at present [46, 47].

In this context, the purpose of the paper was to study the education level of the population in the EU according to ISCED 2011 classification for the population aged from 15 to 64 years in the year 2021. Starting from the EU-27 average, there were made comparisons establishing the countries whose performance is over and, respectively, below the EU mean. This is helpful to determine the gaps existing in education level in the rural areas compared to all the areas (cities, small towns and suburbs and rural areas) and to issue recommendations how these differences to be diminished.

MATERIALS AND METHODS

The paper was to set up based on the literature regarding the achievements and prospects in the field of education, emphasizing the ones related to rural areas.

The main indicator taken into consideration was the education level of the people aged 15-64 years, as these persons could be potentially employed and become work force.

The analysis was logically run by education level as established by ISCED 2011.

The statistical information were collected from Eurostat, and were classified according to the EU-27 average so that there were established groups of countries with an education level over the EU mean and another group with a performance below this mean.

After presenting a short situation in 2015, the study pointed out the actual education level in the year 2021 expressed in percentage of the educated population in the total population of a country, taking into account all the areas (rural, towns and suburbs and cities) and separately only rural areas.

In this way, the comparison method was used to evaluate the differences in percentage points between rural areas and all the regions both for the countries whose education level is over the EU-27 average and the ones whose level of education is below this mean.

The results were tabled and interpreted, and finally the main conclusions were drawn and a few recommendations were issued for diminishing the gap regarding the education level in the rural areas and all the regions as a whole.

RESULTS AND DISCUSSIONS

Demographic trends in the EU-27, emphasizing in rural areas

In 2022, of its surface of over 4 million km^2, 44% of the total land expanse is considered rural territory. France has the largest surface, while Malta the smallest.

The EU-27 is highly economic developed area, contributing by 16% to the world Gross Domestic Product, expressed in Purchasing Power Standard. The EU-27 economy is in a permanent competition with ones of USA and China, being the three leaders in the global economy.

In 2021, the EU-27 mean of GDP per capita accounted for Euro 27,810 [11].

In 2022, EU-27 population accounts for 446.9 million inhabitants. The country with the highest population is Germany with over 83.2 million inhabitants (18.6%), and the country with the smallest population is Malta having 520 thousands inhabitants (0.1%) [13].

In 2022, in the EU-27, about 100 million people live in the rural areas, representing 22.3%. It worth to note that in 2015, the rural population accounted for 28% in the total number of the EU-28 inhabitants. In 2018, 29.1% people lived in the rural areas, while 39.3% in the cities and 31.6% lived in towns and suburbs [20].

In 2020, a number of 15 countries have a share of over 30% rural population in their total population (Fig. 1). Looking at the figures we may consider that three countries are rural: Lithuania, Romania and Slovakia [38, 44, 45].

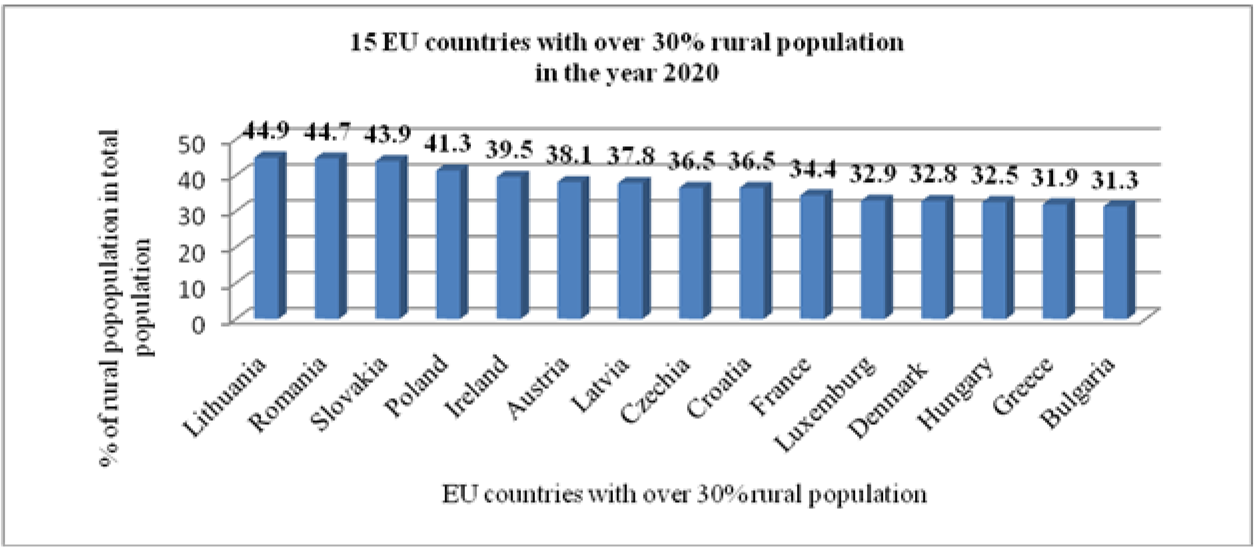

Fig. 1. A number of 15 EU countries have over 30% rural population in the year 2020
Source: Own design based on Eurostat Data, 2022 [14].

In the year 2015, Slovakia was on the top position with 56.2%, but in 2020, the share of the rural population declined to 43.9%.

Also, in 2015, in Denmark, Croatia, Latvia, Luxemburg and Hungary, the rural population had a share ranging between 45% and 49%.

In 2020, the EU countries with the smallest share of the rural population in their total population were: Italy 18.3%, Belgium 15.3%, Netherlands 10.7% and Malta 0.2%. In 2015, their shares were a little higher: Italy 18.9%, Belgium 18%, Netherlands 14.7% and Malta 0.3%.

Therefore, in the period 2015-2020, in the EU-27 it is an ascending trend of the population in the rural areas and also in towns and suburbs, while in the cities, the population is declining.

Compared to 2019, in 2050, the overall population of the EU-27 is projected to increase only in four member states: Ireland (+24.5%), Sweden (+10.9%), Denmark (+1.2%) and Belgium (+1%).

In 20 EU states it is projected to decrease.

Regarding the rural population, it is expected a decline in Lithuania (-43.5%) and Austria (-0.6%), and also in Latvia (-37.6%), Bulgaria (-26.8%), Romania (-25%) and Croatia (-23.3%).

Also, compared to 2019, it is projected that till 2050, urban population to increase in only 15 EU member states, ranging between + 35.4% in Malta to +2.3% in Croatia.

The urban population is expected to decline in Latvia (-17.7%0, Greece (-16.7%), Poland (-10.3%), Romania (-8.6%), Italy (-3,1%), Lithuania (-2.7%), Hungary (-1.7%), Portugal (-1.6%) and Bulgaria (-1.4%).

The reasons are the high living costs in the urban zone and the new orientation of the people during the COVID-19 pandemic to less crowded places.

It worth to mention that in the rural and remote areas, the population being below 50 years old has the lowest shares [17].

Labor force in the rural areas

The EU-27 is facing a decline in work force in the rural areas, especially in agriculture, first of all due to the modernization of fixed capital and more productive technologies, but also due to the population aging, outmigration of the young people, the lower qualification level of the ones involves in farming and other sectors compared to the urban areas [27, 45].

The development of agriculture is highly conditioned by labor force. The number of people working in agriculture, their training level, practical and managerial skills are the key factors which could contribute to agriculture development in the future. The existing gap between the availability of jobs and the supply of graduates is an important barrier which could affect agricultural labor force in the coming years [27, 36, 40, 44].

There are differences among the EU countries regarding the number of employed people in agriculture, its training level, the efficiency of the labor force in terms of productivity, product quality, gross value added, agricultural production value [40, 41, 42, 44]. Also, regarding GDP created in agriculture like in Romania and Bulgaria [29, 35, 43].

Schools in rural areas

Compared to cities and towns where population is more numerous, the number of schools is higher and of a large range of educational profile and the number of pupils who could be enrolled is also high, in the rural areas there is a few number of schools, located in general in the larger communities (communes and villages), which means that there are many small localities where schools are missing. More than this, the number of pupils who could attend education is smaller as well as the number of teachers.

This is a real challenge for rural schools which are many times dependent on the community conditions.

More than this, rural schools have a lower endowment and infrastructure due to the lower funding, teachers have limited opportunities for professional development, book shops and libraries are missing in many cases and schools are situated far away from cultural centers.

The schooling is limited to the curricula, without other alternatives of educational activities dedicated to pupils, teachers and parents.

Since 2018, in the EU it was launched eTwinning experience to sustain rural education by helping the teachers to explore new topics as:" multi-level classes, involvement of the parents, media literacy, universal design for learning, social-emotional learning and well-being of the pupils and teachers" [10].

Digitalisation in the rural areas

Digital skills have become very important for the population living in the rural area in order to ensure the contact and the best access to information and communication needed to develop and perform better in schools and local communities, to be more competitive economically. socially, environmentally by increasing the education and training level of the local population.

In 2019, in the rural areas of the EU, the share of the adult population having digital skills was 48% for basic and above basic skills compared to 62% in cities and 55% in towns and suburbs.

However, in the period 2015-2019, the overall level of digital skills in the EU increased in the rural areas from 46% to 48%, but the shares varies from a country to another.

A similar increasing trend it was recorded in the urban areas from 60% in 2015 to 625 in 2019 [12, 16, 20].

Education and skills

In 2021, in the EU-27, the percentage of the total early leavers from education and training for the age 18-24 years accounted for 9.7%, compared to 9.9% in the year 2020 and 10.2% in 2019 when United Kingdom was included.

By degree of urbanization, the situation is the following one:

- rural areas, registered 10% in the year 2021 compared to 10.7% in 2020;

-cities recorded 8.7% in 2021 compared to 8.6% in 2020;

-towns and suburbs registered 10.7% in 2021 compared to 11.1% in 2020 [15].

In the rural areas, the tertiary education has a lower share than in the urban areas.

However, in the interval 2012-2019, the share of the population aged 25-64 years in the rural areas increased from 18% to 22%, which is a positive aspect.

But, the gap between cities and villages has become larger as in the cities the share increased from 17% to 19% in the same period [12].

In 2015, the early-leaving rate of the educated and trained people between 18 and 24 years old in the EU accounted for 12.2% in the rural areas compared to 9.8% in cities and 11.5% in towns and suburbs. But, among the EU member states there are substantial differences.

The highest early-leavers' rate in the rural areas was recorded in Slovakia, Spain, Greece, Hungary, Estonia, Romania and Bulgaria, while in France, Germany, Belgium and Austria belong to the city residents.

The EU rural population aged 30-34 years having a tertiary level of educational attainment had a share of only 27.9% in 2015, compared to 33.4% in towns and suburbs and 48% in cities.

And this gap between rural and urban level of tertiary education continues to grow. Therefore, the tertiary level of educational attainment is deeply lower in the rural localities of the EU countries.

Also, in 2015, the rate of people aged 30-34 years having a tertiary education level ranged between 44.9% in rural Luxemburg compared to 77.7% in cities.

At the opposite pole, there were Bulgaria and Romania, where the rate was only 10% in the rural areas compared to 46.6% in the cities of Bulgaria and 44.4% in the cities of Romania.

The level of this rate much higher in the cities than in the rural communities is explained by the fact that the institutions providing tertiary education programmes are located in the cities, where labour market is deeply specialized, there is a large scale of jobs and the graduates are more attracted by better paid jobs and the city living standard [3].

Analysis of education level of the population aged 15-64 years according to ISCED 2011 in the year 2021

Less primary, primary and lower secondary education (level 0-2)

In the EU-27, in 2021, the average rate of less primary, primary and lower secondary education (level 0-2) for the population aged 15 to 64 years was 24.9%.

For the whole population (rural and urban), the highest rate was achieved, in the decreasing order, in: Portugal, Italy, Spain, Malta, Luxemburg, Netherlands, Greece, France, Romania and Germany.

In the rural areas, the average EU-27 rate for this level of education was 25.5%.

The EU countries with a higher rate than the EU average in the rural areas were, in the descending order: Portugal, Spain, Italy, Greece, Malta, Bulgaria, Romania, Denmark and Hungary (Table 1 and Figure 2).

Table 1. The rate of education level - less than primary, primary and lower secondary (level 0-2) for the EU-27 people aged 15-64 years in 2021

EU-27 Average 24.% - Urban and rural areas			EU-27 Average 25.5% - Rural areas		
The highest rate			The highest rate		
Country	Rate %	Difference from the EU average pps	Country	Rate %	Difference from the EU average Pps
1.Portugal	40.3	+23.4	1.Portugal	50.8	+25.3
2.Italy	39.2	+14.3	2.Spain	47.1	+21.6
3.Spain	37.9	+13.0	3.Italy	42.6	+17.1
4.Malta	36.1	+11.2	4.Greece	38.5	+13.0
5.Luxemburg	25.1	+0.1	5.Malta	36.9	+11.4
6.Netherlands	23.6	-1.3	6. Bulgaria	35.0	+9.5
7.Greece	23.5	-1.4	7.Romania	33.8	+8.3
8.France	22.1	-2.8	8.Denmark	30.4	+4.9
9.Romania	21.6	-3.3.	9.Hungary	27.9	+2.4
10.Germany	21.0	-3.9			

Source; Own calculation based on Eurostat, 2022 [18, 19].

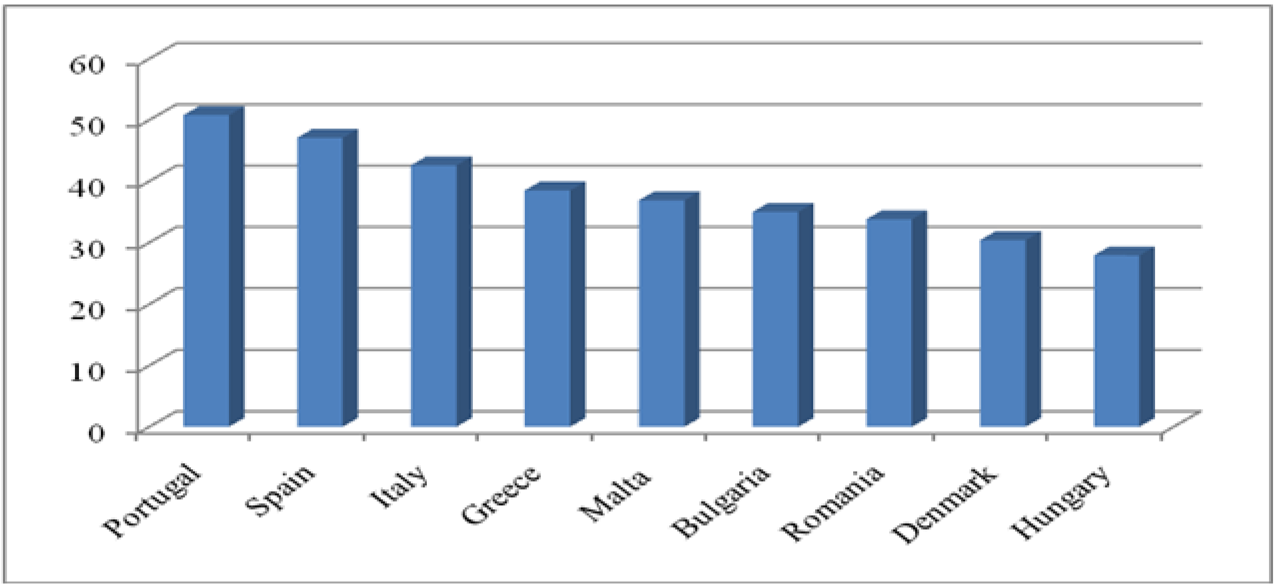

Fig. 2. The EU countries where the average rate for the education level (0-2) in the rural areas is higher than the EU average
Source: Own design based on Eurostat data, 2022 [18, 19].

Upper secondary, post secondary non-tertiary education (level 3-8)

In the EU-27, in 2021, the average rate of upper secondary, post secondary non-tertiary education (level 3-8) for the population aged 15 to 64 years was 75.1%, taking into account both rural and urban areas.

A higher rate than the EU-27 mean was carried out by the following countries, in the descending order: Lithuania, Czechia, Poland, Slovenia, Slovakia, Latvia, Estonia, Croatia, Ireland, Finland, Austria, Hungary, Cyprus, Sweden, Germany, Romania, Netherlands and Greece (Table 2).

A rate below the EU average was registered by: Denmark (74.5%), Malta (63.9%), Spain (62.1%), Italy (60.8%) and Portugal (59.7%).

In 2021, in the EU rural areas, the population aged from 15 to 64 years recorded an average rate for this level of education of 74.5%. Below this EU average rate, there were situated the following countries: Hungary, Denmark, Romania, Bulgaria, Malta, Greece, Italy, Spain and Portugal (Table 2 and Fig. 3).

Table 2. The rate of education level - upper secondary, post-secondary non-tertiary (level 3-8) for the EU-27 people aged 15-64 years in 2021

EU-27 Average 75.1 % - Urban and rural areas			EU-27 Average 74.5% - Rural areas		
The highest rate			A lower rate than the EU average		
Country	Rate %	Difference from the EU average pps	Country	Rate %	Difference from the EU average Pps
1.Lithuania	89.1	+14.0	1.Hungary	72.1	-2.4
2.Czechia	88.0	+12.9	2.Denamark	69.6	-4.9
3.Poland	87.0	+11.9	3.Romania	66.2	-8.3
4.Slovakia	86.8	+11.7	4.Bulgaria	65.0	-9.5
5.Slovenia	86.7	+11.6	5.Malta	63.1	-11.4
6.Latvia	85.8	+10.7	6. Greece	61.5	-13.0
7.Estonia	83.3	+8.2	7.Italy	57.4	-17.1
8.Croatia	83.0	+7.9	8.Spain	52.9	-21.6
9.Ireland	82.3	+7.2	9.Portugal	49.2	-25.3
10.Finland	81.8	+6.7			
11.Austria	81.5	+6.4			
12.Hungary	80.8	+5.7			
13.Cyprus	80.3	+5.2			
14.Sweden	79.9	+4.8			
15.Germany	79.0	+3.9			
16.Romania	78.4	+3.3			
17.Greece	76.5	+1.4			
18.Netherlands	76.4	+1.3			

Source: Own calculation based on Eurostat, 2022 [18, 19].

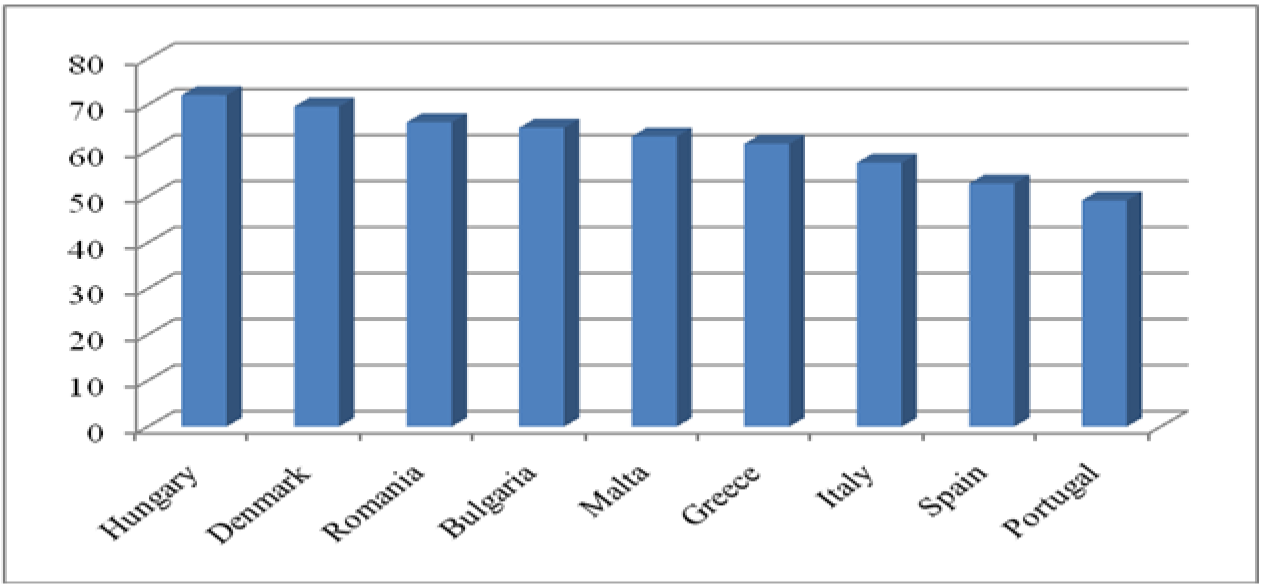

Fig. 3. The EU countries where the average rate for the education level (3-8) in the rural areas is smaller than the EU average

Source: Own design based on Eurostat data, 2022 [18, 19].

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Upper secondary and post secondary non-tertiary education (level 3 and 4)

In 2021, for this level of education, the EU-27 average rate accounted for 45.6% for all the areas: rural, cities and towns and suburbs.

The EU member states with a higher rate than the EU mean were: Czechia, Slovakia, Romania, Croatia, Bulgaria and Germany.

The countries recording the lowest level for this rate were: Denmark, Netherlands, Cyprus, Belgium, Ireland, Malta, Portugal, Luxemburg and Spain (Table 3).

In the rural areas, the EU-27 average rate for this education level was 53%.

But there were countries which recorded a higher rate than the EU average like: Czechia, Slovakia, Poland, Croatia, Romania, Hungary and Germany (Table 3 and Fig. 4).

A lower rate than the EU mean in the rural areas was achieved by Luxemburg, Malta, Portugal and Spain (Table 3).

Table 3. The rate of education level - upper secondary and post-secondary non-tertiary (level 3 and 4) for the EU-27 people aged 15-64 years in 2021

EU-27 Average 45.6 % - Urban and rural areas			EU-27 Average 53% - Rural areas		
The highest rate			A higher rate than the EU average		
Country	Rate %	Difference from the EU average pps	Country	Rate %	Difference from the EU average Pps
1.Czechia	64.5	+18.9	1.Czechia	71.5	+18.5
2.Slovakia	62.1	+16.5	2.Slaovakia	68.3	+15.3
3.Romania	62.1	+16.5	3.Poland	65.2	+12.2
4.Croatia	61.3	+15.7	4.Croatia	64.2	+11.2
5.Bulgaria	53.3	+7.7	5.Romania	61.1	+8.1
6.Germany	52.0	+6.4	6. Hungary	59.8	+6.8
			7.Germany	59.2	+6.2
The highest rate			The highest rate		
1.Denmark	39.7	-5.9	1.Luxemburg	37.3	-16.7
2.Netherlands	38.9	-6.7	2.Malta	35.1	-17.9
3.Cyprus	38.4	-7.2	3.Portugal	31.0	-22.0
4.Belgium	37.6	-8.0	4.Spain	24.8	-28.2
5.Ireland	37.1	-8.5			
6.Malta	34.5	-11.1			
7.Portugal	31.4	-14.2			
8.Spain	25.6	-20.0			

Source; Own calculation based on Eurostat, 2022 [18, 19].

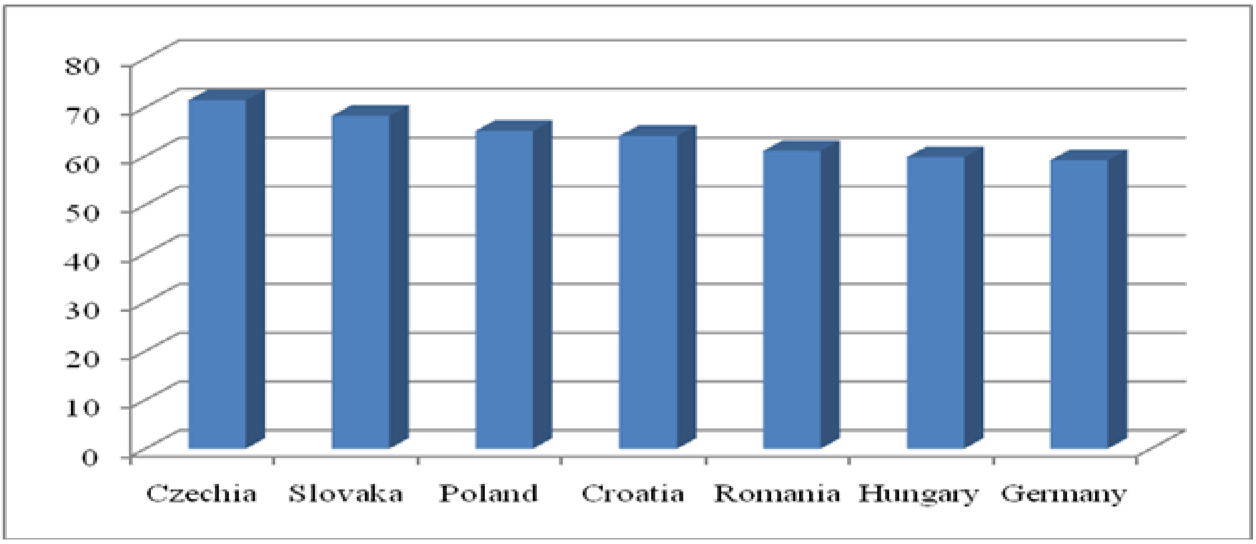

Fig. 4. The EU countries where the average rate for the education level (3-4) in the rural areas is higher than the EU average

Source: Own design based on Eurostat data, 2022 [18, 19].

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Tertiary education (levels 5-8)

Tertiary education was attained by a smaller number of people and for this reason this indicator of education level has a smaller rate than the rates analyzed so far.

In 2021, for this level of education, the EU-27 average rate accounted for 29.5% for all the areas (rural and urban).

Table 4. The rate of tertiary education level (level 5-8) for the EU-27 people aged 15-64 years in 2021

EU-27 Average 29.5 % - Urban and rural areas			EU-27 Average 21.4% - Rural areas		
The highest rate			A higher rate than the EU average		
Country	Rate %	Difference from the EU average pps	Country	Rate %	Difference from the EU average Pps
1.Ireland	45.2	+15.7	1.Ireland	39.2	+17.8
2.Luxemburg	44.5	+15.0	2.Belgium	38.7	+17.3
3.Cyprus	41.9	+12.4	3.Luxemburg	37.9	+16.5
4.Lithuania	39.8	+10.3	4.Slovenia	30.3	+8.9
5.Belgium	39.7	+10.2	5.Sweden	29.9	+8.5
6.Netherlands	37.5	+8.0	6. Cyprus	29.9	+8.5
7.Spain	36.5	+7.0	7.Estonia	28.7	+7.3
8.France	36.3	+6.8	8.France	28.4	+7.0
9.Estonia	36.0	+6.5	9.Lithuania	28.3	+6.9
10.Denmark	34.8	+5.3	10.Malta	28.0	+6.6
			11.Spain	28.0	+6.6
			12.Netherlands	27.6	+6.2
			13.Finland	26.8	+5.4
			14.Austria	25.8	+4.4
The lowest rate			The lowest rate		
1.Italy	17.8	-11.7	1.Croatia	12.8	-8.6
2.Romania	16.4	-13.1	2.Italy	12.7	-8.7
			3.Hungary	12.3	-9.1
			4.Bulgaria	8.9	-12.5
			5.Romania	5.1	-16.3

Source; Own calculation based on Eurostat, 2022 [18, 19].

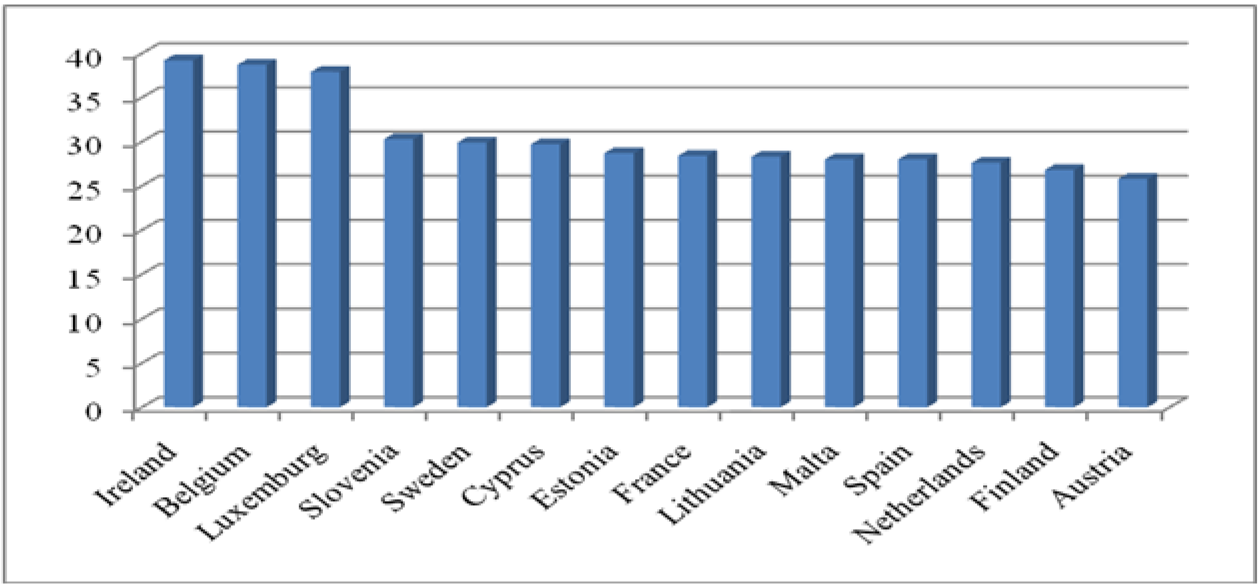

Fig. 5. The EU countries where the average rate for the education level (5-8) in the rural areas is higher than the EU average
Source: Own design based on Eurostat data, 2022 [18, 19].

The EU countries which registered a higher rate than the EU mean were Ireland, Luxemburg, Cyprus, Lithuania, Belgium, Netherlands, Spain, France, Estonia, Denmark. For this indicator, the lowest rate was achieved by Romania and Italy (Table 4). In the rural areas, the average rate of the EU-27 accounted for 21.4%. Rates higher than the EU mean were carried out in Ireland, Belgium Luxemburg, Slovenia, Sweden, Cyprus, France, Estonia, Lithuania, Malta, Spain, Netherlands, Finland, Austria (Table 4 and Fig. 5). Smaller rates than the EU-27 average were noticed in Croatia, Italy, Hungary, Bulgaria and Romania (Table 4).

A comparative and synthetic situation is presented in Figure 6, which shows that:
-For the levels 0-2, the EU mean rate rural areas exceeds the average rate for all the areas (urban and rural) by +0.6 pps;
-For the level 3-8, the EU average rate is a little below the EU mean for all the regions, more exactly by - 0.6 pps.
-For the level 3-4, the EU mean in the rural areas is by 7.4 pps higher than the EU average for all the regions;
-For the level 5-8, in the rural areas the EU average rate is by 8.1 pps smaller than the EU mean rate for all the regions (Fig. 6).

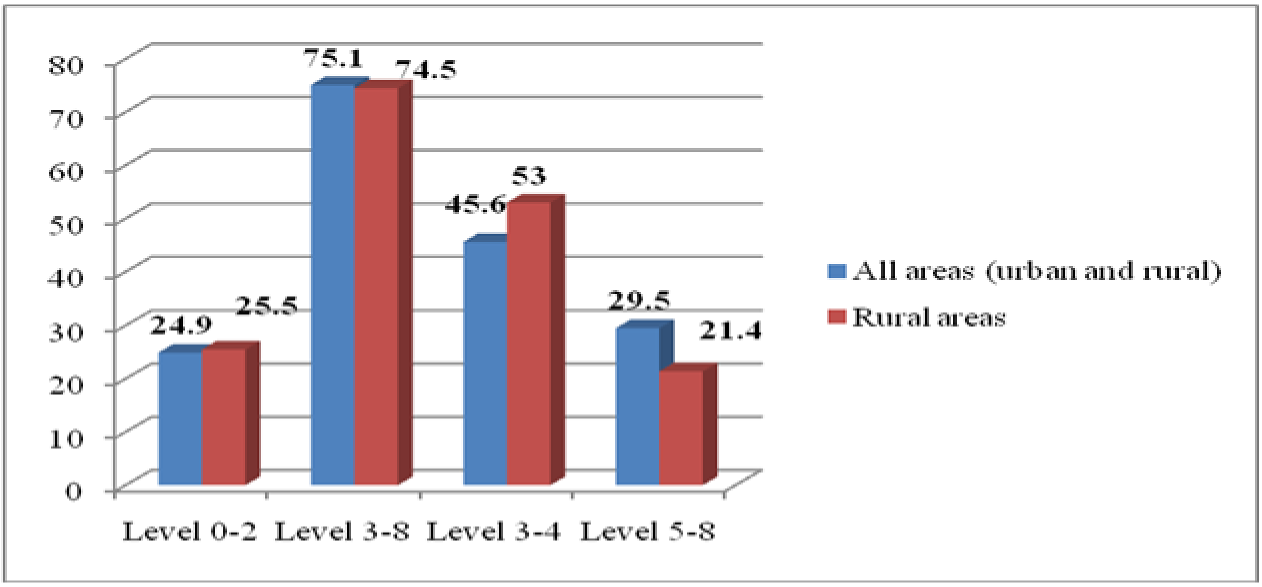

Fig. 6. The EU average rate of education level for the population aged from 15 to 64 years in the rural areas compared to the average rate in all the regions by level of educational attainment in the year 2021
Source: Own design based on Eurostat data, 2022 [18, 19].

It is obvious that education should start with the basic levels of education (1-2) and to continue with the following superior levels (3-5) and it is possible with the level (5-8), but not all the people is able to perform in this way, so that we could discuss of pyramidal distribution of the educated people, at the peak of the pyramid being situated the people with the highest education level.
The development of the rural areas depends on the level of education of each individual who could attend a form of another of education and training The higher the education level of the rural population, the higher the economic and social development of the rural areas.
However, based on their research, [26] found that "a 10 per cent increase in secondary education leads to a 1.5 per cent increase in economic growth, while an increase of 10 per cent in tertiary education increases economic growth by 0.9 per cent, *ceteris paribus*".
Also, they affirmed that secondary education is not statistically significant for economic growth, which depends on GDP recent history, physical capital, labour force and public government expenditure on education. But this does not diminish the importance of

secondary education. A higher education level has a deep impact on economic growth [26].

For this reason, the EU pays a special attention to education and training in the rural areas starting from a new concept on the rural schools and teaching strategy which have to be focused much more on competence than on knowledge, or, in other words, much more on scholars or students than on the curriculum.

The Europenisation process has imposed a new vision on the development of skills deeply anchored in the reality, in the real requirements of the economic and social development.

For this reason, the teaching staff has to be highly qualified and competent to help the scholars to get the necessary knowledge and mainly skills.

The increase of the education level in the rural areas needs a close communication and contact with the urban educational units in order to exchange experience, models, ideas to attain a better performance.

The rural schools need highly competent teachers, a new orientation of the purpose of education programmes which have to be competence-oriented, using modern tools regarding infrastructure, digitalization, teaching staff mobility and develop school partnerships and networks, exchange of experience and good practices, creating educational platforms and internet connections to ensure the permanent interlinks in the community and in the territory between rural communities and the urban ones [47].

This supposes a more intense collaboration between schools, local authorities, universities, private business sector and voluntary organizations for improving education level of the rural population.

More than this, an important financial support is also required and in this respect, there are many alternatives among which the most important ones are:

-CAP 2021-2027 destined to promote knowledge transfer and innovation, social inclusion and economic development;

-The European Regional development Fund (ERDF) which is destined to sustain technical vocational education and training oriented to smart specialization, a better employable work force adapted to market requirements;

-The European Social Fund (ESF) as well as EaSIF- European and Social Innovation Fund focused on the school digitalisation to enable the leavers to become more employable as required by labour market;

-ERASMUS Programme sustains the teaching staff mobility and learning for various purposes such as: study periods, traineeships, apprenticeships, staff exchange etc in any country of the EU;

This programme helped more than 4 million people to study and train abroad between 2014 and 2020.

-Horizon 2020 is focused on the research and innovation development based on projects which have to respond to the major problems of agriculture, food, rural development and other fields.

Taking into account that agriculturists have the highest share among the rural population, the increase of their education and training level will help them to be more competitive and successful in developing their business in agriculture and various services especially in agrotourism, to increase their income, living standard and also to sustain the development of their communities. In other words this means an improvement the local population's social, cultural and economic situation as well as of the local community [7, 49].

CONCLUSIONS

The paper analyzed education level in the rural areas of the EU-27 countries and pointed out the differences compared to the urban areas.

Also, it synthesized the main factors which influence education level in the rural areas and accentuate these gaps that could be only partially diminished.

As long as in the year 2022, the EU-27 rural population is 22.3% of its total population and in more than 50% of the member states is over this mean, ranging between 31.3% in Croatia and 44.9% and 44.7% in Slovakia and Romania, this is a challenge which will led to both to decreases and increases in rural population as well as in urban localities.

The decline in rural population will diminish the potential reserve of labor force in the future, which actually is facing a real crisis in many countries. This lack of work force should have to be compensated by more productive technologies which have to be aligned to the Green Deal for a sustainable agriculture.

The early school-leaving rate is the highest in the rural areas, and for the other education levels, rural areas have lower percentages in comparison with the urban localities. Tertiary education of the people aged 30-35 years in the rural areas accounts for only 28%. Bulgaria and Romania has a lower share than 10%, the smallest level of tertiary education.

Taking into consideration ISCED classification of education levels, in the year 2021, the population aged from 15 to 64 years living in the rural areas presents the following situation:

- For *Less primary, primary and lower secondary education (level 0-2)*, the EU-27 average is 25.5%, and only in 9 countries: Portugal, Spain, Italy, Greece, Malta, Bulgaria, Romania, Denmark and Hungary is higher;

- For *Upper secondary, post secondary non-tertiary education (level 3-8)*, the EU-27 average is 74.5% and a lower level was registered in only in nine countries: Hungary, Denmark, Romania, Bulgaria, Malta, Greece, Italy, Spain and Portugal.

-For *Upper secondary and post secondary non-tertiary education (level 3 and 4),)*, the EU-27 average is 53% and a higher education level was performed only by seven countries: Czechia, Slovakia, Poland, Croatia, Romania, Hungary and Germany.

-For *Tertiary education (levels 5-8)*, the EU-27 average is 21.4% and a higher education level was performed only by fourteen countries: Ireland, Belgium Luxemburg, Slovenia, Sweden, Cyprus, France, Estonia, Lithuania, Malta, Spain, Netherlands, Finland, Austria.

Education and training are and will remain key factors which could contribute to the development of the local communities and sustainable development of the rural areas from an economic, social and cultural point of view.

The challenges through which rural areas are passing at present require to be surmounted only by increasing education level of the rural population.

However, outmigration will remain a restraining factor which will diminish the potential labor force in the rural areas, as getting a higher education will enable people to look for better paid jobs which could be find only in the urban areas. Local authorities have to find effective solutions to diminish migration outflow.

Rural schools have to adopt a new strategy in the development of education of the scholars being more oriented on competence and useful skills as required by labor market and employers.

IT and digitalization skills have to complete the large range of abilities and knowledge as they offer access to information and communication with the whole world and strengthen work efficiency, personal and community development.

A modern infrastructure, a higher qualified teaching staff, competence based educational programmes, partnerships and networks, exchange of experience and good practices, educational platforms and internet connections to ensure the permanent interlinks in the community and in the territory represent solutions to improve educational level of the rural population and work force in the local communities and diminish the gaps versus the performance in the urban areas.

The EU funding provided by CAP 2021-2027, European Regional development Fund (ERDF), European Social Fund (ESF), EaSIF- European and Social Innovation Fund, ERASMUS Programme and Horizon 2020 is destined to sustain the increase of education level in the rural areas and completed the allocations from the budget of each EU member state to the field of education.

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INCOME INEQUALITY IN THE COUNTRIES OF THE EUROPEAN UNION

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Abstract

The paper aimed to analyze income inequality in the EU-27 countries in the period 2014-2021 based on Eurostat data and methodology involving specific indicators. Dynamic analysis, regression equations, R^2, growth or decline rates, classifications, comparisons, and graphical and tabled illustration of the results were the main procedures for data processing. In the most member states it was noticed a reduction of disparities, grace to the measures taken by each country to improve income of the citizens by social transfers. In the Euro area, income level is higher than in EU-27 and income disparities are smaller. In 2021, the EU-27 median disposable income accounted for Euro 18,369 by +21.6% higher than in 2014. In the Euro area, it reached Euro 20,776 (+19.4%). The highest median disposable income exceeds Euro 25,000 in Luxemburg, Denmark, Netherlands, Ireland, Belgium, Sweden, Finland and Germany, while the lowest level is in Romania Euro 4,832. In 2021, Gini coefficient of equalized disposable income was 30.1 in the EU-27 and 30.5 in the Euro area, showing a slight decline of income inequality. While Lithuania and Latvia are the countries with the highest income disparity, Slovenia, Belgium and Czechia have a lower income inequality. Income by quantiles reached Euro 12,790 in the EU-27 and Euro 14,622 in the Euro area. Luxemburg, Ireland, Austria and Netherlands registered the highest income by quantiles, while Latvia, Croatia, Hungary, Bulgaria and Romania the lowest one. Income quintile share ratio S80/S20 for disposable income, reached 4.97 in the EU-27 and 5.02 in the Euro area. It increased in France, Italy, Latvia, Luxemburg, Malta, Netherlands and declined in all the other countries. Despite of a relative reduction in income inequality during the analyzed period, the process has to continue for ensuring the goal 10 of the 2030 Agenda and its Sustainable Development. For this reason, researchers and policy makers have to look for new strategies to improve income and increase the living standard of the population and assure the sustainable development of all the member states.

Key words: *income inequality, median disposable income, Gini index, income by quantiles, income quintile share ratio S80/S20, EU-27*

INTRODUCTION

Income is one of the indicators reflecting living standard. Its level is closely linked to the economic development which also depends on technology advancement grace to the results of the scientific research, the accumulation of capital stock and labor force education and training Stimulating productivity and human capital the development generates economic growth, more job opportunities and higher incomes [21].

The development level is influenced by income distribution as it determines the society cohesion, the increase of poverty and even the population's health. Income inequality has a negative and statistically significant impact on economic growth. That is why policies are called to diminish income inequalities for improving social outcomes and also to sustain long-term growth [3].

As inequality has a large variability from a country to another, in order to assure an econometric comparison, usually the main indicators taken into consideration are: GDP per capita coverted to purchasing power parity

(PPP), average income, median income, Gini Index. In the year 2020, regarding GDP/capita, at the global level, there are countries with the highest GDP per inhabitant in constant international $ (Luxemburg, Switzerland, Norway, USA) and countries with the lowest level (Burundi, Central African Republic, Democratic Republic of Congo). But these figures do not say anything about income inequality. As GDP does not necessarily create an image about the citizens' welfare, average and median income are of much help to create a more detailed image, but not enough convincing. That is why, Gini Index is the most frequently utilized indicator to analyze income inequality among countries. Gini index (GI) or coefficient takes values between 0 and 1, and reflects income distribution within a country. When GI = 0, it reflects a perfect equality, meaning that the income of a country is equally distributed among its inhabitants, and when GI = 1, it means a perfect inequality, that is only one citizen keeps all the income of the country [18].

A suggestive comparison at the global level between the indicators mentioned above between the countries with the highest GDP/capita (PPP) and the one with the lowest GDP in the year 2020 is presented in Table 1.

Table 1. Inequality in terms of average income, median income, Gini Index and % below poverty line in the countries with the highest GDP/capita (PPP) and the one with the lowest GDP in the year 2020

	GDP/capita (PPP)	Average income	Median income	Gini Index	% below poverty line
Countries with the highest GDP/capita					
Luxemburg	124,590	31,376	26.321	0.35	0
Switzerland	72,376	25,787	21,490	0.33	0
Norway	70,005	25,272	22,684	0.27	0
Australia	53,381	21,329	17,076	0.34	0
USA	65,297	25,332	19,306	0.41	0.01
Countries with the lowest GDP/capita					
Burundi	785	640	475	0.39	0.31
Central African Republic	986	891	491	0.56	0.33
Congo Democratic Republic	1,146	548	395	0.42	0.07

Source: [47].

According to Eurostat methodology used for analyzing income inequality, two forms of income are utilized:

-equivalised disposable income, which is the available income for spending or saving per household, resulting from total income less tax and other deductions. It is divided by the number of the household members converted into equalised adults by weighting each according to their age, using OECD equivalence scale. This indicator reflects the living standard of the population and it is destined to be used for calculating Gini Index which confers a more adequate comparison of income inequality among the EU member states [7].

-income quintile share ratio or the **S80/S20 ratio** which is a measure of the inequality of income distribution. It is calculated dividing the total income received by the 20 % of the population with the highest income (the top quintile) by the total income received by the 20 % of the population with the lowest income (the bottom quintile).

All incomes are compiled as equivalised disposable incomes [8].

Gini Index and the S80/S20 income quintile share ratio are used to offer more detailed information about income inequalities [9].

Literature proves that many researchers studied income inequality in order to identify causes and look for solutions destined to be helpful for policy makers in setting up new strategies aiming to improve income and diminish the disparities among the citizens of a country and among different countries.

[5] pointed out that there are many other methods which could be used for analyzing income inequality, such as: Atkinson Index, generalised entropy, coefficient of variation, Lorenz curve, Gini Index and decile ratios. [45] used Gini Index and the income share held by the top 10%, and the income share held by the bottom 10%. [22] used a large variety of procedures for analyzing income inequality in the period 2006-2008 compared to 1995 and 2000 in Romania: the interquintile and interdecile ratio [(D9-D1)/Me)], the ratio of top quintile incomes and the lower one (S80/S20), the ratio between incomes from the upper and lower deciles (S90/S10), Kuznets/Robin Hood Index, the three Éltetö-Frigyes indices, Dispersion of the logarithm of income, Gini coefficient, Theil Index, Robin Hood, and Atkinson index class. The author found that in the period 2007-2008, income increased so that the inequality declined compared to the previous period. Theil index showed income differences by inter-groups based on various characteristics of the households. The largest income gaps were given by the education level, household type in equivalent adult and also by zone: urban or rural area. Compared to urban area, in the rural areas income level is smaller due to the fact that income coming from agriculture is low, also agriculturists pensions are small, and households have more children. The persistence of subsistence agriculture and also the lack of job opportunities, the low education and training level led to a low income and increased inequality. Also, there were found inequalities among the development regions. The incomes obtained in the regions from the South, South East and South West of Romania were smaller than the incomes obtained by the households situated in the West, North West and Central Romania. Redistribution (social transfers, social contributions and taxes) had a positive impact contributing to the reduction of income inequality by 34%. Also, [38] analyzed average income and consumption expenditures per household in Romania in the interval 2007-2017 and emphasized their changes, trends and relationships.

Using Gini Index for assessing the income distribution and gaps among the countries, [17] affirmed that it is a rising concern regarding income disparities and social exclusion in the EU, due to the low growth rate recorded during the last decades. That it is why the EU launched 2020 Strategy for diminishing social exclusion and each member state adapted the national strategy in order to decrease disparities.

[23] used a multi-metric approach to identify and analyze income inequality both at macro and microeconomic level pointing out the advantages and disadvantages of each approach. A composite index was calculated to allow a deeper understanding of income inequality and to be of much help for setting up policies and strategies.[44] investigated the determining factors of inequality in G20 countries and found that labour income is the most important factor which causes inequality in all the studied countries. [19] studied the income inequality in the period 2006-2015 in the Republic of Moldova and noticed that Gini Index declined both regarding disposable income, and consumption expenditures, reflecting a reduction of inequality.

[46] affirmed that it is needed to use more precisely measures to analyze income inequality inside of a country as this aspect is connected to poverty, deprivation, depression, low education level, employment, life expectancy. In this respect, it is considered that the most commonly used measures are: "the Lorenz curve, the Gini coefficient, decile ratios, the Palma ratio, and the Theil index, methods whose benefits and thresholds are still commented. [2] used "Gini coefficient and the 10 shares to study the channels that theoretically transmit the effects of inequality to economic growth and found that "the transmission channels could led to opposite situations and the net effect is difficult to be quantified on the economic growth". Using Gini index, [4] has approached income inequality in the Republic of Moldova compared to EU countries in the period 2014-2020.

[16] found that "inequality among EU citizens, for instance, between Bulgaria and

Lithuania, bis significantly lower than among US citizens, but slightly higher than in Australia and Japan".

[20] analyzed the Gini coefficient of equivalised disposable income in the interval 2005 to 2019 in the EU-27, and found a reasonable distribution of income, not exceeding 40% in almost all the member states, except Bulgaria. They highlighted the situation especially in Italy, Spain, Germany, Slovakia, Hungary and Bulgaria.

[18] used the meta base of World Bank and described the advantages and disadvantages of using different methods for evaluation income disparities and also provided information about GDP/capita, median income, Gini index for 177 countries in the world in the year 2020.

Approaching the problem of regional disparities, which is a subject of discussions and a key aspect to be solved in front of the policy makers, [1] emphasized the existence of the low-income level in the rural areas, which are facing a large number of challenges and where agriculture is the key sector of existence, the major source of employment and income for local population.

In this context, there is still an open bow to approach and discuss the income inequality in the EU-27 emphasizing the position of each member state countries based on various indicators. First of all, GDP, as a measure of economic development and then the indicators reflecting income inequality like: median disposable income, equalized disposable income, Gini coefficient of equalized disposable income, income by quantiles, income quintile share ratio S80/S20 for disposable income. This analysis aimed to point out in what measure income inequalities have been diminished in the period 2014-2021 in the EU-27 and Euro area, and also in each member state as provided by Agenda 2030 regarding sustainable development.

MATERIALS AND METHODS

The data used in this study have been collected from Eurostat data bases for the interval 2014-2021 and also from the World Bank for the year 2020.

The main indicators used in this research have been:

-GDP per capita (PPP) in order to assess the economic development

-Specific indicators reflecting income inequality as used by Eurostat methodology, as follows: median disposable income, Gini Coefficient (GI) of equalized disposable income, income by quantiles, and income quintile share ratio S80/S20 for disposable income.

For each indicator, it was presented the dynamics in the EU-27 compared to the countries belonging to the Euro area, using graphical method and calculating the trend line and regression equations which reflect the general tendency and also R square coefficient, which shows in what measure the variation of the analyzed indicator was influenced across the time.

Also, based on the levels of these indicators in the year 2021 for each indicator mentioned above, the EU-27 member states have been grouped in classes based on the intervals established by Eurostat. In this way, it was easy to make comparisons and identify which are the countries with the high income inequality and which are the ones with a lower disparity.

In addition, for each member state, it was compared the level of each indicator in the year 2021 with its level in the year 2014, and it was established the growth or decline rate which were of much help to understand the results of the national policies destined to diminish income inequality.

Besides dynamic analysis, regression equations, R^2, growth or decline rates, classifications, comparisons, the results were synthetically shown in tables and graphics.

Finally, the main ideas resulting from this research have been joined and presented in the conclusions.

RESULTS AND DISCUSSIONS

Economic development of the EU countries

EU is one of the most important players in the world economy and it operates as a single market of which benefit all the actual 27 countries after the Brexit in 2020, when the EU reached Euro 16.4 trillion GDP. EU together with China and USA represent the largest three global players in the international trade [6].

GDP is a key measure of economic growth and economic development of a nation [24]. GDP level is influenced by consumption expenditures, investments, exports and imports. There are countries whose GDP is in a larger proportion influenced by export, and other countries where GDP is determined by consumption [28, 35]. Consumption expenditures are deeply influenced by income level per household, which differs in the urban areas compared to the rural ones [38].

All the economic branches give their contributions in different proportions to the creation of gross domestic product. Also, GDP is formed by the contribution of the development regions and its concentration differs from an area to another and from a country to another [27, 39].

GDP differs in urban areas and in the rural ones. In general, it is much higher in the urban areas where industry, constructions, trade are better developed and it is lower in the rural areas where agriculture is the main economic branch, followed by services etc. [29, 30].

Agriculture contribution to GDP differs from a country to another, but in general it has a lower share than that of other economic branches.

A high importance for increasing GDP from agriculture play fixed assets, employment, labor productivity, and farmers' training [31, 32, 33, 42].

Labor force by its education and training level and productivity and employment rate favors GDP [25, 26]. Productivity in agriculture is a result of land use [37], farm structure [34], technological level, investments, and demographic changes in the rural space (aging, migration, fertility rate, education level etc) [36, 40, 41, 43].

Gross domestic product is an indicator which allows the comparison of the economic development among the EU countries is GDP per capita in PPP. Considering EU-27 GDP/capita = 100, the countries belonging to the Euro area registered 108 in 2014 and 105 in 2021, reflecting a higher level than all the other member states.

In the year 2021, a number of nine countries exceeded the EU level, being in the decreasing order the following ones: Luxemburg (277), Ireland (220), Denmark (134), Netherlands (132), Sweden (124), Belgium (1210, Austria (120), Finland (113) and France (105). At the opposite pole, it was situated just one country, Bulgaria (55) (Table 2).

Table 2. GDP per capita (PPP) in the EU-27 in the year 2021 -EU average = 100

GDP per capita (PPP) classification according to Eurostat, 2022						**No available data**
≥ 32 to 64		≥ 75 to 89	≥ 89 to 110	≥ 110 to 131	≥ 131 to 277	
Bulgaria -55	Slovakia N.d. in 2021, but in 68 in 2020.	Czechia-91	France -105	Sweden-124	Luxemburg-277	Slovakia N.d. in 2021, but in 68 in 2020.
	Romania-73	Cyprus-88	Malta-99	Belgium-121	Ireland-220	
	Latvia-71	Lithuania-88	Italy-95	Austria-120	Denmark-134	
	Croatia-70	Estonia-87	Slovenia-90	Germany-119	Netherlands-132	
	Greece-65	Spain-84		Finland -113		
		Poland-77				
		Hungary-76				

Source: Own results based on the data from [13].

Compared to the GDP per capita level registered in the year 2014, in 2021, the countries which registered a higher GDP were the following ones for which it is presented the additional difference: +82 Ireland, +17 Romania, +8 Bulgaria, +3 Czechia, +5 Denmark, +7 Cyprus, Latvia, Hungary, Malta, Slovenia, +9 Estonia, Poland, +10 Croatia, +11 Sweden, +12 Lithuania.

Other countries registered a negative difference as follows: -12 Austria, -8 Germany, -7 Greece, -6 Spain, Luxemburg, -

3 France, Italy, Portugal, -1 Netherlands, while Belgium and Finland registered the same level in 2021 like in 2014.

Romania is situated in the group ≥ 64 to 75 occupying the 2nd position with 73 after Portugal 74.

However, this distribution of the countries according to their GDP per capita does not reflect income inequality due to the methodological aspects involved in the calculation of GDP.

In this case, other indicators have been taken into consideration.

Median disposable income

This indicator reflects the existence of income disparities within a country and among countries.

In the EU-27, the median disposable income increased from Euro 15,101 in 2014 to Euro 18,369 in 2021, meaning + 21.6%, which is a positive aspect.

In the Euro area, median disposable income is much higher than in other EU countries and it also registered an ascending trend from Euro 17,393 in 2014 to Euro 20,776 in the year 2021 (+19.4%) (Fig.1).

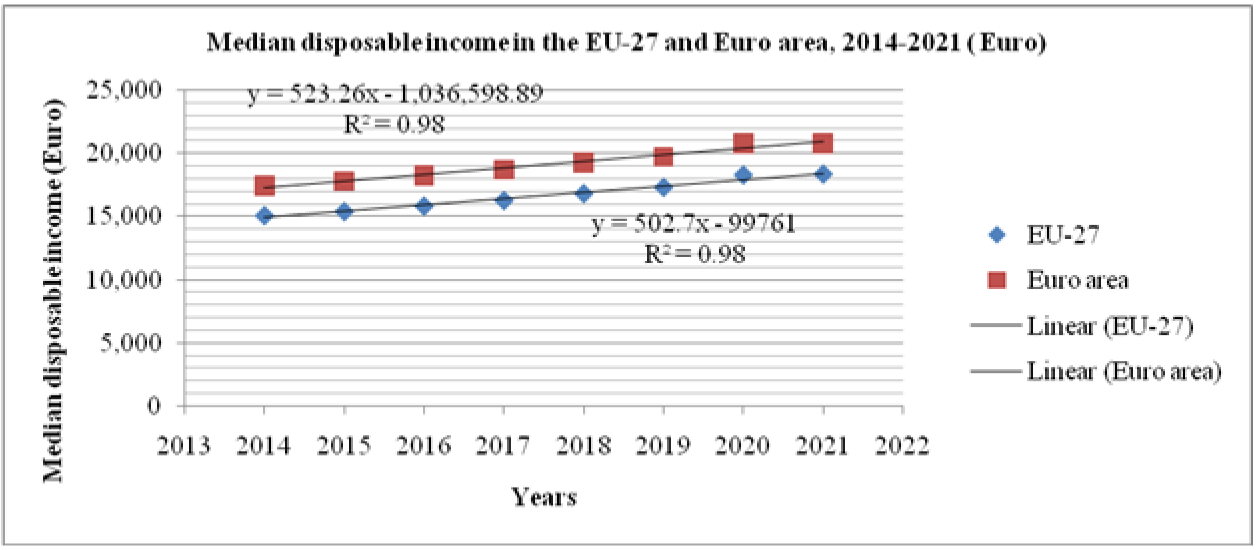

Fig.1. Dynamics of median disposable income in the EU-27 and Euro area
Source: Own design based on the data from [12].

The differences among the EU countries still exists even thou each member state has made efforts to improve income level of its citizens.

In 2021, the countries with the highest median disposable income, in the descending order, were: Luxemburg, Denmark, Netherlands, Ireland, Belgium, Sweden, Finland, Germany, therefore eight countries exceeded Euro 25,000 (Table 3).

The data from Table 3 show that, in the year 2021, the smallest median income is in Romania, accounting for Euro 4,832.

The level of this indicator also included in the income group ≥ 4,174 to 6,945 other two countries: Bulgaria and Hungary.

A number of eight countries achieved a median income between Euro 6,945 and Euro 12,808.

Estonia comes on the 1st position in this group and on the 8th position is Croatia.

Italy, Malta, Cyprus, Spain and Slovenia are included in the next group with a superior median income.

France carried out Euro 22,680 median income and stays alone in the income group ≥ 20,409 to 23,375.

In Romania, median income is the smallest in the EU-27.

However, its level increased 2.24 times in the analyzed interval from Euro 2,155 to Euro 4,832 in 2021.

Compared to the level of median income in the year 2014, in the year 2021, almost all the EU countries recorded higher levels, except Sweden, where it declined by 1.4%.

Table 3. Median disposable income in the EU in the year 2021(Euro)

≥ 4,174 to 6,945	≥ 6,945 to 12,808	≥ 12,808 to 20,409	≥ 20,409 to 23,375	≥ 23,375 to 43,775	No available data
Hungary 6,614	Estonia 12,623	Italy 17,532	France 22,680	Luxemburg 42,482	
Bulgaria 5,157	Portugal 11,089	Malta 17,036		Denmark 32,088	Slovakia N.d. in 2021, but 8,703 in 2020.
Romania 4,832	Czechia 10,625	Cyprus 16,686		Netherlands 28,441	
	Lithuania 9,669	Spain 15,892		Ireland 28,120	
	Latvia 9,437	Slovenia 15,415		Belgium 25,739	
	Greece 8,752			Sweden 25,498	
	Poland 8,295			Finland 25,456	
	Croatia 8,061			Germany 25,015	

Source: Own results based on the data from [12].

The highest growth rates were recorded in: Romania +124.4%, Lithuania +100.4%, Lavia + 91.3%, Estonia +74.9%, Bulgaria +55.7%, Poland +55.4%, Croatia +54.2%, Hungary + 46.5%.

About 20% of the EU population with the highest disposable income represents about 33% of the total income, except Slovakia, while 20% of the population with the lowest income accounts for less than 10% of the total income, except Czechia, Slovakia and Slovenia [10].

The increased income was favored by social transfers which diminished the inequalities. It is about: pensions, unemployment aids, sickness and invalidity benefits, housing allowances, social assistance and tax reductions and exemptions. [10].

Gini Coefficient (GI) of equalized disposable income

This indicator reflects the degree of inequality and its decreasing trend in the analyzed period from GI =30.9 in 2014 to GI = 30.1 in the year 2021, which means a reduction by -0.8, reflecting the diminishing of disparities.

In the Euro area, GI declined by -1.5 from GI= 31 in 2014 to GI = 30.5 in 2021, showing a more intensive reduction of inequality (Fig. 2).

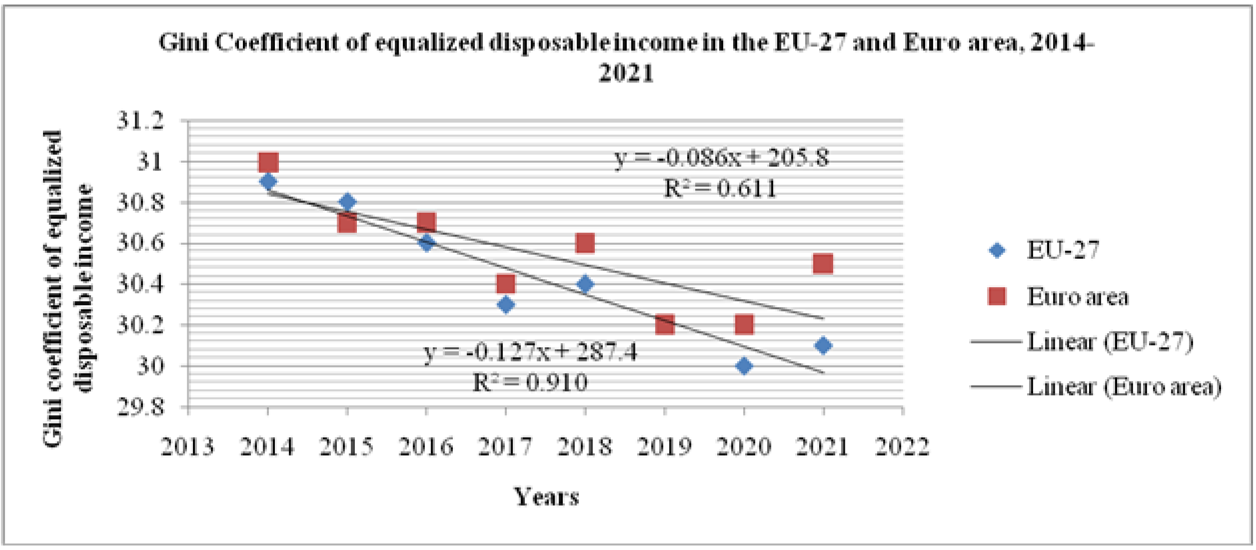

Fig. 2. Gini coefficient of equalized disposable income in the EU-27 and Euro area
Source: Own design based on the data from [14].

It is known that a closer GI to 0 reflect a reduction in income inequality and distribution, while a closer GI to 1 shows a higher inequality. Having this in our mind, we may easily interpret the data from Table 4 that Slovenia, Belgium and Czechia have a lower income inequality, while Lithuania and Latvia are the countries with the highest income disparity. Romania is included in the second group of countries having GI= 34.3, by -0.7 smaller than GI =35 in 2014.

In the year 2021, in the following countries, Gini index was higher than in 2014: Malta (+3.5), Luxemburg (+0.9), Italy (+0.5), Lithuania (+0.4), Germany (+0.2), Latvia (+0.2), Netherlands 9+0.2), France (+0.1).

Table 4. Gini coefficient of equalized disposable income in the EU-27 in the year 2021

≥ 22.7 to 26.03	**≥ 26.03 to 28**	**≥ 28 to 30.7**	**≥ 30.7 to 34.5**	**≥ 34.5 to 35.27**	**No available data**
Slovenia 23	Netherlands 26.4	Croatia 29.2	Malta 31.2	Lithuania 35.4	
Belgium 23.9	Austria 26.7	France 29.3	Greece 32.4	Latvia 35.7	Slovakia N.d. in 2021, but 20.9 in 2020.
Czechia 24.8	Poland 26.8	Cyprus 29.4	Italy 32.9		
	Sweden 26.8	Luxemburg 29.6	Spain 33		
	Ireland 26.9	Estonia 30.6	Portugal 33		
	Denmark 27	Germany 30.9	Romania 34.3		
	Hungary 27.7				
	Croatia 8,061				

Source: Own results based on the data from [14].

On the opposite side, there are other countries where GI value declined as follows: Czechia (-10.6), Cyprus (-5.4), Estonia (-5), Sweden (-5), Poland (-4), Ireland (-4.1), Greece (-2.1), Belgium (-2), Slovenia (-2), Spain (-1.7), Portugal (-1.5), Croatia (-1), Hungary (-0.9), Austria (-0.9), Romania (-0.7), Denmark (-0.6), reflecting an improvement of equalized disposable income and reduction of inequalities. Social transfers gave their contribution to the results mentioned above regarding Gini coefficient.

Distribution of income by quantiles

At the EU-27 level, income by quantiles increased in the period 2014-2021 by Euro +2,089 from Euro 10.701 in 2014 to Euro 12,790 in 2021, meaning (+19.52%).

In the Euro area, the level of this indicator also has grown from Euro 12,303 in 2014 to Euro 14,622 in 2021 (+18.81%) (Fig. 3).

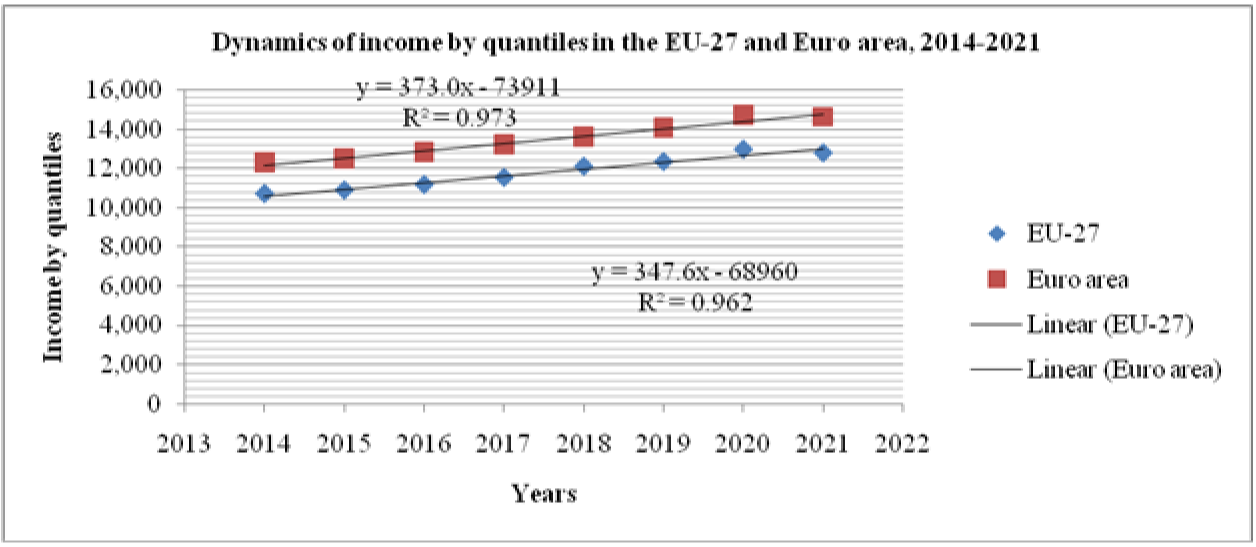

Fig. 3. Dynamics of income by quantiles in the EU-27 and Euro area
Source: Own design based on the data from [11].

The position of the member states according to Eurostat income group classification is presented in Table 5.

Table 5. Distribution of income by quantiles in the EU-27 in the year 2021 (Euro)

≥ 3,027 to 5,910	≥ 5,910 to 7,852	≥ 7,852 to 11,780	≥ 11,780 to 17,376	≥ 17,376 to 20,039	≥ 20,039 to 28,610	No available data
Latvia 5,902	Portugal 7,627	Slovenia 11,776	France 16, 467	Finland 19,010	Luxemburg 28,610	
Croatia 5,483	Lithuania 6,357	Spain 10,291	Cyprus 12,071	Belgium 18,607	Denmark 24,021	Slovakia N.d. in 2021, but 6,719 in 2020.
Hungary 4,765	Poland 6,057	Czechia 8,344	Malta 12,034	Sweden 18,132	Ireland 20,400	
Bulgaria 3,280	Greece 5,947	Estonia 8,302	Italy 11,784	Germany 17,830	Austria 20,326	
Romania 3,027					Netherlands 20,245	

Source: Own results based on the data from [11].

The countries with the highest income by quantiles are, in the decreasing order: Luxemburg, Ireland, Austria and Netherlands.
At the opposite pole, there are the countries with the lowest income by quantiles, which in the descending order are: Latvia, Croatia, Hungary, Bulgaria and on the last position Romania with the smallest income accounting for Euro 3,027, 9.45 times smaller than in Luxemburg.
In almost all the EU countries, in the period 2014-2021, income level by quantiles increased in various proportions. The highest growth rate was noticed in: Romania +135.5%, Lithuania +94.8%, Estonia +79.4%, Latvia +76.3%, Poland 61.5%, Croatia +55.8%, Bulgaria +51.6%, Hungary +45.8% and Ireland +43.5%.
The smallest increase was: +6.1% in France, +10.5% in Italy and +10.1% in Finland.
The only country were income by quantiles declined is Sweden which registered -2.1% in 2021 versus 2014.
Income quintile share ratio S80/S20 for disposable income
This indicator registered a decline in the EU-27 from 5.20 in 2014 to 4.97 in 2021 (-0.23). A similar decreasing tendency was recorded in the Euro area from 5.23 in 2014 to 5.02 in 2021 (-0.21) (Fig. 4).

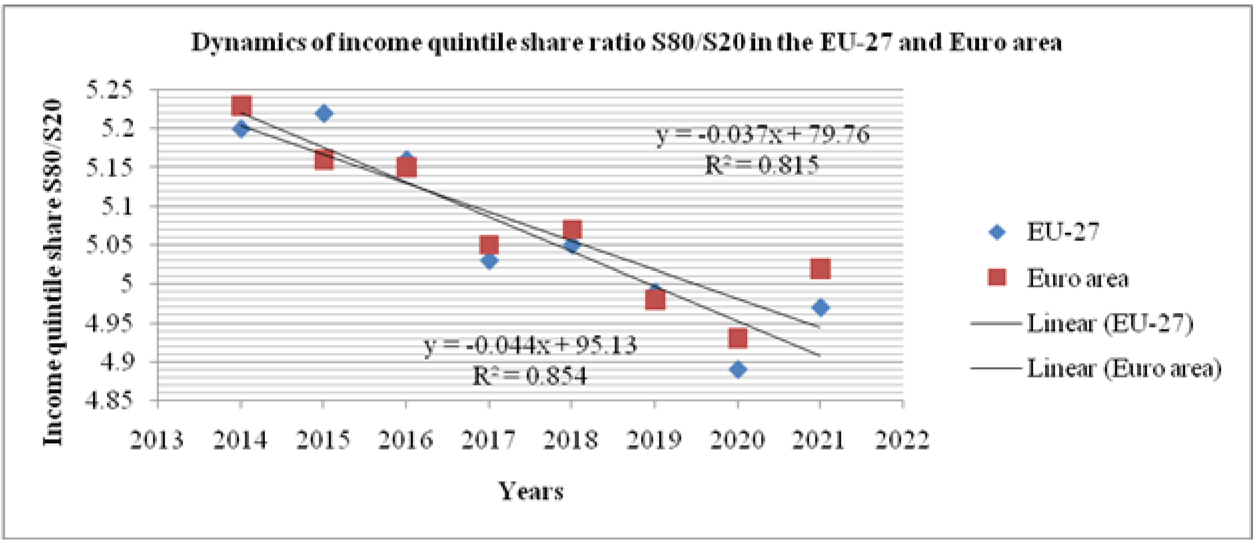

Fig. 4. Dynamics of income quintile share ratio S80/S20 in the EU 27 and Euro area
Source: Own design based the data from [15].

By member state, the situation is presented in Table 6. In the analyzed interval 2014-2021, income quintile ratio S80/S20 increased in France (+0.15), Italy (+0.08), Latvia (+0.15), Luxemburg (+0.17), Malta (+0.98), Netherlands (+0.05) and declined in all the other countries: Belgium (-0.40), Czechia (-0.07), Denmark (-0.19), Germany (-0.24), Estonia (-1.45), Ireland (-1.07), Greece (-0.67), Spain (-0.62), Croatia (-0.34), Cyprus (-1.14), Hungary (-0.14), Austria (-0.05), Poland (-0.89), Portugal (-0.57), Romania (-0.11), Slovenia (-0.46), Slovakia (-0.90), Finland (-0.04) and Sweden (-0.11).

Table 6. Income quintile share ration in the EU-27 in the year 2021

≥ 3.24 to 3.84	**≥ 3.84 to 4.05**	**≥ 4.05 to 4.51**	**≥ 4.51 to 5.03**	**≥ 5.03 to 6.09**	**≥ 6.09 to 7.45**
Ireland 3.83	Sweden 4.04	France 4.42	Estonia 5.03	Spain 6.19	Romania 7.13
Finland 3.58	Poland 4.02	Cyprus 4.23	Malta 5.03	Italy 5.86	Latvia 6.63
Czechia 3.43	Denmark 3.93	Hungary 4.19	Germany 4.88	Greece 5.79	Lithuania 6.14
Bulgaria 3.41	Netherlands 3.88	Austria 4.08	Croatia 4.78	Portugal 5.66	
Slovenia 3.24			Luxemburg 4.59		
Slovakia 3.03					

Source: Own results based on the data from [15].

CONCLUSIONS

Despite that EU-27 is an important economic power area in the world, income inequality still persists.

But in the analyzed period in most member states it was noticed a reduction of disparities, explained by the measures taken by each country authorities to improve income of the citizens and also due to the social transfers under various forms.

In the Euro area, income level is higher than in EU-27 and income disparities are smaller.

In 2021, in the EU-27, the median disposable income accounted for Euro 18,369 being by +21.6% higher than in 2014. In the Euro area, it is higher than in the other EU countries and accounted for Euro 20,776 exceeding the level of 2014 by +19.4%.

The highest median disposable income exceeds Euro 25,000 in Luxemburg, Denmark, Netherlands, Ireland, Belgium, Sweden, Finland and Germany, while the lowest level is in Romania Euro 4,832.

In 2021, Gini coefficient of equalized disposable income was 30.1 (-0.8) in the EU-27 and 30.5 (-0.5) in the Euro area, showing a slight decline of income inequality. While Lithuania and Latvia are the countries with the highest income disparity, Slovenia, Belgium and Czechia have a lower income inequality.

In the same year, in the EU-27, income by quantiles reached Euro 12,790, being by +19.52%, than in 2014, while in the Euro area it accounted for Euro 14,622 (+18.81%). Luxemburg, Ireland, Austria and Netherlands have the highest income by quantiles, while Latvia, Croatia, Hungary, Bulgaria and Romania have the lowest level.

Income quintile share ratio S80/S20 for disposable income, in 2021 reached 4.97 in the EU-27 and 5.02 in the Euro area, but in the both cases is has registered a slight decline.

Income quintile ratio S80/S20 increased in France, Italy, Latvia, Luxemburg, Malta, Netherlands and declined in all the other countries.

The income inequality analysis is still in the attention of researchers and policy makers who are looking to improve income policy and strategies to increase the living standard of the population.

As provided by the 2030 Agenda and its Sustainable Development Goal 10, the inequalities within and among the EU countries have to be reduced not only regarding income level, but also concerning other aspects such as those related to age, race, disability, sex, origin, religion, economic status etc. And this is a key goal which has to ensure the sustainable development of all the member states.

The allocation of the expenditures and social protection have to remain in the attention of each country and also the demographic aspects and have not to be denied.

For this purpose, important funds have to be allotted which have to be efficiently used to reduce inequalities, assure social inclusion of all and continue the policy of sustainable development.

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TRENDS IN AVERAGE ANNUAL FOOD CONSUMPTION PER INHABITANT IN ROMANIA

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Abstract

The paper aimed to analyze the dynamics and trends in average annual food consumption of the population in Romania based on the empirical data provided by National Institute of Statistics for the period 2014-2020. Fixed basis index, growth rate, regression equation, coefficient of determination, graphical method and comparisons were the main procedures used to process. Cereals consumption declined by 1.26%, accounting for 204.4 kg/capita in 2020 and wheat and rye have the highest share in consumption. In the studied interval, vegetable consumption increased by +6.28%, accounting for 194.4 kg in 2020. Consumption decreased for potatoes (-7.4%) and cabbage, while for onion remained the same. Tomatoes reached 42.1 kg (+10.5%) and keep the top position among vegetables. Fruits consumption increased by +34.1%, reaching 107.6 kg in 2020. The consumption increase for (+15.5%), plums (+68%), grapes (+27.4%), peaches (+12.1%), melons (+5.5%), and nuts, while for cherries remained relatively constant and for apricots declined. Romanians consume 39.5 kg Mediterranean and exotic fruits by + 53.6% more, exceeding the apple consumption. Sugar consumption increased 25.5 kg in 2020 (+20.8%), while egg consumption decreased to 236 pieces (-4.1%. Milk and dairy products consumption increased 252.6 litres in 2020 (+3.4%). Oil consumption increased to 18.3 kg with 85.2% share in vegetal fats. Butter consumption account for 3.5 kg/capita. Meat consumption is by +27% higher in 2020, accounting for 77.4 kg/capita. Pork keeps its top position with 38.3 kg (+28.6%), being followed by poultry meat 28 kg (+39.3%). Pork keeps 48.1% and poultry meat 36.1% in meat consumption and together accounting for 84.2%. Fish consumption reached 6.3 kg (+38.5, while honey attained 0.8 kg. Income and price are the main factors influencing buying decision and consumption in Romania, besides product quality, landmark and fidelity, life style and desire to a healthier diet. Consumption plays an important role in GDP creation, and that is why the authorities have to increase salaries and pensions, income per household in a word and to establish thresholds among which prices could vary to stimulate consumption.

Key words: *average annual food consumption per inhabitant, trends, features, factors of influence, Romania*

INTRODUCTION

The population dynamics changes the current production and consumption patterns to achieve a more sustainable development model [72].

In this context, food security is one of the major challenges of mankind because it is needed to produce for the entire population [3].

Only in this way, economic development, growth and stability, a low unemployment rate, a higher productivity, trade intensification, poverty reduction and health improvement could be attained [60].

Food consumption is linked to purchasing power, in close relationship with disposable income, inflation rate, price levels of food products. Taking into consideration the inequalities of income distribution and between urban and rural areas, the high pressure on the family budget, human consumption varies between different categories of consumers. Therefore, income level per household is one of the major economic factors which influence consumer decision to buy [2].

Besides this, other factors like education, cultural level, lifestyle, and other psychological aspects could influence purchasing behaviour. Consumers with higher income are more oriented to buy products of high quality and with a high price, while the ones with a lower income per household are obliged to choose food products of lower nutritional value being marketed at a lower price.

Therefore income and price are the main factors influencing buying decision, but consumers also take into account other choosing criteria like: aspect, taste, durability, nutritive and energetic value, satisfaction degree after consumption, choice of the purchase place, landmark, brand loyalty. A comprehensive understanding of consumer consumption and purchasing behaviour should substantiate an efficient marketing strategy [16].

An interesting validation of Engel's law on the connection between household income and food expenditure is proved by the decline in real income [17, 32].

Romania has a high agricultural potential to increase production to cover better the population consumption. However, in the period 2007-2013, the analysis regarding food consumption per capita reflected that it is either insufficient for a category of agri-food products (fruits, vegetables, milk and dairy products) or quantitatively sufficient for other groups of products (cereals and oilseeds). In this case the surplus is destined to export and the deficit of the internal market requests to be covered by imports [3].

Agricultural and food industry are called to produce more products and of higher quality to cover the demand, and food supply to correspond as volume, diversity, quality and sufficiency.

As a country cannot produce all sorts of agro-food products, imports are needed to complete domestic production for covering consumers' requirements [60].

An analysis on agro-food products consumption in Romania in the period 2015-2020 proved that consumers have become more oriented to a healthier diet, as consumption of fruits, vegetables, meat and fish increased, while the consumption of potatoes, cereals, sugar and eggs declined [60].

During the COVID-19 pandemic, a new problem has been raised regarding the transfer of agri-food products from the place of production to the final consumer. The movement restrains imposed to the population by authorities proved the necessity to emphasize the role of short food supply chains, which are the most preferred solutions both by consumers and producers [70].

Food wastes are a big problem along the product chain from farm to fork. New challenges are in front of the research, practitioners, organizations and authorities for preventing and reducing food waste, and a large range of models and good practices are recommended (digital technology, projects and platforms, volunteering, food banks, mobile applications, social innovation, corporate social entrepreneurship, education, and public awareness [69].

In Romania, the growth of the average monthly income per household had a positive influence on the average monthly expenditure, but there are still differences between the residence areas (urban and rural). Taking into account the difference of income level between Romania and all the other EU countries, consumption in Romania accounts for 71 % of total expenditure, compared to a much lower percentage in the high developed countries. Regarding the expenditures on agro-food products, it was noticed that, in the urban area, they exceed the national average, while in the rural area they represent 96.7 % of the country average [61].

For having a healthy population, Romania has proposed to develop a sustainable agriculture and to improve life quality and the living standard and at the same time to make the population more conscious of the importance of healthy nutrition. Aligned to the EU Green Deal, Romania has proposed to pay more attention to organic agriculture to strike a balance between the three areas of agricultural sustainability: environmental, economic and social. Despite that, organic products have appeared in the domestic market of Romania, but a few studies have been done on organic farming and consumption of organic products. However, it is expected that the consumption of organic products to ensure environment protection and at the same time to support family farming and the local economy [8].

Ecological system is planned to be applied on more than 25% of the EU agriculture by 2030. In this way, the synergy between European Green Pact, Biodiversity Conservation Strategy and Fork Farm Strategy is expected to be ensured [10].

A study on consumer behaviour related to ECO products, marketed in Romania-Bulgaria cross border, pointed out that it is needed to better clarify and educate the population regarding the notions of ecological, bio, organic and natural product, as between the peoples' thinking on these products is different than the reality [18, 19].

In this context, the purpose of the paper was to examine the dynamics of food consumption in Romania in terms of average annual consumption per inhabitant in the period 2014-2020 for which available data are provided by National Institute of Statistics. The study includes the description of the evolution and structure of various categories of food products, emphasizing the trends in the studied interval as a reflection of the changes in consumer behaviour.

Taking into account the insufficient literature and data regarding the consumption of organic products in Romania, this aspect has not been approached and treated in this study.

MATERIALS AND METHODS

The research paper is based on a large literature which has been carefully studied regarding food consumption and also on the empirical data provided by National Institute of Statistics for the period 2014 -2020.

The average annual food consumption was studied by the main categories of products as follows:

- cereals and products made of cereals (wheat, rye, maize, other cereals, rice) in terms of cereals equivalent in grains;
-potatoes;
-vegetables, including a selection of the main consumed vegetables such as: tomatoes, cabbage, onion, roots (carrots, celery, parsnip, parsley, etc), in terms of fresh vegetables equivalent;
-melons;
-fruit, including: apples, grapes, plums, cherries, peaches and nectarines, pears, apricots, nuts and Mediterranean and exotic fruits, with the highest share in consumption;
- sugar and products made of sugar;
- fats of vegetal origin (oil and margarine) and of animal origin (butter and lard);
-meat and meat preparations, including: pork, poultry meat, bovine meat, sheep and goat meat, other sorts, edible organs), in terms of fresh meat equivalent;
-fish.

The main procedures used to process the statistical data have been: fixed basis index, growth rate in 2020 versus 2014, regression equation, coefficient of determination, graphical method and comparison method.

The results are illustrated in graphics and conclusions emphasize the main ideas resulting from this research.

RESULTS AND DISCUSSIONS

Cereal consumption

Cereals, especially wheat, rye, maize, oats, barley and rice represents an important raw material for food industry.

The flours made of wheat, rye, barley, oats grains are utilized in the milling and bakery industry for producing various sorts of bread and specialties (croissants, buns, bagels, pasta, biscuits etc) [63].

Maize flour is utilized for producing "polenta", frequently used in Romania but also under other names and means of preparation in other 16 countries in the world (Italy, Switzerland, Slovenia, Croatia, North Macedonia, Turkey, Canada, Mexico, USA, Ghana, Kenya, Zambia, Nigeria, South Africa, Zimbabwe, Sri Lanka). In Romania, polenta or "mamaliga" in Romanian, usually accompanies other dishes like: polenta with fresh cheese and sour cream, like garnish for "sarmale" another traditional dish (cabbage leaves rolled and filled with chopped pork meat, rice, onion, pepper), for "tochitura"(minced pork and slices of sausages), for "ciulama" (scumbag made of poultry meat or mushrooms), also for dishes made of fish (carp brine, fried fish), and for mutton pastrami. In Romania, rice is used like an ingredient in soups and borsch, and also in dishes like pilaf or garnish to other basic dishes and rice and milk which is an well known dessert. Rice has many types: brown, white, red and black which are consumed being rich in phosphorus, potassium, magnesium and B1 vitamin [9]. The average annual cereal consumption per inhabitant in grains equivalent decreased by 1.26% from 207 kg/year in 2014 to 204.4 kg in the year 2020. This decline is justified by the consumer awareness about the fact that flour products could increase body weight and the modern consumer has become more interested in a healthy diet. However, cereals cannot be entirely eliminated from the daily diet being necessary for their content in fibres. Cereal consumption was studied by many authors in Romania but in various period of time pointing the specific trends [30]. Average annual wheat and rye grain consumption registered variations from 160 kg in the year 2014 to 163.2 kg in 2017, but then, it declined to 160.5 kg in the year 2020, meaning by +0.3% more than in 2014. Similar results were found [22]. Maize grains consumption recorded a significant decrease from 42 kg in 2014 to 38.8 kg in 2020 (-7.7%). Similar results were found by [29]. Rice consumption varied between 4.4 kg in 2014, then to 5.2 kg in 2015, and after this year it declined to 4.1 kg in 2018, and again, it started raising to 4.6 kg in 2020 (+4.5% compared to 2014 level). Analyzing rice balance sheet, it was found an increased rice consumption in Romania by [20]. Other cereals are more and more consumed, the average amount of grains increasing from 0.2 kg in 2014 to 0.5 kg in 2020, meaning + 150% . Figure 1 reflects the dynamics of the average annual consumption of cereals, and also for wheat and rye, and maize grains.

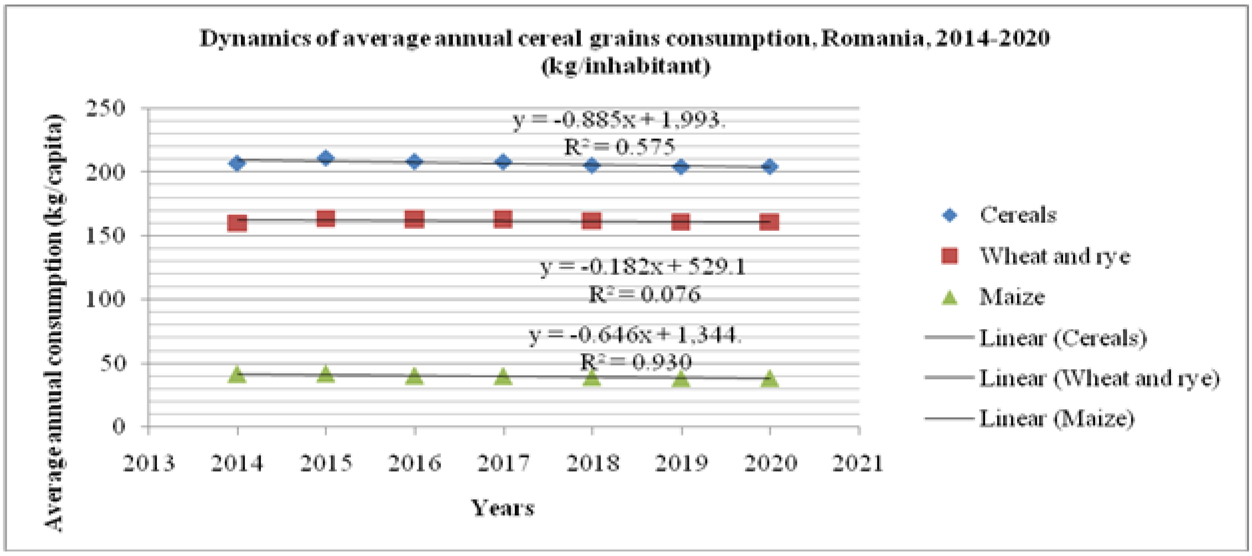

Fig. 1. Dynamics of the average annual consumption of cereals grains, of which: wheat and rye, and maize grains, in equivalent cereal grains, 2014-2020 (kg/inhabitant/year)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23,24, 25, 26, 27, 28].

Analyzing the structure of cereal consumption, we may notice that the highest share belongs to wheat and rye, 77.3% in 2014 and 78.5% in 2020, meaning +1.2 pp, followed by maize with 202.2% in 2014 and 18.9% in 2020 (-1.3 pp).

Rice has a relatively small share, but with an increasing trend from 2.1% in 2014 to 2.25% in 2020 (+0.15 pp), and other cereals have the smallest weight, but with an ascending tendency from 0.2% in 2014 to 0.5% in 2020.

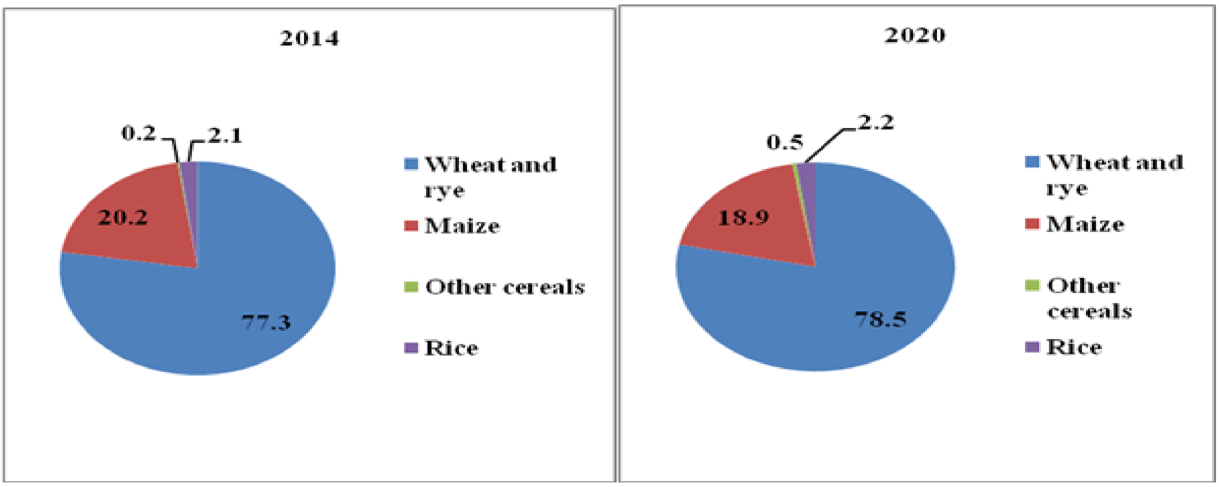

Fig. 2. The share of various cereals in average annual consumption in the year 2020 versus 2014 (%)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

This structure reflects the importance of wheat and rye, and also of maize, which are the basic grains consumed in Romania.

Wheat and rye grains are the main raw material for producing bread and specialties. The average monthly bread consumption in Romania accounted for 7.38 kg/inhabitant in the year 2021, being by -20% smaller than in 2008. In 2020, the annual consumption accounted for 88.57 kg/capita compared to 91.19 kg in the year 2020 [1].

Cereal production in Romania is enough to cover consumption needs and even to assure amounts for export [40, 58].

Potatoes consumption

Potatoes are a basic food for the population, being considered a vegetable, used in general like: boiled potatoes, mashed potatoes, fries, crisps, flakes or as an ingredient in soups, borsch, dishes. Also, potatoes are considered a healthy food being recommended to the people having: diabetes, heart disease, high blood pressure, indigestion etc.

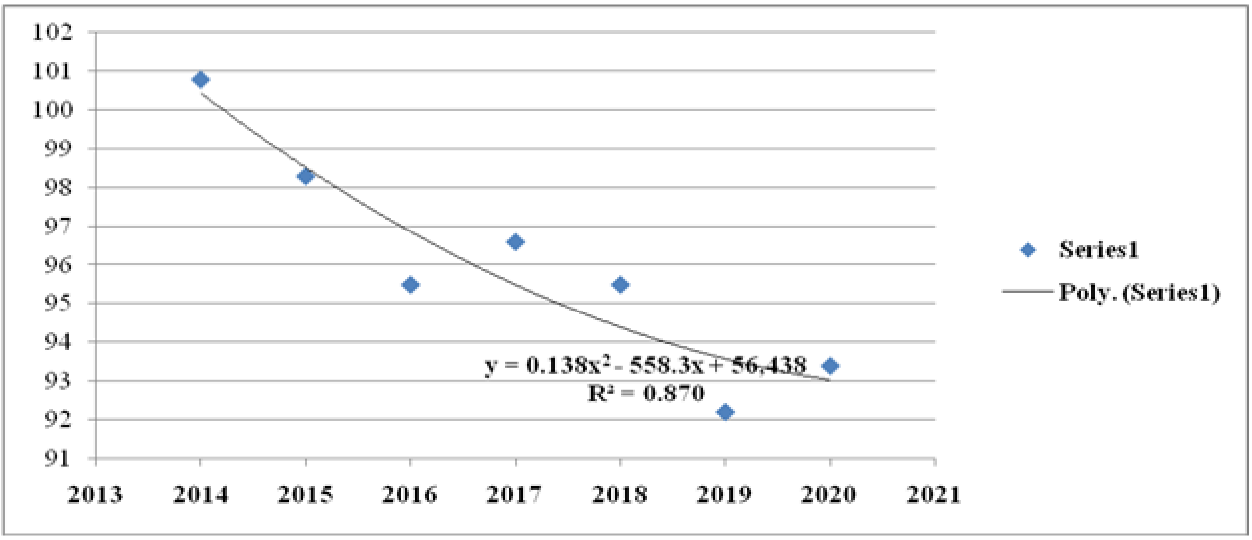

Fig. 3. Dynamics of average annual potato consumption, Romania, 2014-2020 (kg/capita)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

Potatoes consumption declined in Romania by -7.4% from 100.8 kg/capita in 2014 to 93.4 kg in 2022, as a result of the higher price on the internal market, caused by the imbalanced ratio between the high demand and low production. The climate change and the increased prices for farm inputs during the last years determined the reduction of production and for covering market needs, imports were needed [35, 36, 66] (Figure 3).

Vegetable consumption

Vegetables are an important item in the daily diet taking into account their high content in vitamins and minerals. For this reason, they are recommended to be used fresh in various salads and vegetable juices, and also processed in various dishes like: soups, borsches, vegetable mix, garnishes, pickles, and also like canned vegetables.

Romania has a high potential to produce a large range of vegetables: lettuce, tomatoes, cucumbers, green peppers, onion, garlic, roots (carrots, celery, parsnip, parsley), mushrooms, cabbage, cauliflower, pumpkins, beans, peas etc. The internal production is not sufficient at present, despite that it is achieved both in the field and the protected areas, and imports are required mainly in extra season [42].

The average annual vegetable consumption per capita increased in the studied period by + 6.28% from 182.9 kg in 2014 to 194.4 kg in 2020 (Fig. 4).

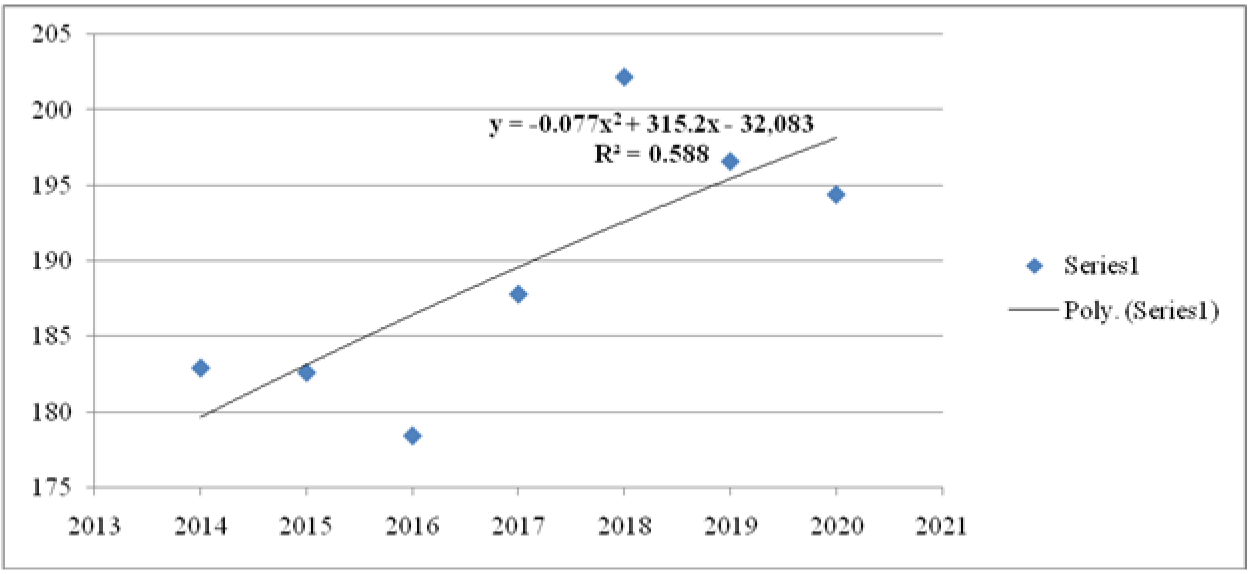

Fig. 4. Dynamics of average annual vegetables consumption, Romania, 2014-2020 (kg/capita)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The maximum consumption was recorded in the year 2018 and accounted for 202.8 kg/capita, but then, it declined year by year due to the increased price for various vegetables [51].

Regarding the evolution of the vegetables consumption in the analyzed interval, we may notice that from 2014 to 2020 the tendency was as follows:

- consumption of tomatoes increased by +10.5% from 38.1 kg to 42.1 kg; similar trends were found by [21, 67].

-cabbage consumption declined by -1.2% from 44.1 kg to 43.6 kg;

-onion consumption remained relatively the same about 20.6 kg, despite that in 2019 it reached a peak of 22.8 kg;

- roots consumption increased by + 2.9% from 13.6 kg to 14 kg;

-consumption of green peppers also increased, but by +8.3% from 12.1 kg to 13.1 kg (Figure 5).

In the vegetable consumption, the share of each vegetable differs from a category to another and also in 2020 compared to 2014 (Figure 6).

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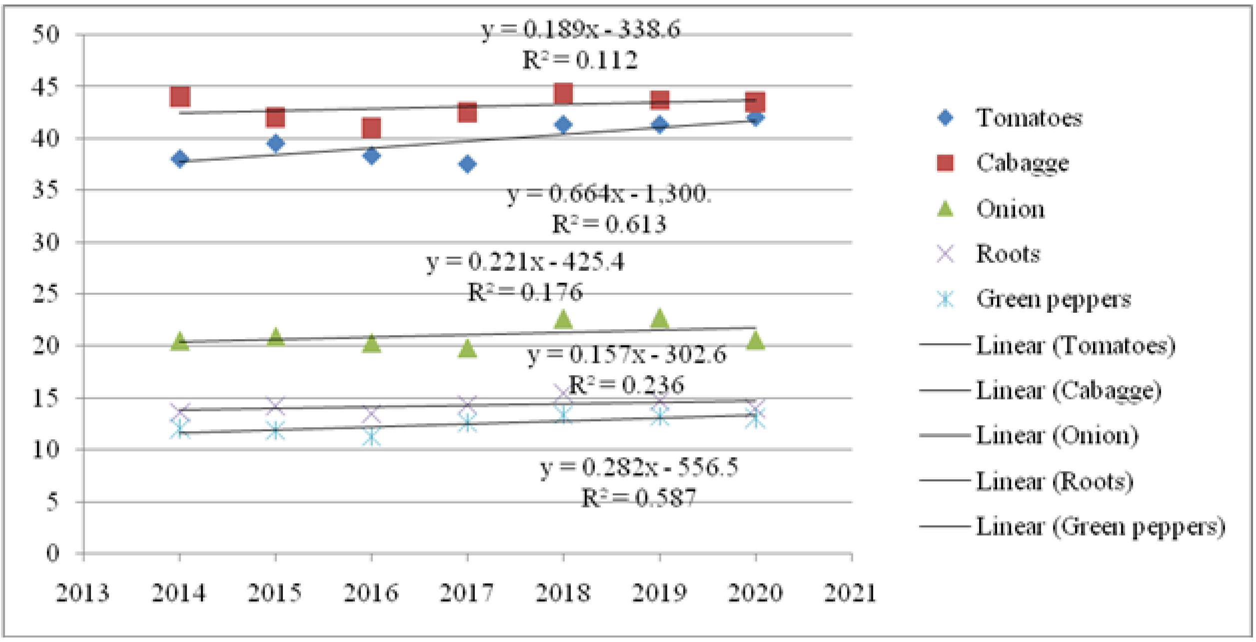

Fig. 5. Dynamics of average annual vegetables consumption by main categories, Romania, 2014-2020 (kg/capita)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

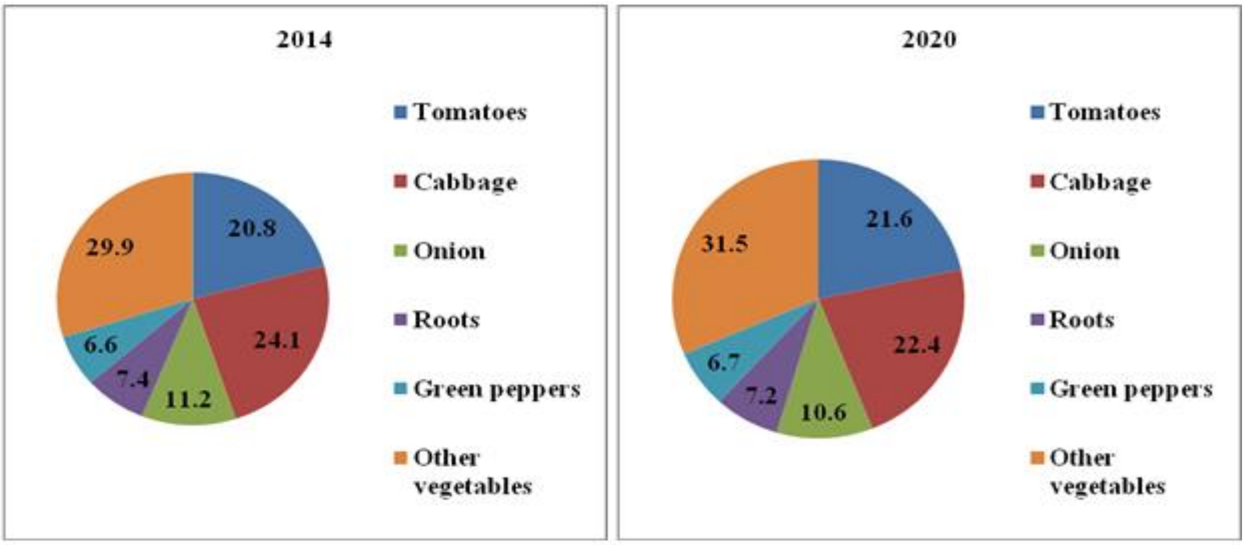

Fig. 6. The share of various vegetables in average annual consumption in the year 2020 versus 2014 (%)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The data from Fig. 6 shows that, compared to 2014, in the year 2020, the share of tomatoes increased in consumption by +0.8 pp, for green peppers by +0.1 pp and for other vegetables by +1.6 pp, while for the other vegetables their weight diminished as follows: cabbage by -1.7 pp., onion by -0.6 pp and roots by -0.2 pp.

Melon consumption

Melons could be considered fruits, but also vegetables being preferred by consumers especially during summer season when Romanian melons appear in the market, but also in a few measure in extra season when imports try to diversify the fruit offer.

The Romanian producers passed to the use of early and extra early cultivars and to the implementation of modern technologies producing melons in protected spaces besides the field cultivation so that the melons to be sold in the market at the end of June and beginning of July.

In extra season, Greece, Turkey and Spain are the main suppliers of melons on the Romanian market [38, 39]. Grace to their sweet taste, pleasant flavour and succulence, melon consumption increased from 21.8 kg/year and capita in the year 2014 to 23 kg in 2020 (+5.5%) (Figure 7).

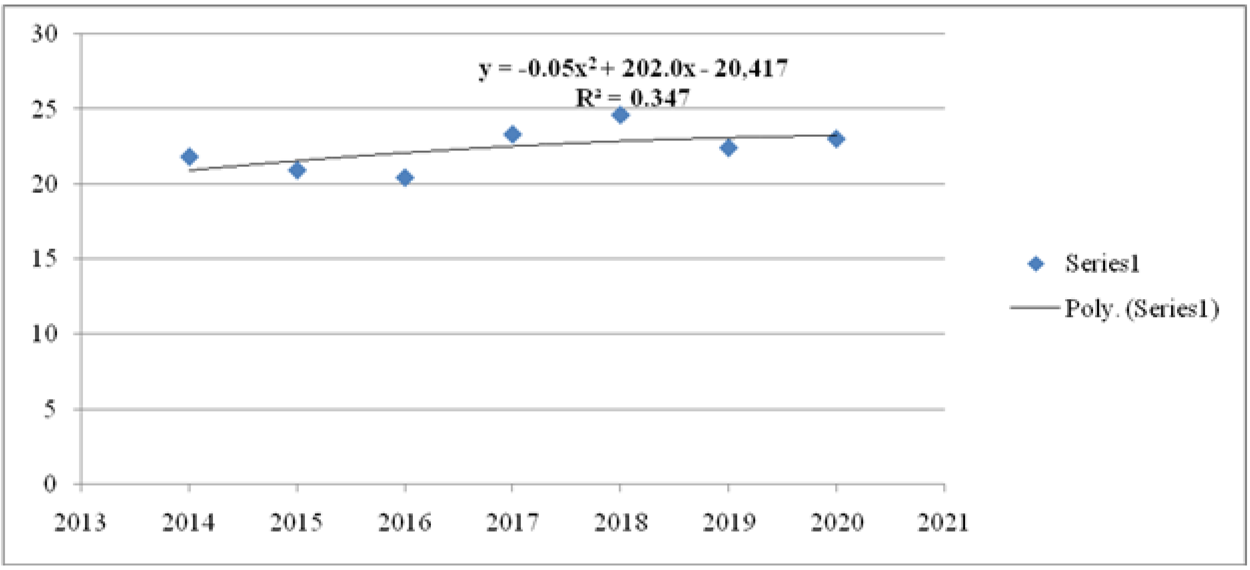

Fig. 7. Dynamics of average annual melon consumption, Romania, 2014-2020 (kg/capita)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

Fruits consumption in fresh fruit equivalent

Fruits are very important for human diet due to their intake in fructose and vitamins from which the body absolutely needs. Fruits are recommended to be consumed fresh, in the morning on an empty stomach, before breakfast, but also between meals.

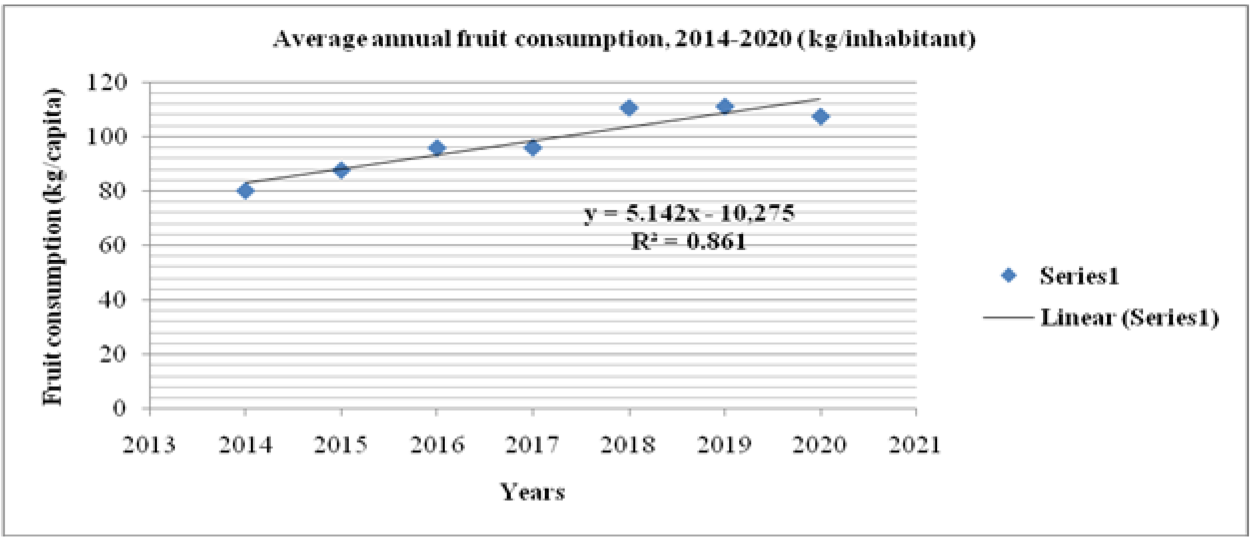

Fig. 8. Dynamics of average annual fruit consumption, Romania, 2014-2020 (kg/capita)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The daily fruit recommended consumption is 350-400 grams and should include different sorts of fruits. It is preferred to be consumed as fresh fruits, but they also could be used as fresh fruit juices, liqueur, brandy, jams, compote and canned fruit [50].

Average annual fruit consumption in Romania increased by +34.1% in the studied period from 80.2 kg in 2014 to 107.6 kg in 2020, but in 2019 it was recorded the peak of 111.3 kg/inhabitant (Figure 8).

Romania produces a large range of fruits: apples, plums, cherries, apricots, peaches, nectarines, pears, nuts, but production is not sufficient, and that is why the needs of the internal market are covered by imports which also diversify the offer bringing Mediterranean and exotic fruits like oranges, lemons, pineapple, bananas, kiwi, kaki, papaya, pomegranates, dates etc. [50, 55].

In the analyzed interval 2014 to 2020, fruit dynamics was as follows:

- apple consumption increased by +15.5% from 25.2 kg to 29.1 kg, but the highest performance was 34.5 kg in 2019 [55, 68].

-grapes consumption also increased but by +27.4% from 6.2 kg to 7.9 kg;

-plums consumption increased by +68% from 4.7 kg to 7.9 kg because this sort of fruits is consumed not only like fresh fruit, but also like jam and raw material for producing plum brandy called "tuica" in Romanian.

-cherry consumption remained relatively at the same level of about 4-4.1 kg/capita, the peak being registered in the year 2018 when it accounted for 4.8 kg/capita;

-peaches and nectarines consumption increased by +12.1% from 4.1 kg to 4.6 kg;

-pear consumption also increased by +11.1% from 4.5 kg to 5 kg;

-apricots consumption declined by -9.1% from 2.2 kg to 2 kg, due to the diminished production and the high price of imported apricots coming mainly from Turkey;

-nuts consumption increased 3.87 times from 0.8 kg top 3.1 kg;

-Mediterranean and exotic fruits were consumed in a higher proportion, + 53.6%, as the offer is attractive; therefore, from 25.7 kg to 39.5 kg per inhabitant (Figure 9).

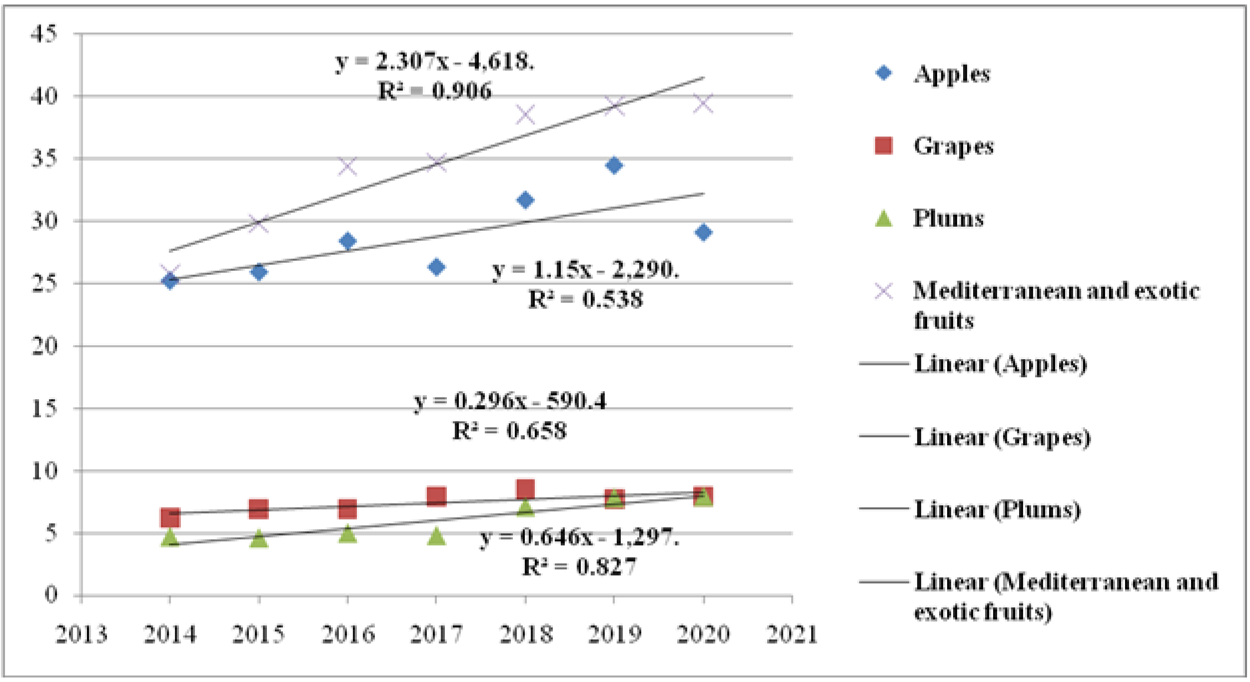

Fig. 9. Dynamics of average annual consumption for apples, grapes, plums and Mediterranean and exotic fruits, 2014-2020 (kg/inhabitant)

Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The share of different types of fruits in average annual consumption has changed depending on consumers' preferences and price evolution. Figure 10 reflects these changes in 2020 versus 2014.

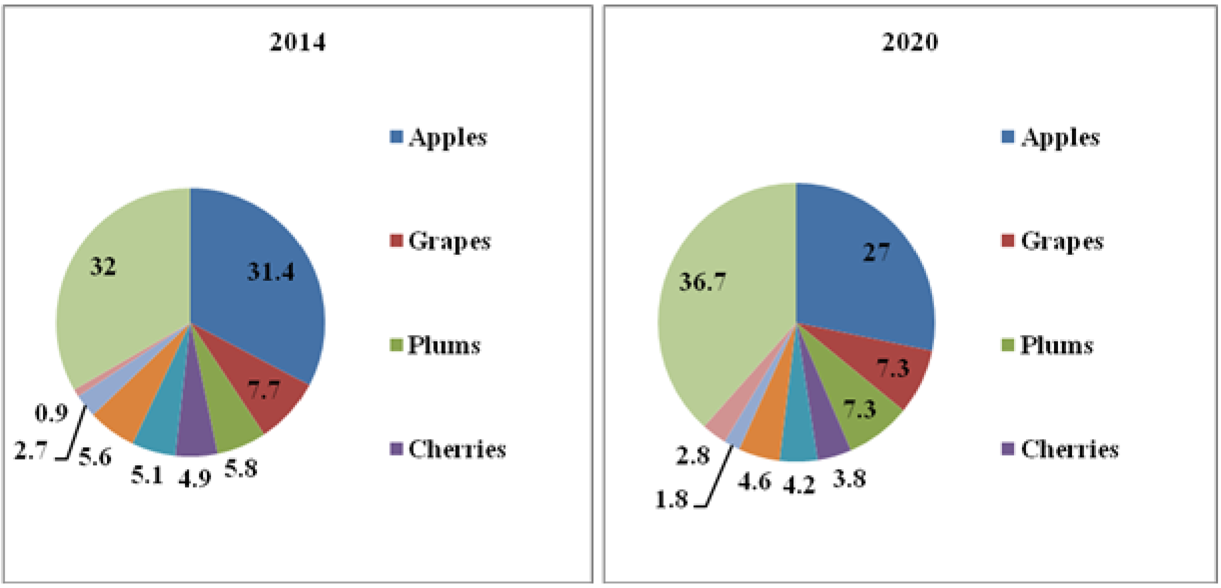

Fig. 10. Changes in the share of various fruits in average annual consumption (%)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The data from Figure 10 show that in 2020 compared to 2014, it was recorded a higher share in case of apples, plums, nuts and Mediterranean and exotic fruits. as well as a decline of the weight of grapes, cherries, peaches and nectarines, pears, apricots in close relationship with the high price of the imported fruits.

Consumption of sugar and products made of sugar

Sugar consumption increased from 21.1 kg in 2014 to 25.5 kg in 2020, meaning by + 20.8%, despite that a more intense advertising was made for decreasing sugar consumption due to the high risk of diabetes, heart diseases etc. (Figure 11).

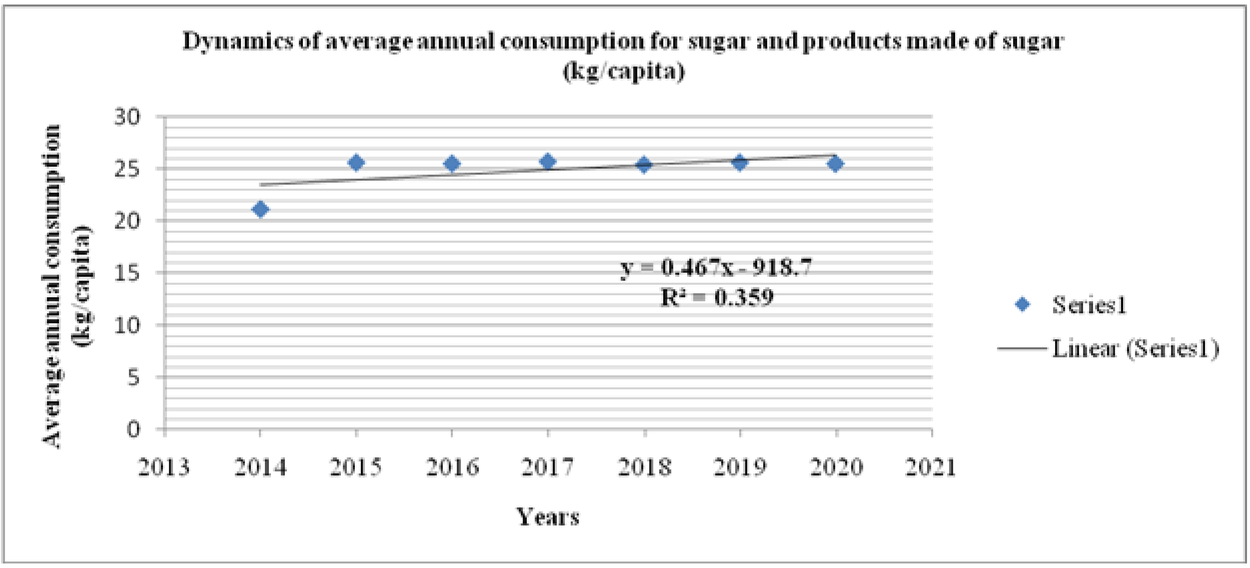

Fig. 11. Dynamics of average annual consumption for sugar and products made of sugar, 2014-2020 (kg/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

Egg consumption

Eggs are important in human diet due to their content in high value protein, amino-acids and A vitamin. A higher consumption of eggs could increase cholesterol. Egg consumption declined in Romania from 246 pieces per year and inhabitant in 2014 to 236 pieces in 2020 (-4.1%). This was a result that consumers thought that it is healthier to consume less eggs and also the higher prices have had a negative influence on consumption level, Similar results were found by [5, 57]. (Figure 12).

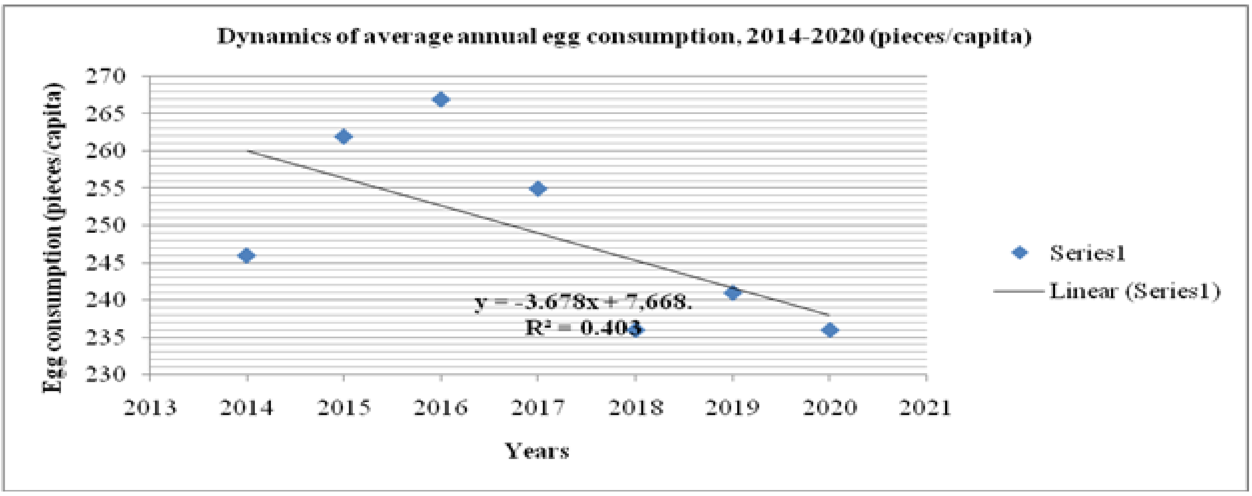

Fig. 12. Dynamics of average annual egg consumption, 2014-2020 (pieces/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

Milk and dairy products consumption in fresh milk equivalent with 3.5% fat (butter excluded)

Due to their high content in nutrients especially high value protein and calcium., milk and dairy products are extremely important in adults and children diet. Yoghourts and cheese should not miss from the daily diet of any consumer. They could be used together with fruits, for example, there are sorts of yoghourts with fruits (forest fruits, cherries, apricots, raspberry, blueberry etc), and cheese made of cow, buffalo, sheep and goat milk which could be served with fruits mainly grapes and apples at the end of the meals.

Milk and dairy products consumption increased from 244.2 litres in 2014 to 252.6 litres per inhabitant in 2020, meaning by +3.4% (Figure 13).

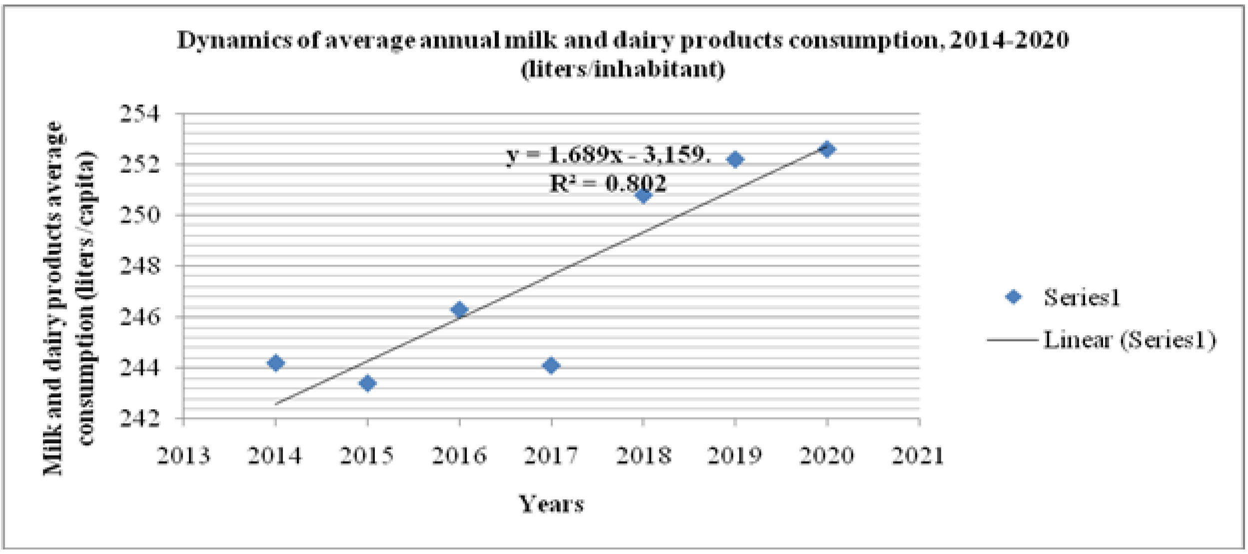

Fig. 13. Dynamics of average annual milk and dairy products consumption, 2014-2020 (liters/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

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Various authors sustained that milk sector in Romania is passing through a period of crisis due to the reduction of the bovine livestock, high prices for farm inputs, problems in milk collection and quality and decline in self-sufficiency [11, 12, 14, 45, 54].

Milk market is dominated by a few milk and dairy products producers, the competition has increased and also sheep and goats contribute in a slight higher percentage to milk production due to their increased livestock [44, 46, 49, 56]

Consumption of fats of vegetal and animal origin

Fats, both of vegetal origin (oil and margarine) and of animal origin (butter and lard) are an important source of energy for our body, under the condition to be consumed in small quantities. Butter could be used at breakfast on a slice of bread or in a few dishes, oil is used in salads and also for the preparation of some meals, margarine, butter and lard are used for frying meat or potatoes etc.

The consumption of fats of vegetal origin is higher than the one of fats of animal origin. The consumption of fats of vegetal origin increased by +6.4% in the studied interval from 17.2 kg in 2014 to 18.3 kg in 2020. In consumption, oil has the highest share accounting for 79% in 2014 and for 85.2% in 2020, reflecting a considerable reduction of margarine consumption from 3.4 kg in 2014 to 2.7 kg in 2020 (-21%) (Figure 14).

Oil is commercialized in a large range of seeds sources (sunflower, maize, rape, olives etc) and technologies (extra virgin or refined) satisfying much better consumers' preferences.

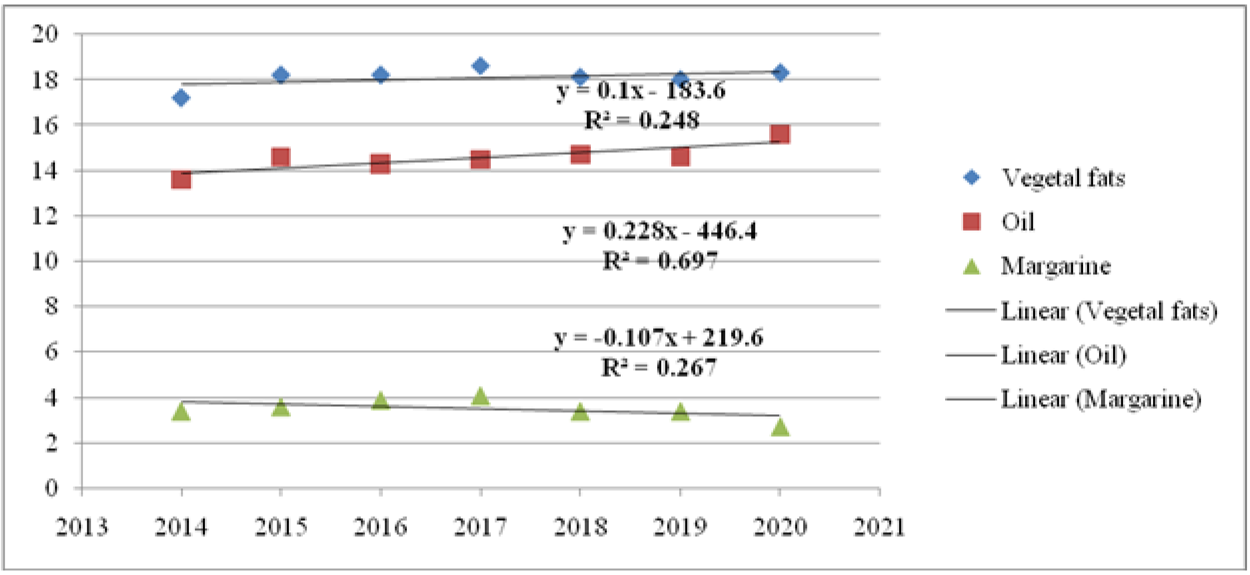

Fig. 14. Dynamics of average annual consumption of vegetal fats, 2014-2020 (kg/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The consumption of fats of animal origin has registered an important growth especially regarding butter, from 0.8 kg/ capita in 2014 to 3.9 kg/capita in 2020, meaning that in the last year of the study it was 4.8 times higher than in the first year (Figure 15).

This figure shows that butter consumption exceeded lard consumption.

Consumption of meat and meat preparation in term of fresh meat

Meat brings a rich content of high value protein needed by the metabolic processes in our body.

The average consumption in Romania registered a spectacular increase in the studied period from 60.9 kg/capita in 2014 to 77.4 kg in 2020, meaning by +27% more (Figure 16).

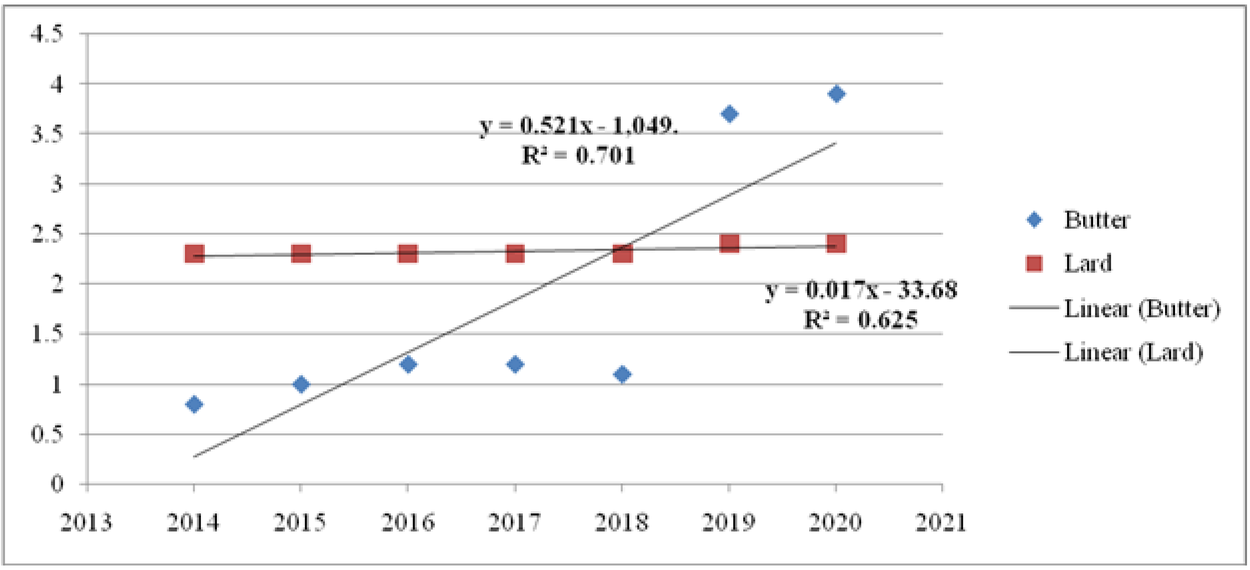

Fig. 15. Dynamics of average annual consumption of animal fats, 2014-2020 (kg/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

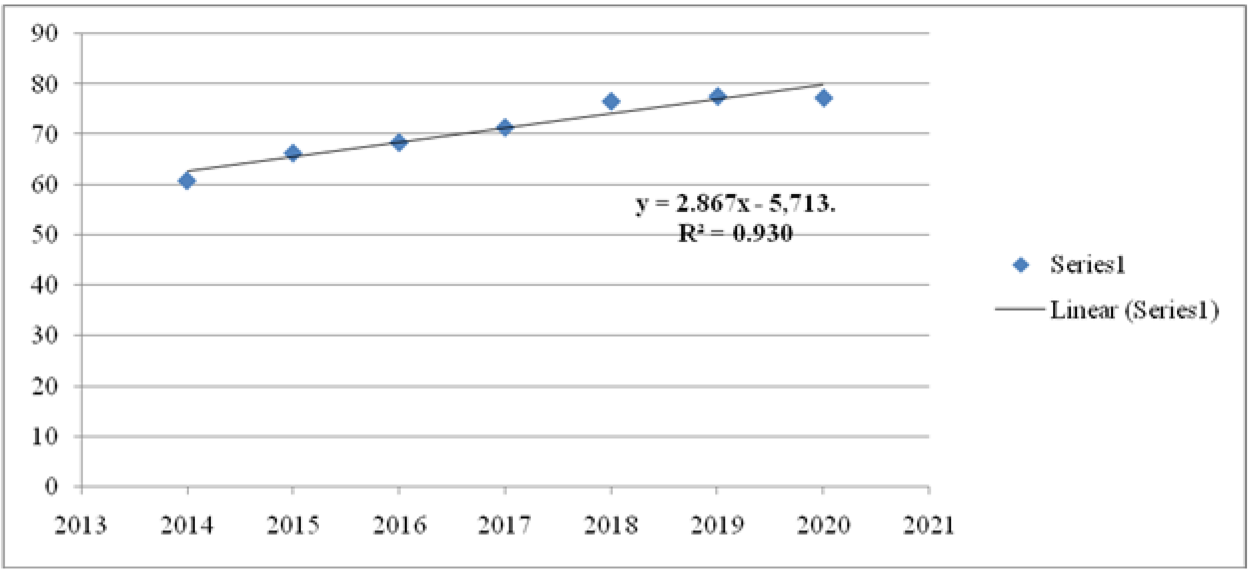

Fig. 16. Dynamics of average annual consumption of meat and meat products, 2014-2020 (kg/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

If we analyze average daily meat consumption, we may notice that it increased from 166.8 gr. per day in 2014 to 212 gr. per day in 2020, which is very much.

Many authors shows that pork dominates consumption, production is completed by imports, and that is why the trade balance is a negative one [31, 33, 41, 71].

The average annual meat consumption by meat sorts has evolved as follows from 2014 to 2020:

-pork is on the top position as it is a traditional type of meat in Romania; its average consumption increased from 29 kg to 37.3 kg (+28.6%); pork is the most preferred meat by Romanians, but pork market is passing through a period of crisis related to the lack of piglets, high price for farm inputs, low price at delivery to slaughter houses, competition with imports, African fever which diminish the livestock [47, 48, 59, 64].

-poultry meat comes on the 2nd position and registered an increase from 20.1 kg to 28 kg (+39.3%); poultry is a lean meat, with high value protein and less cholesterol than pork, reasons to be more and more preferred by consumers and also assures farmers' profit [6].

-bovine meat is consumed in a lower amount which continue to decline from 5.6 kg in 2014 to 5.4 kg in 2020 (-3.6%); however, efforts are done to recover this sector and improve trade balance [13, 15, 52, 65].

-sheep and goat meat registered a growth by +13 % from 2.3 kg in 2014 to 2.6 kg in 2020; sheep and goat stock has increased during the last years favouring to grow their contributions to milk and meat production [4, 7, 56].

-other sorts of meat are maintained at a constant level of 0.8 kg/capita/year;

- edible organs are consumed in a higher amount, whose level raised from 3.1 kg to 3.3 kg (+6.4%) (Figure 17).

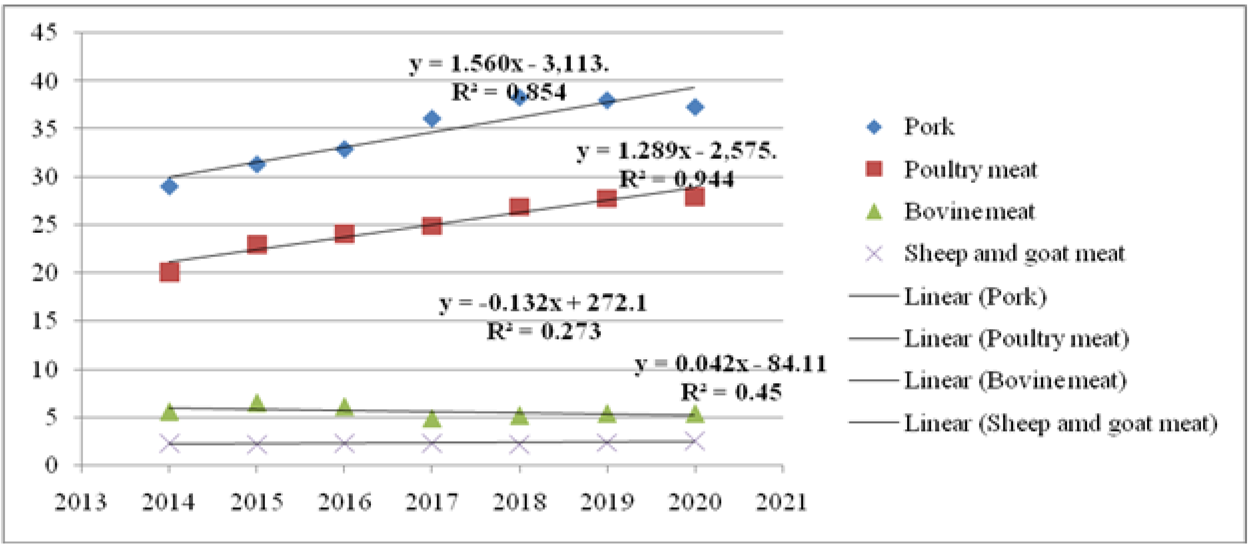

Fig. 17. Dynamics of average annual consumption of pork, poultry, bovine and sheep and goat meat, 2014-2020 (kg/inhabitant)

Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26,27, 28].

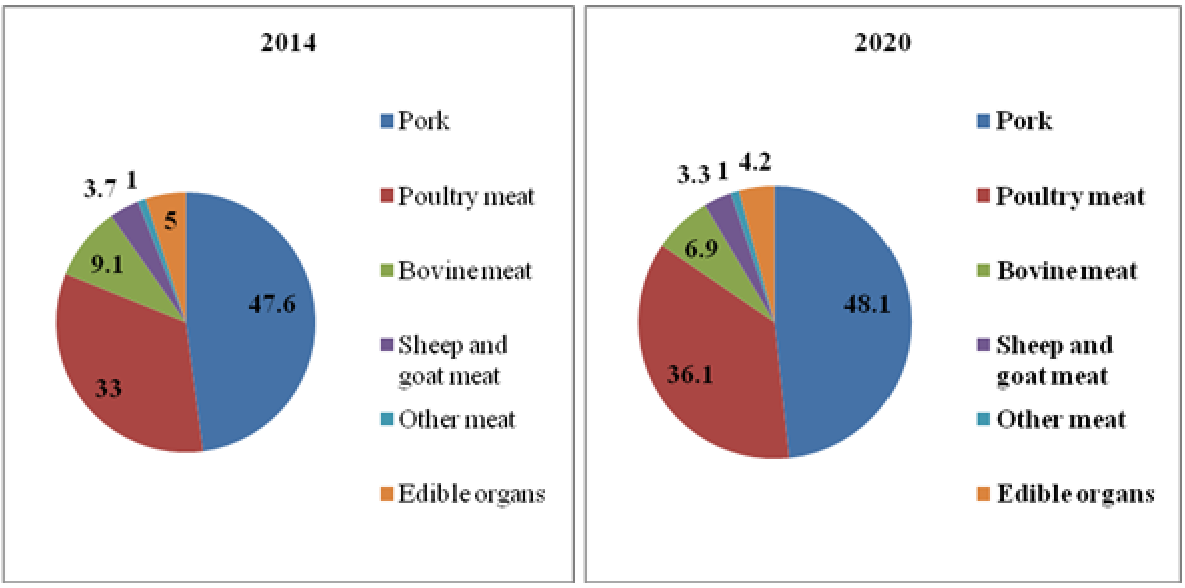

Fig. 18. Changes in the share of various sorts of meat in average annual consumption per inhabitant (%)

Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The share of various sorts of meat in the average annual consumption of meat has changed in 2020 compared to 2014 as shown in Figure 18. From Figure 18, we may see an increase of the share of pork meat to 48.1%, of poultry meat to 36.1% and a decrease of the weight of bovine meat, sheep and goat meat, other meat sorts and edible organs.

Fish and fish preparations consumption in terms of fresh fish equivalent

Fish consumption increased from 4.9 kg in 2014 to 6.3 kg in 2020, that is by +38.5%, which reflects the orientation of the consumers to this sort of food of high value protein, despite that the price per kilogram is much higher than in case of meat (Figure 19).

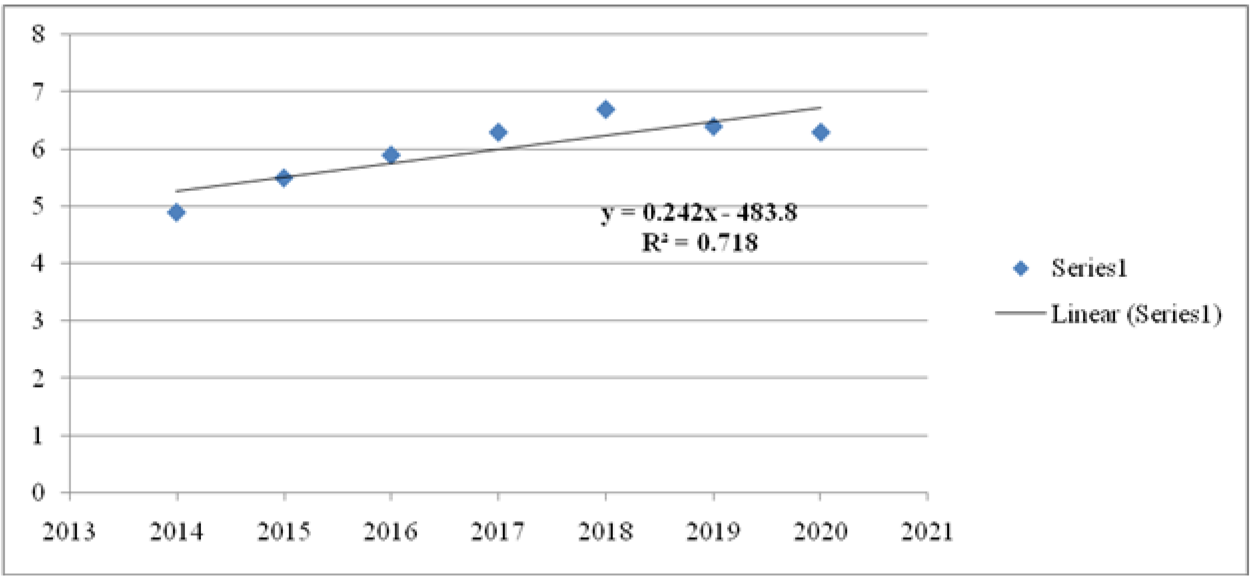

Fig. 19. Dynamics of average annual consumption of fish and fish products, 2014-2020 (kg/inhabitant)
Source: Own design and calculation based on National Institute of Statistics, 2015-2021, Consumption availability of the population [23, 24, 25, 26, 27, 28].

The sorts of fish are less from the domestic production, but more from imports: salmon, sea bream fish, tilapia fish, trout, sea fruits etc.

Honey consumption

Bee honey is a natural product, a food of high nutritive and energetic value, and also a medicine utilized in the prophylaxis and therapeutics being used in the treatment of digestive affections, nutrition, cardiovascular, respiratory, nervous system, and infectious diseases. Romania produces has many honey types, 50% of production is represented by floral honey, 35% by monofloral honey (Robinia) , and 15% by Tillia honey.

Romania, next to Spain, Hungary and Germany are the major honey producers in the EU with over 20,000 tons per year.

The ascending trend of honey demand has encouraged the beekeeping development and production responded with higher performance across the time in the main producing countries.

Beekeepers made efforts to extend the apiary size and grow strong bee colonies and produce more honey and other bee products to satisfy better the market needs and increase their income [34, 37, 43].

Romanian honey has a high quality well appreciated at export.

However, Romanians still not consume too much honey compared to the Western EU countries, but consumption raised even thou price honey is higher than sugar price [53, 62].

Honey consumption increased from 0.2 kg in the year 2009, to 0.7 kg in 2019 and to 0.8 kg in 2021, therefore very slowly and that is why most of honey production is exported. Consumption in Romania is lower than 2.4 kg/inhabitant per year in Switzerland, 2.2 kg in Germany, 1.5 kg in Netherlands and Belgium.

Factors which influence average annual food consumption

There are many economical, social and psychological factors which could influence

average annual food consumption. A selection in our opinion is presented below a follows:
- the need of nutrients: proteins, carbohydrates, fats, vitamins, minerals, enzymes, energy etc for sustaining our body to live and work;
- the existence of the health problems (obesity, diabetes, heart diseases, cancer, osteoporosis, dental diseases etc) which imposes a specific diet;
- changes in our life style in the sense of a new orientation to a healthier diet, based on natural food, with lower calories, organic food, which could assure food security;
- a higher consciousness degree regarding the nutritive and energetic value of food;
-the need of a spiritual satisfaction after consuming food and dishes, besides the basic vital needs;
-the limited capacity of intake, storage and processing of our stomach, which imposes a careful selection and suitable association of various food products in consumption, a reasonable amount and high quality;
-the utility and novelty of food which create the volume and structure of the daily food basket;
-consumption habits and routine in daily food, the preference for specific food products, tastes, flavours etc;
-product quality which is quantified by consumer using multiple criteria such as: aspect, colour, freshness, taste, smell, flavour, nutritive value;
-product price in the market and in the supermarket shelf; any increase of food product price could led either to a change in purchasing options preferring lower quality products but cheaper or giving up buying that product;
-product landmark and consumer fidelity to products and producers which satisfy the best his needs by product quality well related to price;
-identifying the products achieved by farmers who used technologies environmentally friendly, assuring animal welfare and environment quality preservation;
- average income per household which influences the budget allotted for expenses destined to buy food in close relationship to their amount and price.

In the EU, food expenditures in the family budget represent about 21.5%, while in Romania their share is about 31%.

Average annual food consumption is closely linked to food balances which reflects production, imports, exports, stock variation and availabilities for consumption.

In many cases, the internal market is completed by imports in order to diversify offer and to cover better the population needs.

CONCLUSIONS

This study reflected the average annual consumption of agri-food products per inhabitant in its dynamics during the interval 2014-2020 and identified the following trends and aspects:
-Cereals consumption declined by 1.26%, accounting for 204.4 kg/capita in 2020; wheat and rye keeps the highest share in consumption connected to the fact that they are the basic raw material for producing bread and specialties, being followed by maize.
-Potatoes consumption decreased by -7.4% accounting for 93.4 kg/capita in 2020; this happened due to the lower internal production, imports invasion on the market and high selling price.
-Vegetable consumption increased by +6.28%, accounting for 194.4 kg in 2020; both internal production and imports represent the availabilities to cover the consumer demand.
-By vegetable category, tomatoes are the most consumed vegetable, and its consumption increased by +10.5%, reaching 42.1 kg; roots consumption also increased, as well as green peppers consumption; in case of cabbage, consumption declined and onion remained at the same level.
-The highest share in vegetable consumption is kept by tomatoes, cabbage and other vegetables.
-Melons consumption raised by +5.5%, accounting for 23 kg/capita in 2020.

-Fruits consumption increased by +34.1%, reaching 107.6 kg in 2020, but it is still below its level in the Western countries.

-The level of consumption increased for apples to 29.1 kg (+15.5%), plums (+68%), grapes (+27.4%), peaches (+12.1%), nuts, while for cherries remained relatively constant and for apricots declined.

-The consumption of Mediterranean and exotic fruits increased by + 53.6%, accounting for 39.5 kg/capita in 2020, exceeding the consumption of apples.

-The highest share in fruit consumption is kept by Mediterranean and exotic fruits (36.7%) followed by apples (27%).

- Sugar consumption increased 25.5 kg in 2020 (+20.8%).

- Egg consumption decreased to 236 pieces in 2020 (-4.1%) due to the high selling price and consumers tendency to a healthier diet.

- Milk and dairy products consumption increased 252.6 litres per inhabitant in 2020, meaning by +3.4% .

- The consumption of fats of vegetal origin is higher than the one of fats of animal origin. Oil consumption has increased to 18.3 kg in 2020, and its share in vegetal fats reached 85.2%.

-Butter consumption raised to almost 3.5 kg/capita and year while lard remained at the level of consumption.

-Meat consumption is by +27% higher in 202o, accounting for 77.4 kg/capita.

-Pork is maintaining its top position, being the most preferred meat sort by Romanians and its consumption increased by +28.6% in 2020 attaining 37.3 kg.

-Poultry meat comes on the 2nd position and its consumption also increased (+39.3%) and its level reached 28 kg in 2020.

-Bovine meat consumption is in decline by -3.6%, while sheep and goat meat consumption increased by +6.4%.

-The highest weight in meat consumption is kept by pork 48.1% and poultry meat 36.1%, together accounting for 84.2%.

- Fish consumption increased by +38.5%, reaching 6.3 kg in 2020, reflecting consumers orientation to a high value protein.

- Honey consumption increased and accounted for 0.8 kg in 2021, but it is still lower than in the Western EU countries, and this contributed to the export intensification.

Among the factors which influence food consumption are income and price being considered the most important, besides product quality (aspect, colour, freshness, taste, smell, flavour, nutritive and energetic value), landmark and fidelity, life style and desire to a healthier diet of the consumer.

Consumption is close related to production, import and export, and the analysis of the balances for each food product could reflect in what measure internal production could cover the market needs. From this point of view, Romania has a high potential to produce enough food, but there are other restrictive factors like climate change, high input prices for farm inputs, imbalances along the market chain, which do not allow this and for this reason imports are required to cover the demand.

As long as in Romania consumption contributes in a higher proportion than export to GDP, the authorities have to increase salaries and pensions, income per household in a word and to establish thresholds among which prices could vary to stimulate consumption.

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ANTI-DRIFT TECHNOLOGY: MARKET, FORMULATION, APPLYING METHODS

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Abstract

Drifting is a global issue worldwide and consists in the application of crop protection products or other sprayed materials away from the target area, leading to substance loss, possible damage to nearby crops and plants and pollution of local surface waters. Without the use of anti-drift agents, drift-reducing nozzles or other drift-reducing techniques, spraying fertilizers, herbicides and pesticides in general would be ineffective. Thus, crop protection effect is reduced and waste, which can result in lower incomes for farmers and higher costs for food consumers. Concrete solutions to reduce drifting and waste of crop protection products are necessary and require focus on specific particularities. The present research should increase the interest for multifaced solutions to reduce drifting. In this light the purpose of this review considers the most important data and relevant literature on this topic in order to offer significant insights and to identify knowledge gaps within literature. Thus, short- and long-term solutions refer to proper identification of the best agents that can be used for anti-drift technology. Without the use of anti-drift agents, drift-reducing nozzles or other drift-reducing techniques, spraying fertilizers, herbicides and pesticides in general would be ineffective. The anti-drift market is at a very early stage due to the lack of user education and lack of high-quality research.

Key words: *crop protection, drift, formulation, product, solution*

INTRODUCTION

Nowadays climate changes have become significant issue worldwide threatening agriculture across the planet, creating concern about the health of plants, animals and people and the ability to provide food for billions of people [19][24][25].
Despite the genetic and biotechnological progress, machinery revolution, improved cropping technologies, agricultural systems are affected by climate change through changes in temperatures, precipitation and extreme weather events, impacting directly crops production and availability and indirectly the biotic constrainers of crops, such as weeds, pests and pathogens and their relationship with plants [10][11][22][30]. Beside the impact of abiotic constrainers (heat, soil salinity, soil acidity, lodging, snow, hail, variable humidity, natural disasters) and social events (pandemics, markets, income variability and stability, consumption, globalization of food production), controlling biotic constrainers plays one of the most important roles on the crops yield, availability and stability of food [3][5][7][8][23].Thus, climate change together with human-induced changes is expected to increase the spread of pathogens, pests and invasive species in areas where they have not been relevant before, bringing new challenges for crop management, especially in using crop protection products, in order to face yield losses and avoid alteration of natural landscape vegetation [12].
In this context, drift effect is an increasingly important concern of the agricultural industry because even if small droplets of plant protection products (commonly defined as less than 150 microns in diameter) traditionally provide better crop coverage,

they are also more prone to drift. Large droplets (commonly thought to be larger than 400 microns in diameter) tend to resist drifting, but are prone to jumping off crop surfaces, leading to reduced coverage and efficiency. The optimal size range for minimizing drift and maximizing efficiency is generally considered to be 200-400 microns [17][18]. Also, a great challenge is to find a functional balance between controlling drift and preserving the effectiveness and coverage of pesticides applied to crops. One of the aspects considered to be of great benefit in achieving this balance is the use of anti-slip or anti-drift products. By using anti-drift agents, the aim is to reduce the level of pollution, to increase the consumption of fertilizers and biostimulants with foliar or on soil application, and to increase the production of agricultural and horticultural crops.

Without the use of anti-drift agents, drift-reducing nozzles or other drift-reducing techniques, spraying fertilizers, herbicides and pesticides in general would be ineffective, primarily because there could be inadequate treatment of land and growing areas intended for treatment, and, the resulting spray, if transported beyond the intended treatment area, can have negative effects on crops, land and water courses [14][15][32].

Also, by reducing drift, more food could be made accessible for consumption without an increased demand for higher yields.

MATERIALS AND METHODS

In order to provide a comprehensive overview of the current state of knowledge on the article topic, the current study research included and synthesized pertinent literature that was indexed in international databases, using a qualitative informational approach based on books, scientific articles, news articles, reports, and websites [29].

The goal of this paper is to provide significant insights based on the article's topic and to identify knowledge gaps in the literature. To achieve this goal, systematic, semi-systematic, and integrative research approaches were used to compare current literature, papers, studies, reports, and statistics [21][26]. Additionally, the text mining approach, a well-known text analysis methodology used to draw connections and knowledge from a vast number of textual sources, was applied.

This review highlights the status and views of anti-drift technology, identifies their current issues, and suggests appropriate solutions.

The following sections outline how the books, articles, studies, and reports consulted for this review were grouped.

RESULTS AND DISCUSSIONS

Anti-Drift products-Formulations/Market

Controlling drift can provide more stable and secure yields with less crop protection product loss, even though biotechnology and gene editing have the potential to increase yield and breed cultivars with beneficial traits like drought and heat resistance, pest and disease resistance, and improved nutraceutical properties [4].

All over the world the objectives of any spraying applied in agriculture are to balance production, effectiveness of spraying and prevention of drift generated by the application of pesticides to protect the environment. Frequently, anti-drift products are incorporated into pre-packaged pesticide products and are referred to as "built-in" or "in-formulation" adjuvants. Anti-drift adjuvants reduce the risk of drift and maximize performance by binding ultra-small particles into larger droplets after spraying, which are less exposed to drift.

Tests have indicated that in some cases, anti-drift agents have reduced the drift effect by between 50-80% [6][17][31].

Currently available products used to reduce the drift phenomenon can be classified as: emulsions, thickeners, agents that cause particle formation and foaming agents.

Emulsions are viscous, white, miscible with water, having a creamy consistency like a mayonnaise (Table 1). These emulsions, formulated especially in the case of herbicides, are widely used to reduce drift. In the case of emulsions, small water droplets are dispersed in a homogeneous oily phase. In contrast, the most common emulsions form dispersed, non-homogeneous oily particles in the water. Most phenoxyacetic herbicides are in the form of highly volatile esters, oil-soluble amines or soluble acids. The drift effect is not entirely eliminated and some small drops are produced during spraying.

Table 1. Adjuvant products

Petroleum spray oils (1-3% emulsifier)	**Petroleum spray oil plus surfactant (5% emulsifier)**	**Petroleum spray oil concentrates (>15% emulsifier)**	**Vegetable oils (emulsified)**	**Vegetable oils (Esterified and emulsified)**
Ad-Here^{TM} [970 mL/L]	Bolster [838 g/L]	Adjuvator [582 g/L]	Biotrol Oil	Activoil
Broadcoat [846 g/L]	D-C-Trate [839 g/L]	Agridex [730 g/L]	Chemag Extend	Adigor
Empower [861 g/L]	D-C-Tron Cotton [827 g/L]	Amplify [432 g/L]	Chemtrol	Bolster
SACOA AntiEvap [859 g/L]	Rulvapron [838 g/L]	Auster Spraying Oil [582 g/L]	Codacide	Dasher
SACOA CottOil [859 g/L]	Trump^{tm} [830 g/L]	AW Power Tek [432 g/L]	Ecotrol	Effectivoil
		Bonza [411 g/L]	Endorse	Fastup
		Canopy [792 g/L]	Envoy (blend with buffer and surfactants)	Glysarin 704
		D-C-Trate Advance [653 g/l]	Intact	Hasten
		Enhance [598 g/L]	Miller Exist	Impel
		Genboost {426 g/L]	Nexus Spray Adjuvant	Inflirtrator
		Hot-Up [190 g/L]	Nuturf Driftex	Kwickin
		Hotwire [598 g/L]	ProCanOil Spray Oli	Phase Dispersant Penetrant
		Hustle [598 g/L]	Protect oil	Plantocrop
		In-bound [653 g/L]	Rutec Control Oil	Promax
		Magnify [426 g/L]	Sacoa Xseed	Pronto
		PCT Reactor [582 g/L]	Simplot oilon	Protec Plus
		Powersurge [598 g/L]	Smart Crop Spray Oil	Racer Ultra
		Propel [432 g/L]	Spalding canola oil spray oil conc.	Rapid Oil
		Supercharge [411 g/L]	Praytech oil	Rocket
		T-oil [432 g/L]	Stoler Natur Oil	Swift
		Tribute [666 g/L]	Supa Stik	Synertrol Excel
		TurboOil [426 g/L]	Synertrol	Trio Sterycon oil 700
		Uptake [582 g/L]	Xtend Plant Oil	4-Farmers Speedy
		Vibral [432 g/L]		
		Voltage [432 g/L]		
		Yakka [426 g/L]		
Oil adjuvants groped in the various categories in the Table may not be necessary identical in their composition or performance. Differences in the qualities of the feedstock used (e.g. hydrocarbon chain length); types of emulsifiers used and combination with other minor ingredients for example can give rise to differences in performance. Where pesticide labels specify a particular brand of adjuvant for use, it is wise to establish equivalency of similar products before substituting an alternative branded product.				

Source: Adjuvants – Oils, surfactants and other additives for farm chemicals – revised 2012 edition [2].

Using conventional sprayers, the percentage of small drops produced when using emulsions is affected by factors such as nozzle type, hole size, nozzle orientation during spraying, all of which influence the quality of spraying.

The viscosity of the emulsion also affects the degree of control of the drift phenomenon. Thin emulsions produce much smaller droplets, likely to be exposed to drift during spraying. The viscosity of the emulsions depends on the water/oil ratio and the size of the stirring drops. Some formulations of emulsions become more viscous as they are stirred and pumped, and the number of small drops increases. In the field, viscosity can be adjusted by varying the water/oil ratio as more oil is added. The emulsion becomes thinner and more fluid.

Thickeners are synthetic polymers that are soluble in water. They increase the viscosity of the water fraction of the spray solution, thus increasing the size of the drops during spraying. Many thickeners act as adhesives, increasing the adhesion of the sprayed substance to the leaves and stems of plants and reducing the slip from them during spraying.

Polymers used as anti-drift control agents are the most common type of adjuvants and work by increasing the size of drops during spraying. Adjuvants used as anti-drift agents aim to increase the coarse fraction of the spray mixture while reducing the fine fraction.

Most of the anti-drift agents mentioned in the literature are based on polymers of high molecular weight and possessing good viscosity. Commonly, polyacrylamide (PAM), polyethylene eoxides (PEO), polyvinylpyrrolidone (PVP) have been used over time as anti-drift agents [20][28]. Even at a high dilution, usually at 100-100 ppm, these polymers are effective in delaying the breakage of the spray mixture and reducing the formation of isolated droplets [16][20].

In any case, the current formulations of anti-drift agents have a limited effect on reducing drift for a number of reasons, most commonly known as physical degradation by shear. This type of polymer degradation leads to a significant decrease in the viscosity of the mixture resulting in a decreased control of the distribution of drops during spraying. To minimize this, polymers with an intrinsic viscosity of between 6 and 15 DL/g. should be used.

It is generally accepted that the polymers that provide the best control of drift are either non-ion polymers (e.g. homopolymer acrylamide) or have a relatively low anionic content (e.g. 5 to 30 wt.%) and have high intrinsic viscosity, above 6 DL/g.

Such polymers tend to form viscous mixtures with water at low concentrations. Normally, in practice, the emulsion or powder should be mixed with water directly into the tank of the sprayer to form an aqueous polymer solution.

Results from a study conducted at USDA-ARS Texas showed that the type of polymer significantly influences the size of the droplets that form in the sprayer mixture [13]. For example, polyvinyl and polyacrylamide are much more effective than alkyepoxides or copolymers in increasing the diameter of particles and reducing the volume of the spray solution composed of small particles.

[9] experimented with several chemical formulations such as emulsifiable synthetic resins, plant polymers, synthetic latex or fluid organosilicon, phosphatidyllcholine and propionic acid, sodium dodecylbenzenesulfonate and carboxymethylcellulose, nonylphenoxy polyethanol and ethoxylnonylphenol. The results showed that the group of mineral oils and anti-drift agents determined better control of drifting than surfactants and water.

Guar gum and its derivatives have been used in aqueous mixtures as an excellent anti-drift agent without presenting the disadvantages of polymers. The ability of guar gum to alter the rheology of liquids and increase their adhesion is important in increasing the effectiveness of foliar splashes. The water-guar gum mixture not only possesses desirable characteristics as an anti-drift agent, but maintains these characteristics for a long time during spraying conditions and is resistant to mechanical shear and degradation effect. In any case, the gums do not shear as easily as the polymer chain, and some types of polymers (polyethylene oxide) shear even faster than other polymers (polyacrylamide) when passing through the spray pump.

On international markets there are products (Atplus™ DRT-EPS, Atplus™ DRT-100, 41-A©, Control™) mentioned to have an anti-drift effect suitable both for mixing in the tank of the sprayer and directly incorporated in the plant protection products used, proving good performance in several types of nozzles used.

Recently, [27] tested the anti-drift potential of folic acid and zinc nitrate in a supramolecular hydrogel formulation biocompatible with the herbicide dicamba in a low-volume mixture. This hydrogel containing non-organic solvents has shown biocompatibility and biodegradation due to its natural compounds. The main way this hydrogel reduces the drift phenomenon is by increasing the size of the droplets and this is due to the three-dimensional structure of this gel. This study showed a new strategy to diminish the drift effect and use hydrogels in agriculture.

According to the Agricultural adjuvants market report (2020), the global adjuvant market is estimated to reach $4,4 billion in 2026, recording an annual growth rate of 6.1% between 2020 and 2026 [1].

Currently, the adjuvant market is relatively small in the global pesticide segment. However, the adjuvant market has seen significant growth due to the increasing need to control harmful organisms in agriculture, especially in developed countries. The targeting of research funds by companies to develop such anti-drift products and anti-foaming agents will lead to the growth of the adjuvant market in the next 7 years In addition, with the increase in the use of drones for pesticide application, companies will focus on obtaining compliant drone application adjuvants.

Technologies of application of anti-drift products

The factors that influence the drift are: weather conditions (wind speed and direction, ambient temperature and humidity), sprayer and application technology (type, parameters and position of nozzles, nozzle spacing, working pressure, dose per hectare, working speed) and other application parameters.

Spray disperses the liquid into small diameter droplets, the average diameter of the resulting droplets may be very different, from a few microns (μm) to 2-3 mm. Depending on the average size of the drops, the following forms (categories) of dispersion of the spray liquid are distinguished: Atomization, fine spraying, spraying and rain (artificial). Current use sprayers make drops with diameters between 50 μm and 1.5- 2 mm. The size of the drops used depends on the applied treatment and the sprayed product. Thus, for the work of fighting cryptogamic diseases are mainly used small-diameter drops, the application of fungicides is usually done by fine spraying. For the rest of the control products and depending on the toxicity of the product to the environment, it is recommended to perform drops of diameter between 150 and 600 μm.

When spraying, the compact jet of solution coming out of a limited space, the body of the nozzle or sprayer, is converted into a droplet by dispersing the liquid in open space in different directions at a speed capable of overcoming the internal cohesion forces of the dispersed liquid.

The hydraulic spraying process is only one of the technical possibilities used for spraying liquids. In spray pest control machines, several spraying procedures are used, which are distinguished by the way the liquid is trained at the speed necessary to annihilate the internal cohesion forces and propitious to disperse, as follows:

- hydraulic spraying, by passing the pressurized liquid through a small section hole and design in the open space;
- pneumatic spraying, here bringing the liquid to the speed required for dispersal is achieved by taking it over and transporting it in a high-speed air stream;
- centrifugal spraying, where both the speed and direction of dispersion is achieved by draining the liquid from a rotating disc at a high speed;
- "two medium" spraying is a combined process, resulting from the combination of hydraulic and pneumatic spraying.

For the characterization of the droplet spectrum in a nozzle jet, several reference sizes such as the mean volumetric diameter (VMD), which represents the limit size against which 50% of the total spray volume consists of droplets larger and smaller than VMD, respectively. Of importance for practice is another size denoted by Dv0.1 (median volume (10%)) volumetric diameter 10% - where 10% of the total spray volume is less than Dv0.1 expressed in μm. For fan or conical nozzles used in field crop treatments, the minimum allowable diameter Dv0.1 = 100 μm is considered, i.e. the value below which droplets can be easily carried by air currents (drift hazard). Also based on experimental data are given as optimal values of wind speed up to which spraying treatments can be applied, speeds between 2.0 and 6.5 km/h and maximum of about 9.0 - 15 km/h (3 - 5 m/s).

If losses of plant protection material due to evaporation and sublimation can be reduced by the use of suitably conditioned preparations, by the addition of organic solvents with a low degree of volatility or by the addition of adhesives to reduce the volatility of the applied product, losses due to drift can be reduced by using a spray process capable of reducing these losses. The most effective measure to reduce drift losses is the use of sprayers and nozzles with coarse droplet spectrum. With their help, at the same working flow and pressure, the amount of substance lost by drift when spraying with spray nozzles of anti-slip, impact or air injection type is much lower.

Compared to the amount of liquid lost when spraying with universal type nozzles (LU - Lechler Universal), losses due to drift when spraying with anti-slip nozzles (DG - drift guard) and impactful nozzles (TT - TurboTeejet) are only half. By using the air injection nozzles (ID - injector-duction, TD TurboDrop) the drift reduction is even greater, the loss value being half the corresponding value on the nozzles of type DG and TT, respectively a quarter of the drift produced by universal type nozzles.

The classification of sprayers according to the drift reduction capacity is made in three classes, expressed in drift reduction percentages: 90, 75 and 50%.

Lechler ID 120-04 POM (polyoxymethylene) and ID 120-04 C (ceramic material) air injection nozzles as well as spray systems AI 11004 VS nozzles were classified in the drift reduction class by 75%. Nozzles of type ID 120-03 POM, ID 120-03 C and AI 11003 VS are classified only in the 50% drift reduction class.

Regarding the use of the carrier air jet to reduce drift, it should be noted that this system allows to reduce drift only when spraying crops with abundant plant mass. In the case of pre-emergent sprays on unvegetated soil or in very small crops, an increase in the amount of fluid deviated from the treatment site (target) is observed.

Other measures may also contribute in addition to the abovementioned procedures for reducing drift.

Thus, when spraying potato crops, good results in reducing the drift were also obtained by using subfoliar sprinklers of the type Benest-Dropleg (Beneth Sprayer systems) or Fischer (FAT-CH).

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CONCLUSIONS

All over the world the objectives of any spraying applied in agriculture are to balance production, effectiveness of spraying and prevention of drift generated by the application of pesticides to protect the environment. Anti-drift agents are presented in the literature as a specific class of chemical adjuvants that should not be confused with products such as surfactants, wetting agents, scattering agents or adhesives. These agents are normally long-chain polymers or gums that increase the viscosity of the spray mixture leading to more effective spraying. Various anti-drift products are known to have a wide variety of chemical formulations in their composition. Thus, it is very difficult to identify new anti-drift agents or to optimize new formulations of them. The adjuvants market is dominated worldwide by North America where modern technologies are applied to agriculture and where integrated management of harmful organisms in crops is practiced. Researchers and vegetable farmers can use this material as a resource.

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EFFECT OF PRE-SLAUGHTER WEIGHT AND SEX ON THE PERFORMANCE OF IRISH LANDRACE PIG CARCASSES

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Abstract

In order to study the effect of sex and pre-slaughter weight on the performance of Irish Landrace pig carcasses, 400 pigs with equal number of barrows and gilts were selected and fattened. After fattening, the pigs were divided into two groups according to sex. Then, 20 gilts were selected using weighing into 4 groups with a pre-slaughter weight 90 kg, 100 kg, 110 kg and 120 kg. Similarly, 20 barrows were divided for 4 groups with same pre-slaughter weight 90 kg, 100 kg, 110 kg and 120 kg. All gilts and barrows from eight experimental groups were slaughtered and their carcasses were measured and then sampled to determine slaughter parameters. It was found that in general, gilts had higher carcass weight at pre-slaughter weight 90, 110 and 120 kg, higher chilled carcass weight at pre-slaughter weight 120 kg, higher carcass length and length of bacon halves at pre-slaughter weight 120 kg, higher thickness of longest back muscle and meat content at pre-slaughter weight 100 kg.Barrows had a higher fat thickness above the 6-7 thoracic vertebrae, the fat thickness in the buttocks, the fat thickness in the withers at pre-slaughter weight 100 kg.

Key words: *gilts, barrows, slaughter yield, meat content, fat thickness, carcass length*

INTRODUCTION

Pig fattening is the final period in pork production. The level of pigs productivity, the quality of the product and the profitability of pig breeding largely depend on its proper organization. The main purpose of fattening is to obtain maximum growth from animals in the shortest possible time at the lowest cost of feed per unit of output with a high quality product [11, 13]. The quality of the carcass is an important factor that determines the efficiency of production. It is influenced by a number of conditions: the external shape of the animal and its internal structure, namely the ratio of meat and fat, total fat, condition of the animal at slaughter, its age, weight, quality and quantity of feed, methods of slaughter, carcass processing [26]. In the rapidly changing situation of the pork market, the study of slaughter quality of pig meat under the influence of various factors is becoming increasingly important.

Meat productivity is determined by the amount of products obtained from pigs suitable for human consumption. It is estimated by carcass weight and carcass yield [14, 15]. It is known that pig carcasses are affected by genotype and productive type of breed [1]. However, the slaughter quality of pigs also depends on the pre-slaughter weight, which in turn is determined by the intensity of pig growth [25]. As the pre-slaughter weight increases, the slaughter yield, carcass length and fat thickness increase [24]. It is also widely known that in the general understanding of scientists and pork producers an unambiguous decision on the optimal pre-slaughter weight of pork is established. In most European countries, the weight of live animals before slaughter is 110-115 kg. Of course, there are countries, such as Ireland, where pigs are traditionally slaughtered with a pre-slaughter weight of no more than 95 kg to get lean bacon. However, despite the traditional principles of producers and long-term consumer preferences, the development of breeding and genetics of pigs allows to move to heavier carcasses while maintaining their high meat content and save resources [23]. This is confirmed by [27] studies which show that when pigs were reared to a heavy weight of 140 kg, an increase in pre-slaughter weight for every 10 kg decreased the average daily gain by 4.0 g, increased feed consumption by 78.1 g and decreased conversion feed at 0.011 g. The low economic efficiency of growing to heavy weight conditions is indicated by the report [21], which states that the intensity of weight gain is greatly reduced in the later stages of growth when growing to 120 kg and more, due to accelerated fat accumulation and reduced water and protein deposition. In Southern Europe, particularly in Italy, consumer tastes were on the side of pig carcasses with a pre-slaughter weight of more than 150 kg. In the pork market in this country, traditional cured meat with excess fat content is in great demand today. In the Americas, the average pre-slaughter weight is 100-120 kg, in particular in Brazil it is not more than 100 kg [3], in Mexico it is in the range of 120-127 kg [2]. In Asia, including China and South Korea, the pre-slaughter weight of pigs is 90-110 kg, but tends to increase from year to year. Thus, currently the greatest demand is for lean pork, which is obtained when fattening young pigs to a slaughter weight of 90-100 kg [10].

The characteristics of pig carcasses after slaughter depend on various factors. The more closely they are interconnected. In the results of experiments [6] it was proved that with the increase of slaughter conditions from 95–105 to 116–125 kg in pigs was a decrease in the content of meat carcasses and an increase in fat content. Changes in pig carcasses are dynamic and depend on the intensity of their growth. Previously, researchers have reported an increase in the depth of the fat in the pelvic-lumbar part of the carcass linearly, an increase in the thickness of the longest muscle of the back quadratically with increasing live weight [28]. It has been reported increase in fat thickness between the 10th and last ribs was found in the range of 0.8 to 2.6 cm for each additional 10 kg increase in pre-slaughter weight of pigs [12].

Similar findings have been found in other works [29], which indicate the value of the fat thickness in the withers tended to increase with increasing pre-slaughter weight compared to the content of lean meat, which tended to decrease linearly.

Thus, there are still many incomplete relationships between the ratio of pre-slaughter weight and carcass lean parameters, especially in pigs of commercial genotypes, so the study of this issue will become even more relevant in the future, given the trend in breeding pigs to increase carcass weight in the near future decades. Thus, the aim of this study is to find the effect of sex and different pre-slaughter weights on the change in slaughter rates in pigs of commercial genotype of Irish origin.

MATERIALS AND METHODS

In order to achieve this goal, an experiment was conducted to study the influence of sex and pre-slaughter weight of fattening pigs on their slaughter qualities on the basis of fattening farm №3 «Globinsky Pig Complex» LLC, Globinsky district, Poltava region, Ukraine, where a group of 400 Irish Landrace pigs with equal number of gilts and barrows was formed. In the process of fattening, they were kept 50 heads in identical conditions in pens with area 40 m^2, on a totally slotted concrete floor. Feed was fed 8-10 times a day using feeding equipment Weda (Austria).

Feeding of pigs was carried out with liquid complete feed mixtures of own production in the ratio of dry feed to water 1: 3. Compound feeds were balanced in terms of essential nutrients and energy. Conditions for keeping, watering, ventilation and manure removal were identical for all pigs.

After fattening, the pigs were divided into two groups according to sex. Then, 20 gilts were selected using weighing into 4 groups with a pre-slaughter weight 90 kg, 100 kg, 110 kg and 120 kg. Similarly, 20 barrows were divided for 4 groups with same pre-slaughter weight 90 kg, 100 kg, 110 kg and 120 kg.

Gilts depending on the pre-slaughter weight were included in the groups as follows: 90 kg gilts were included in the control group Ig, 100 kg gilts were included in group IIg, 110 kg gilts were included in group IIIg, 120 kg gilts were included in group IVg. Barrows depending on the pre-slaughter weight were included in the groups as follows: 90 kg barrows were included in control group Ib, 100 kg barrows were included in group IIb, 110 kg barrows were included in group IIIb, 120 kg barrows were included in group IVb.

The pigs were transported to the slaughterhouse «Globinsky Meat Processing Plant» LLC, Globinsky district, Poltava region, Ukraine and slaughtered in accordance with the technology adopted by the company by stunning in the Schaller Butina gas chamber - DK 4300 (Butina ApS, Denmark). The carcasses were cooled after treatment in the first stage using shock tunnels from -14 °C during 105 minutes, in the second stage at 4 °C durinf 24 hours. During slaughter, the carcass parameters were determined: average pre-slaughter weight, slaughter weight, slaughter yield, weight of chilled carcass, cooling losses, cooling losses, fat thickness over 6-7 thoracic vertebrae, fat thickness in the buttocks, fat thickness in withers, carcass length, length of bacon halves, thickness of the longest back muscle, meat content.

Carcass rolling was performed according to the generally accepted method ISO 3100-1 [9].

Carcass measurements were performed on the left half-carcass using a ruler and ultrasound device Fat-o-Meat'er II (Frontmatec, Denmark). The fat thickness was measured with a ruler at 3 points: on the withers, above the 6-7 thoracic vertebrae, on the buttocks. The Fat-o-Meat'er II was measured at the third and fourth last edges of the carcass 6 cm away from the mid-back line. The device determined the thickness of the fat and the thickness of the longest back muscle. At the end of the measurement process, the carcasses were divided into parts and evaluated for lean meat content using the deboning method.

To determine the strength of the influence of sex and pre-slaughter weight of animals on their slaughter performance, a two-factor analysis of variance was performed. The obtained results were calculated biometrically using Microsoft Office Excel 2010 applications.

The animals were cared for and used during the experiment in accordance with the requirements of humane treatment according to applicable Ukraine's Law No 3447/IV, 2006, «On protecting animals from brutal treatment» [20].

RESULTS AND DISCUSSIONS

Slaughter weight in pigs with a pre-slaughter weight 90 kg was significantly higher in gilts than in barrows by 1.7 kg or 2.78% ($p < 0.001$). In pigs with a pre-slaughter weight 100 kg, the slaughter weight did not differ in the carcasses of both sexes (Table 1). Slaughter weight in pigs with a pre-slaughter weight of 110 kg was higher in gilts compared to barrows by 2.5 kg or 3.17% ($p < 0.05$). Similarly, 120 kg gilts had a higher slaughter weight than 120 kg barrows by 3.1 kg or 3.48% ($p < 0.05$). According to the indicators of slaughter yield and cooling losses, there was no statistically significant difference between gilts and barrows at the pre-slaughter weight 90, 100, 110 and 120 kg. The weight of chilled carcass was higher in gilts than in barrows by 5.8 kg or 6.47% (p <0.001) at pre-slaughter weight 120 kg, and at other weight conditions statistical differences in pigs of different sexes were not found. The fat thickness at the level of 6-7 thoracic vertebrae was greater in barrows compared to gilts at a pre-slaughter weight of 100 kg by 2.6 mm or 12.04% (p <0.05), and at other values of pre-slaughter weight no significant difference was recorded regardless of pigs sex. The fat thickness in the buttocks was greater in barrows compared to gilts at a pre-slaughter weight 100 kg by 5.9 mm or 44.70% (p <0.001), and at other pre-slaughter weights it had no statistically significant difference in other pigs. The fat thickness in the withers was higher in barrows from group IIb (100 kg) compared to gilts from group IIg (100 kg) by 3.1 mm or 8.07% (p <0.01), and in analogues from other groups of cross-sex no difference was found. The carcass length and the length of the bacon halves were 3.7 cm or 3.74% (p<0.01) and 3.5 cm or 3.99% higher than in gilts with a pre-slaughter weight 120 kg. (0.05), respectively, and in the value of indicators among pigs of both sexes of different pre-slaughter weights there was no difference. The thickness of the longest back muscle was probably higher in gilts at pre-slaughter weights 100 kg compared to 100-kg barrows by 4.2 cm^2 or 8.47% (p <0.01), it did not differ at other pre-slaughter weights in barrows and gilts carcasses.

Table 1. Slaughter qualities of pigs with different pre-slaughter weight, (n = 20)

Indicators	**Gilts**			
	Ig (90 kg)	**IIg (100 kg)**	**IIIg (110 kg)**	**IVg (120 kg)**
Average pre-slaughter weight, kg	84.1±0,71	92.3±0.91	105.5±0.97	116.67±0.73
Slaughter weight, kg	62.8±0.62^{B3}	69.1±0.88^{A3}	78.9±0.99^{A3B1}	89.0±0.83^{A3B1}
Slaughter yield, %	73.4±0.83	74.8±0.52	74.7±0.32	76.2±0.49
Weight of chilled carcass, kg	60.9±0.61	67.7±0.88^{A3}	77.2±0.94^{A3}	89.7±0.82$^{A3\ B3}$
Cooling losses, kg	1.8±0.48	1.4±0.02	1.7±0.20	2.2±0.13
Cooling losses, %	2.9±0.74	2.0±0.04	2.1±0.25	2.5±0.14
Fat thickness, cm:				
over 6-7 thoracic vertebrae, mm	18.6±1.55	21.6±0.62	25.3±1.52^{A2}	27.4±1.30^{A3}
in the buttocks, mm	14.3±2.08	13.2±1.02	17.7±0.85	18.0±1.58
in withers, mm	34.±1.21	38.4±0.50^{A2}	42.1±3.12^{A1}	45.8±2.25^{A3}
Carcass length, cm	87.1±1.01	89.9±1.47	93.0±0.62	98.9±0.53^{B2}
Length of bacon halves, cm	80.8±1.82	79.8±1.02	82.3±0.51	87.7±1.25^{A3B1}
Thickness of the longest back muscle, cm^2	47.2±2.45	49.6±1.17^{B1}	45.8±0.79	51.6±1.94
Meat content,%	53.4±0.83^{A3}	52.1±0.48^{B1}	49.4±0.55	49.5±1.40
Indicators	**Barrows**			
	Ib (90 kg)	**IIb (100 kg)**	**IIIb (110 kg)**	**IVb (120 kg)**
Average pre-slaughter weight, kg	83.3±0.33	92.3±3.01	102.7±0.54	113.2±0.90
Slaughter weight, kg	61.1±0.23	68,.0±0.77^{A3}	76.4±0.61^{A3}	85.9±0.81^{A3}
Slaughter yield, %	73.3±0.35	73.7±2.84	74.4±0.81	75.8±0.39^{A3}
Weight of chilled carcass, kg	59.6±0.21	66.5±1.05^{A3}	75.1±0.60^{A3}	83.9±0.76^{A3}
Cooling losses, kg	1.4±0.08	1.5±0.12	1.3±0.24	1.9±0.10
Cooling losses, %	2.4±0.13^{A1}	2.2±0.16	1.5±0.29	2.2±0.11
Fat thickness, cm:				
over 6-7 thoracic vertebrae, mm	19.4±1.31	24.2±0.95$^{A2\ B1}$	26.5±0.77^{A3}	30.5±1.91^{A3}
in the buttocks, mm	17.5±1.55	19.1±0.86 ^{B3}	17.1±1.21	20.6±0.87
in withers, mm	35.1±1.58	41.5±0.87$^{A2\ B2}$	43.1±0.84^{A3}	48.6±2.71
Carcass length, cm	89.7±1.04	90.8±0.99	91.6±0.70	95.2±0.92^{A3}
Length of bacon halves, cm	79.0±0.53	79.7±0.89	82.8±0.79^{A3}	84.2±0.65
Thickness of the longest back muscle, cm^2	49.2±1.61	45.4±1.38	49.1±2.95	52.3±1.57
Meat content,%	54.4±0.78^{A3}	50.5±0.57	51.8±0.97	50.6±0.98

Note: Comparison between columns: ^{A1} – P < 0.05; ^{A2} – P < 0.01; ^{A3} – P <0.001; Comparison between lines: ^{B1} – 0.05; P < ^{B2} - P < 0.01; ^{B3} - P < 0.001;
Source: Own calculations.

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The meat content was higher in carcasses of gilts at a pre-slaughter weight 100 kg by 1.6% ($p < 0.05$) and in carcasses of barrows at a pre-slaughter weight 110 kg by 2.4% ($p < 0.05$). The meat content for weights 90 and 120 kg was the same for pigs of different sexes.

Based on the obtained results, it became known that gilts from the control group with a pre-slaughter weight 90 kg had a lower carcass weight than gilts with a pre-slaughter weight 100 kg by 6.3 kg or 10.03% ($p < 0.001$) than gilts with a pre-slaughter weight 110 kg by 42.7 kg or 67.99% ($p < 0.001$) than gilts with pre-slaughter weight 120 kg by 53.8 kg or 85.78% ($p < 0.001$). According to the slaughter yield indicator, there was no statistically significant difference between gilts of all groups. Evaluation of the weight of chilled carcass showed that gilts with a pre-slaughter weight 100 kg were superior to analogues from the control group Ig by 6.8 kg or 11.17% ($p < 0.001$), gilts with a pre-slaughter weight 110 kg, were superior to peers with 90 kg and 16.3 kg or 26.77% ($p < 0.001$), and gilts with a pre-slaughter weight 120 kg were heavier than control gilts by 28.8 kg or 47.29% ($p < 0.001$). A significant difference in the rate of cooling losses between gilts of all groups was not detected. The fat thickness above the 6-7 thoracic vertebrae was the lowest in 90 kg of gilts and was 18.6 mm, which was lower than in gilts of group IIIg (110 kg) by 6.7 mm or 36.02% ($p < 0.01$) and lower than in gilts group IVg (120 kg) by 8.8 mm or 47.31% ($p < 0.001$).

The fat thickness in the buttocks of gilts with different pre-slaughter weights was statistically equal. The fat thickness in the withers in gilts from the group Ig (90 kg) was 34.5 mm, which was thinner than in gilts with a pre-slaughter weight 100 kg by 3.9 mm or 11.30% ($p < 0.01$), thinner than in gilts with a pre-slaughter weight 110 kg by 7.6 mm or 22.03% ($p < 0.05$) and thinner than in 120 kg of gilts by 11.3 mm or 32.75% ($p < 0.001$). Gilts from the control group Ig (90 kg) in terms of the length of the bacon half were lower compared to analogues from IVg (120 kg) by 6.9 cm or 8.85% ($p < 0.001$), and from gilts of other groups it did not differ significantly. The thickness of the longest back muscle did not show statistically significant differences in gilts of all groups. The meat content was the highest in gilts with a pre-slaughter weight 90 kg and amounted to 53.4%, which was higher than 110 kg gilts by 4.0% ($p < 0.001$) and higher than 120 kg analogues by 3.9% ($p < 0.001$).

A study of the slaughter weight showed that it was highest in barrows with a pre-slaughter weight 120 kg. Barrows from control group Ib (90 kg) had a lower carcass weight than barrows from group IIb (100 kg) by 6.9 kg or 11.29% ($p < 0.001$), than barrows from group IIIb (110 kg) by 15.3 kg or 25.04% ($p < 0.001$), than barrows from group IVb (120 kg) by 24.8 kg or 40.59% ($p < 0.001$). In terms of slaughter yield, there was a significant difference of 2.5% ($p < 0.001$) between barrows with a pre-slaughter weight 90 kg and 120 kg in favor of heavier pigs. The lowest weight of chilled carcass was naturally found in barrows of the control group, where it was lower than in analogues from group IIb (100 kg) by 6.9 kg or 11.58% ($p < 0.001$) than peers from group IIIb (110 kg) by 15.50 kg or 26.01% ($p < 0.001$) than by experimental barrows from group IVb (120 kg) by 24.3 kg or 40.77% ($p < 0.001$). Cooling losses were significantly different only for barrows with pre-slaughter weight 90 kg and 110 kg, where the highest rate was in barrows of group Ib (90 kg) by 0.9% ($p < 0.05$). There was no significant difference between the values of this indicator in barrows of other groups. Estimation of the fat thickness above the 6-7 thoracic vertebrae showed the lowest values in barrows with a pre-slaughter weight 90 kg. Barrows of this group were inferior to analogues: with a pre-slaughter weight 100 kg by 4.8 mm or 24.74% ($p < 0.01$), with a pre-slaughter weight 120 kg by 7.1 mm or 36.60% ($p < 0.001$), with pre-slaughter weight 120 kg by 11.1 mm or 57.22% ($p < 0.001$). The fat thickness in the buttocks did not differ significantly in barrows with different pre-slaughter weight. The fat thickness in the withers in barrows from group Ib (90 kg) was probably lower than in barrows from group IIb (100 kg) by 6.4 mm or 18.23% ($p < 0.01$)

than in barrows from group IIIb (110 kg) by 8.0 mm or 22.79% ($p < 0.001$) than in barrows from group IVb (120 kg) by 13.5 mm or 38.46% ($p < 0.001$). The carcass length had a significant excess only in 120 kg barrows over analogues with a pre-slaughter weight 90 kg by 5.5 cm or 6.13% ($p < 0.001$). The length of the bacon half was higher in barrows with a pre-slaughter weight 110 kg by 3.8 cm or 4.81% ($p < 0.001$) and in barrows with a pre-slaughter weight 120 kg by 5.2 cm or 6.58% ($p < 0.001$) relative to analogues from the control group with a pre-slaughter weight 90 kg. The thickness of the longest back muscle was statistically equal in the carcasses of barrows of all groups. The content of meat in the carcass was the highest in barrows from control group Ib (90 kg) and exceeded the indicators of analogues from group IIb (100 kg) by 3.9% ($p < 0.001$), analogues from group IIIb (110 kg) by 2, 6% ($p < 0.05$), peers from group IVb (120 kg) by 3.8% ($p < 0.01$).

Dispersion two-factor analysis of the influence of sex and pre-slaughter weight on pig carcasses showed the presence of significant influence of these factors (Fig. 1). The meat content significantly depended on 19.49% of the pre-slaughter weight ($F_{13.38} > F_{crit2.66}$), 2.10% of the sex ($F_{4.33} > F_{crit3.90}$), 4.57% of the factor of the interaction of sex and pre-slaughter weight ($F_{3.13} > F_{crit2.66}$) and 73.82% of unaccounted factors.

The thickness of the longest back muscle was significantly affected only by the factor of pre-slaughter weight by 13.98% ($F_{8.68} > F_{crit2.66}$), and the other studied factors had no significant effect. Factors not taken into account in the study had an impact on the indicator at the level of 81.61%.

The level of cooling losses was influenced by the factor of pre-slaughter weight with a force of 5.31% ($F_{2.86} > F_{crit2.66}$), unaccounted factors influenced with a force of 93.89%, and other factors had no effect.

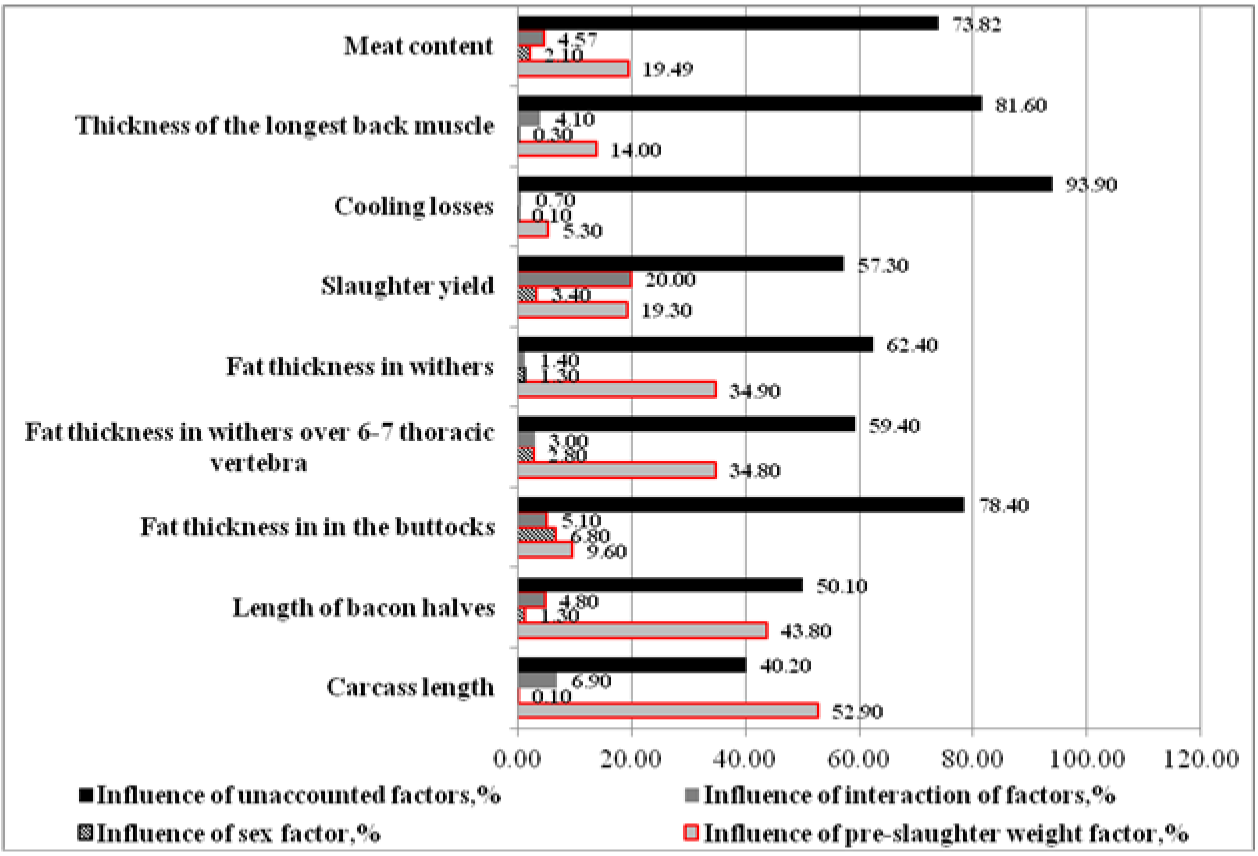

Fig. 1. The strength of the impact of pre-slaughter live weight and sex on the slaughter performance of pig carcasses
Note: (red frame - significant impact, without frame - unreliable impact);
Source: Own calculations.

Slaughter yield significantly depended on the pre-slaughter weight by 19.33% ($F_{17.09}$> $F_{crit2.66}$), on sex by 3.37% ($F_{8.95}$> $F_{crit2.66}$), on the factor of their interaction by 19.99% ($F_{17,68}$> $F_{crit2.66}$) and from unaccounted factors by 57.29%.

The fat thickness in the withers was affected by the pre-slaughter weight by 39.91% ($F_{28.34}$> $F_{crit2.66}$), and unaccounted for factors by 62.40%, and did not depend on sex and its interaction with the pre-slaughter weight factor.

The fat thickness above the 6-7 thoracic vertebrae was influenced by both the pre-slaughter weight factor and the sex factor by 4.87% ($F_{29.70}$> $F_{crit2.66}$) and 40.39% ($F_{7.09}$> $F_{crit3.90}$), respectively. Unaccounted factors had an impact of 49.86% on this indicator of pig carcasses.

The length of the bacon half was under the influence of pre-slaughter weight at 43.76% ($F_{44.27}$> $F_{crit2.66}$), under the influence of sex at 1.32% ($F_{4.01}$> $F_{crit3.90}$), under the influence of their interaction at level 4.82% ($F_{4.88}$> $F_{crit2.66}$) and under the influence of unaccounted factors at the level of 50.08%.

Pre-slaughter weight affected the fat thickness in the buttocks with a force of 9.64% ($F_{6.23}$> $F_{crit2.66}$), and sex and its interaction with the pre-slaughter weight at 6.84% ($F_{13.28}$> $F_{crit3.90}$) and 5.13% ($F_{3.31}$> $F_{crit2.66}$), respectively.

The carcass length depended on the pre-slaughter weight by 52.85% ($F_{55.69}$> $F_{crit2.66}$), on the interaction of sex and pre-slaughter weight by 6.87% ($F_{8.68}$> $F_{crit2.66}$) and on unaccounted for factors by 40.15%.

Published studies [5] have shown a significant increase in the fat thickness on the abdomen, with an increase in carcass weight from 107 to 125 kg. We were able to confirm this in our research. But contrary to the publications [8], wich said that the thickness of the fat on the back increased with increasing carcass weight, we had no such increase. There have also been reports [5] that with increasing pre-slaughter weight, there has been a general trend to increase the thickness of the longest back muscle. Similar data are available in other publications, which indicate that the thickness of the longest back muscle was 1.47 times greater in pigs at slaughter weight 130 kg compared to analogues at 110 kg [4]. Other published experiments on slaughter carcasses of Irish Landrace pigs have shown that for each increase in the fat thickness in the withers at pre-slaughter weight 110 kg by 1.0 mm, the thickness of the longest back muscle of pigs carcasses will also increase proportionally by 3.01 cm^2, and it will decrease by 3.005 mm at pre-slaughter weight 130 kg on the contrary [16]. We did not find similar results, but found that at pre-slaughter weight 100 kg, the thickness of the longest back muscle in pigs carcass was 8.47% greater in gilts than in barrows, and that the pre-slaughter weight did not change.

The researchers reported that the cooling losses at the pre-slaughter weight of pigs 120 kg were higher compared to the pre-slaughter weight of pigs 100 kg, both in absolute and relative terms [22]. However, we had a slightly opposite result, which did not coincide with such a statement. We were able to find that the cooling losses were higher in barrows with a pre-slaughter weight of 90 kg compared to their counterparts at a pre-slaughter weight of 100 kg by 0.9%.

It is also reported that the carcasses of commercial fattening pigs of the Irish Landrace with a pre-slaughter weight 120 kg significantly outweighed the pigs with a pre-slaughter weight 110 kg in terms of meat content in the whole carcass by 1.5 kg or 3.72% and in terms of its thirds: in cervical-scapular by 16.06%, in dorsal-lumbar by 17.37%, in pelvic-femoral by 8.02% [17]. As the pre-slaughter weight of barrows increased, the meat content in their carcass decreased ($P <0.01$), while light carcasses (90 kg) had an advantage of 1.43% compared to the carcasses of heavy barrows ($P <0.01$) [7]. In our experiment, we found a similar manifestation of changes in the meat content in the carcass. The meat content was higher than the lower pre-slaughter weight 90 kg and decreased with its increase to 120 kg. Therefore, we cannot agree with the published report [18], which says that the meat content in carcasses also increased with the pre-slaughter weight of pigs. Our general conclusions about changes in carcass in gilts coincide with the reports in the manuscripts [31], which indicate that in general, gilts had higher ($p < 0.05$) carcass weight, the thickness of the longest back muscle and slaughter yield. Also, our results did not coincide with the reports [19], which indicate that there is no difference between gilts and barrows in fat thickness and carcass length. Our conclusions coincided with the general changes in carcass slaughter rates with increasing pre-slaughter weight, as reported in the published work [30].

CONCLUSIONS

Although the slaughter weight of both gilts and barrows increased with the pre-slaughter weight.

But the slaughter yield, cooling losses, meat content and thickness of the longest back muscle were not statistically significant and remained stable with increasing growth rates from 90 kg to 120 kg in pig carcasses.

With an increase in the pre-slaughter weight to 120 kg, there was an increase in the fat thickness, the carcass length and the length of the bacon half in both gilts and barrows.

In general, the gilts had a higher carcass weight at pre-slaughter weight 90, 110 and 120 kg, a higher weight of chilled carcass at pre-slaughter weight 120 kg, a higher carcass length and a length of bacon halves at pre-slaughter weight 120 kg, a higher thickness of longest back muscle and meat content at pre-slaughter weight 100 kg.

Barrows had a higher fat thickness above the 6-7 thoracic vertebrae, the fat thickness in the buttocks, the fat thickness in the withers at a pre-slaughter weight 100 kg.

Dispersion two-factor analysis showed a significant dependence of slaughter carcasses of gilts and barrows on the pre-slaughter weight of pigs.

Sex significantly affected the slaughter yield, meat content, the fat thickness above the 6-7 thoracic vertebrae, the fat thickness in the buttocks, the length of the bacon halves, carcass length.

The factor of sex and pre-slaughter weight significantly affected the slaughter yield, meat content, the length of the bacon half and the carcass length.

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MEASURING SUCCESS LEVELS OF AGRICULTURAL PRODUCER ORGANIZATIONS AND ORGANIZATIONAL PROBLEMS: THE CASE STUDY IN TURKEY

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Abstract

This study reviews the success status and organizational problems of Agricultural Producer Organizations (POs). The main material of the study consisted of the original data obtained from the surveys carried out with 360 producers determined by the proportional sampling method in the province of Uşak, Turkey. According to the research findings, members/partners found Agricultural Development Cooperatives more successful. Agricultural Development Cooperative, respectively, was followed by Agricultural Credit Cooperative, Stud Breeders Association, Producer Association, Sugar Beet Growers Cooperative, and Chamber of Agriculture. Irrigation Cooperative was the least successful producer organization. It was determined that the most important problem of the POs was the managerial problem, and it was followed by the financial, supervision, education, top organization, and legislation problems. The study is of primary importance in the success of the organization and in the effective use of production resources.

Key words: *agricultural producer organizations, input procurement, marketing, organizational problems, organizational success*

INTRODUCTION

Agriculture is known as the first occupation of human beings and a sector in which organizational formations are for the first time. However, the low technical education and knowledge levels of the people engaged in agriculture, and the weak organizational awareness and administrative skills weaken the organizational development [13].
In the agricultural sector, there are different organizations established according to various laws, which basically aim to protect certain expediencies of their members/partners [20]; [7]. These; are Agricultural Cooperatives, Chambers of Agriculture, Stud Breeders Associations, and Producer Associations. All of these formations are defined as the POs [23].
An Agricultural Producer Organization is a structure formed by the cooperation of farmers for professional, economic, or social purposes, founders and members/partners of which are only farmers [25]. The forms of cooperation of the farmers may differ in terms of the structure of the organization formed and the scope of the activities. The main goals that farmers want to achieve by cooperation are; protecting their expediencies (representation functions); production planning, purchasing of production means and sales (technical and economic functions), and local development [11].
The POs are farmers' economic organizations. A producer organization is understood as any legal entity established on the initiative of the POs, mainly aimed at increasing the economic efficiency of its members/partners by adjusting production and sales to the needs of the market [1]. A PO can have the legal form of a cooperative. The common feature of the POs and cooperatives is that they apply principles of cooperativeness in their activities [4].

The POs occur more frequently during periods of intensification of the transformation and modernization of agriculture, increased integration of rural peoples into markets, or this integration takes place. They are intermediary institutions that serve as an interface between rural societies and their environments, and their aims are to establish external economic, institutional, and political relations between farmers. The POs strive to support the changes that occur on the one hand and to negotiate conditions on the other [16].

POs have many advantages in terms of the agricultural sector. These are:

• Increasing agricultural production and product quality,

• Increasing the living standard of those engaged in agriculture,

• Creation of new agricultural policies,

• Being active in the market and gaining competitive strength,

• Being able to receive affordable and adequate credit,

• Being able to follow innovations in agriculture and so low-cost and high-quality technology use,

• Lowing production costs,

• Having productive, profitable, and rational farms.

• Creating awareness of organization and democracy in the community and making it possible to act together, demand justice, and mold public opinion within the framework of the legislation,

• Protecting small farms' benefits,

• Using scarce sources effectively,

• Being able to increase the country's contribution to the development process.

The POs play an important part in the socio-economic development of the regions where they are established [6]; [15]. However, like other sectors in the economy, the POs also have various problems. In the study, the problems of POs were also investigated in addition to measuring the success of POs, and these problems were analyzed in legal, administrative, and financial terms. These problems were explained in detail in the results section of the study.

Although various studies have been conducted on agricultural sciences in the region, no studies about the POs have been found. Some of the researches related to agriculture in the region are: “Geographical Features of Poppy Agriculture in Uşak” [9]; “The Effect of Climate Changes on Agricultural Products in Usak Province” [10]; **“**Present condition of apple production in Uşak province” [27]; “Current situation, problems and solution of dairy cattle enterprises in uşak province” [2]; **“**Sheep farming business in Uşak city of Turkey: Economic structure, problems and solutions” [3]; “Investigation of chicken meat consumption habits in terms of improvement of broiler breeding: a case study of Uşak Province” [28].

The study consists of four main headings, including the introduction. In the 'Introduction', general information on the topic was reviewed. In the 'Material and Methods', fieldwork and the methods used in the study were explained. In the 'Results', emphasis is on the evaluation of organizational success, and organizational problems. In the 'Conclusion', the fourth heading, the study ended with a conclusion knowledge and some recommendations.

The study will be a guide for policy makers in updating agricultural policies related to producer organizations in agriculture.

MATERIALS AND METHODS

Materials

In Uşak province, there are 155 agricultural producer organizations, of which 73 are Agricultural Developments, 34 are irrigation Cooperatives, 1 is a Sugar Beet Growers Cooperative, 6 are Chambers of Agriculture, 3 are Stud Breeders Associations, 8 are Producer Associations, 23 are Agricultural Credit Cooperatives, 6 are Village Service Associations and 1 of which is Uşak Region Animal Husbandry Cooperatives Association.

The total number of partners/members of these organizations is 144,567.

The main material of the research consisted of the data obtained from the members/partners of the POs in Uşak.

These data obtained through surveys from the farmer members/partners determined by the proportional sampling method formed the primary data of this research.

The field survey was run in the period 2012-2013.

In this study, scientific studies and published papers previously on the subject and the statistics of some institutions were also utilized. The Ministry of Agriculture and Forestry and the Turkish Statistical Institute are the foremost of these institutions. The data obtained from these institutions constituted the secondary data sources of the research.

Methods

The research was performed in the villages of 6 districts including the central district of Uşak.

The proportional sampling method was used to determine the sampling size. The following formula was used in this method [18] and [24].

$$n = \frac{N_p(1-p)}{(N-1)\sigma^2{}_{p_x} + p(1-p)}$$

where:

n = Sampling size,

N_p = The number of total units belonging to the sampling frame,

p = Ratio of the studied feature on in the number of total units,

$\sigma^2{}_{p_x}$ = Variance.

Accordingly, a 360 sampling size calculated for a confidence interval of 95% and an error margin of 5% was found adequate. Considering the sampling volume determined, 5 researchers were selected from each region, and surveys were conducted with 360 producer members/partners. Surveys were filled by meeting face-to-face with them.

Before the surveys, the producers were provided informed consent on the surveys. This consent was verbal. And so their active participation in the surveys was ensured. In order to achieve the goal and acquire the original data, these survey forms were used. The survey forms consisted of questions measuring the success of organizations and about organizational problems.

After the surveys, obtained data were entered into the computer, and then they were analyzed with statistical methods fitting for the purpose of the research. SPSS Package Program was used for statistical analysis. In evaluating the research data, descriptive statistics (mean, standard deviation, frequency) were also used significantly.

RESULTS AND DISCUSSIONS

Success levels of POs

In the research, the success status of the POs was analyzed separately and given in tables. Meanwhile, it was detected that all the producers has been a member of at least one PO.

The Chambers of Agriculture, in which all the farmers are registered are one of the important institutes for the formation of national agricultural policies and running the education-extension services for their members.

In Table 1, the success status of the Chamber of Agriculture, which is a professional organization for the farmers, was investigated and the ratio of farmer members responding "very successful" was 3.7%, those responding "successful" was 49.1%, those responding "I have no idea" was 1.8%, those responding "unsuccessful" was 31.2%, and those responding "very unsuccessful" was found as 14.2%.

Table 1. Success level of Chamber of Agriculture

Success status	Number of members	(%)
Very successful	8	3.7
Successful	107	49.1
No idea	4	1.8
Unsuccessful	68	31.2
Very unsuccessful	31	14.2
Total	218	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

Agricultural Credit Cooperative is considered the financial institution of the producer. It is one of the most active POs since it supplies production inputs and consumption items to its members. Its institutionalized structure has been an important factor in its success.

When the success status of the Agricultural Credit Cooperative is examined, while the ratio of those responding "very successful" was 2.5%, those responding "successful" was 66.3%, those responding "I have no idea" was 1.2%, those responding "unsuccessful" was 19.6% and those responding "very unsuccessful" 10.4% (Table 2). In the study, the total success rate of Agricultural Credit Cooperatives was calculated as 68.8%.

Table 2. Success level of Agricultural Credit Cooperative

Success status	Number of partners	(%)
Very successful	4	2.5
Successful	108	66.3
No idea	2	1.2
Unsuccessful	32	19.6
Very unsuccessful	17	10.4
Total	163	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

In Table 3, the success rates of the Stud Breeders Association were given. When the table is examined, 10.0% of the members found very successful the Stud Breeders Association. The rate of members finding successful the Stud Breeders Association was 58.6%, the rate of those who said they had no idea was 5.7%, the rate of those who found it unsuccessful was 17.1%, and the rate of those who found it very unsuccessful was 8.6%. The total rate of those who found the breeder association successful and very successful was 68.6%. This situation can be accepted as an indication that most of the producers are satisfied with the services of the union.

Table 3. Success level of Stud Breeders Association

Success levels	Number of members	(%)
Very successful	14	10.0
Successful	82	58.6
No idea	8	5.7
Unsuccessful	28	17.1
Very unsuccessful	13	8.6
Total	140	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

As in Turkey, the most common type of cooperative in Uşak is the agricultural development cooperative. Agricultural Development Cooperatives provide their partners with financial and social opportunities and services such as input supply, product marketing, research, training and extension services, and prevention of rural migration. It is one of the most successful cooperatives. The fact that these cooperatives are established in small regions and the works performed can be observed is effective in their success.

The success of Agricultural Development Cooperatives was given in Table 4. According to this; the rate of those expressing that the Agricultural Development Cooperatives were "very successful" was determined at 10.9%, and the rate of those uttering that they were "successful" was 61.4%. On the other hand, the rate of those responding "unsuccessful" was calculated at 8.9%, the rate of those responding "very unsuccessful" was 14.8% and the rate of those stating "no idea" was also 4.0%. The fact that the rate of those expressing "very successful" and "successful" was high (72.3%), shows that these cooperatives are quite effective on partners.

When the Table examined, it is viewed that the rate of Agricultural Development Cooperatives", unsuccessful" and "very unsuccessful", was quite low.

Table 4. Success level of Agricultural Development Cooperative

Success status	Number of partners	(%)
Very successful	11	10.9
Successful	62	61.4
No idea	4	4.0
Unsuccessful	9	8.9
Very unsuccessful	15	14.8
Total	101	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

The Uşak Sugar Beet Growers Cooperative also procures feed, diesel, and irrigation materials in addition to various input procure (seeds, fertilizers, pesticides, etc.) for sugar beet farming to its partners. For this reason, it is known as a "successful" cooperative among producers. In Table 5, the success status of the Beet Growers Cooperative was analyzed. Accordingly, the rate of those declaring "very successful" and "successful" was 58.7%, the rate of those declaring "I have no idea" was 6.7%, and the rate of those declaring "unsuccessful" and "very unsuccessful" was also 34.6%.

Table 5. Success level of Sugar Beet Growers Cooperative

Success status	Number of partners	(%)
Very successful	8	10.7
Successful	36	48.0
No idea	5	6.7
Unsuccessful	13	17.3
Very unsuccessful	13	17.3
Total	75	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

The success status of the Producer Associations, one of the producer organizations, was examined and given in Table 6. When the table is examined, the rate of those stating "very successful" was 5.9%, the rate of those stating "successful" was 61.7%, the rate of those stating "no idea" was 1.5%, the rate of those stating "unsuccessful" was 20.6%, and the rate of those stating "very unsuccessful" was 10.3%. Accordingly, the success rate of Producer Associations in the region was 67.6%, and it was quite high.

Table 6. Success level of Producer Association

Success status	Number of members	(%)
Very successful	4	5.9
Successful	42	61.7
No idea	1	1.5
Unsuccessful	14	20.6
Very unsuccessful	7	10.3
Total	68	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

The last of the producer organizations investigated in the region is the Irrigation Cooperative. Irrigation cooperatives are established by the producers owning land within the irrigation field with the request of the Special Provincial Administration or the Provincial Directorates of State Hydraulic Works being in charge of the establishment of irrigation facilities. Thus, the management of irrigation facilities is transferred to cooperatives, and irrigation services are provided to the producers. Cooperatives give this service to producers for a certain fee, and the income obtained is also used for the maintenance, repair, and deficiencies of irrigation facilities.

Table 7. Success level of Irrigation Cooperative

Success status	Number of partners	(%)
Very successful	3	9.4
Successful	9	28.1
No idea	1	3.1
Unsuccessful	10	31.3
Very unsuccessful	9	28.1
Total	32	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

The rate of producers uttering that the Irrigation Cooperative was "successful" was 37.5%, and the rate of those uttering that it was "unsuccessful" was 59.4%. These rates show that the Irrigation Cooperative was not giving service adequately to the producers.

Information about the success status of producer organizations was given in Table 8. Accordingly, the Agricultural Development Cooperative ranked first with a rate of 72.3%.

Table 8. General success levels of POs

POs	Number of members/ partners	Very successful (%)	Successful (%)	No idea (%)	Unsuccessful (%)	Very unsuccessful (%)	Total (%)
Chamber of Agriculture	218	3.7	49.1	1.8	31.2	14.2	100.0
Agricultural Credit Cooperative	163	2.5	66.3	1.2	19.6	10.4	100.0
Stud Breeders Association	140	10.0	58.6	5.7	17.1	8.6	100.0
Agricultural Development Coop.	101	10.9	61.4	4.0	8.9	14,8	100.0
Sugar Beet Growers Cooperative	75	10.7	48.0	6.7	17.3	17.3	100.0
Producer Association	68	5.9	61.7	1.5	20.6	10.3	100.0
Irrigation Cooperative	32	9.4	28.1	3.1	31.3	28.1	100.0

Source: Sağlam, U., İnan, İ.H., 2013 [24].

It was followed by the Agricultural Credit Cooperative with 68.8, the Stud Breeders Association with 68.6%, the Producer Association with 67.6%, the Sugar Beet Growers Cooperative with 58.7%, and the Chamber of Agriculture with 52.8%. Of unsuccessful ones, the Irrigation Cooperative ranked first with 59.4%. This was followed by the Chamber of Agriculture with 45.4% and the Sugar Beet Growers Cooperative with 34.6%. Producer organizations in the region were generally successful.

Problems of POs

The basic purpose of the organization of producers is to achieve a certain goal together. They encounter some problems in order to achieve these goals determined [19]; [21]. In order to be able to cope with these problems, the organization's management should know about the objectives of the organization and the legislation [12].

In the study, in light of the information obtained from both the organization's members/partners and the producers in the organization's management, the problems of the POs were revealed and given in Table 9. According to this, the rate of the producers thinking that the POs had a “Managerial Problem” was 26.1% and the rate of the producers expressing that they had a “Financial Problem” was 21.4%. 18.3% of the producers also stated that POs had a "Supervisory Problem". This was followed by Education with 16.1%, Top Organization with 8.6%, and Legal Problems with 3.9% respectively.

These problems were explained below.

Managerial problems

From an organizational point of view, management is to ensure harmony, planned, and orderly work of all elements in an organization for the purposes determined [22]. This task is performed by the organization's management.

However, management is a complex and multidimensional function. Managers to fulfill this function must have technical, human relations, and conceptual skills. Of these, the technical dimension states the manager's functional expertise field; the human relations dimension related to the human element is trying to achieve results with others; the conceptual dimension refers to the manager's ability to see entire of the organization as a whole [14]. The existing process for the realization of management activities is planning, organization, execution, coordination, supervision, and manager tendency [5]. The most important thing is to be able to ensure that these functions related to management are carried out with the least error.

The POs must continue their organizational activities to achieve specific aims. However, many factors especially management and labor force opportunities can affect organizational activities positively or negatively. For example, in a study conducted in Germany, organizational problems were stated to primarily result from human resources [26].

The most important problem related to the POs was determined to be management problems with a rate of 26.1%. Successful management is also the best means for the success of organizations. While the timely and correct decisions of organizational management are effective in the success of the organization, organizations can experience difficulty due to wrong and delayed decisions of organizational management. Successful and educated management is also important for the effective use of organizational resources. In this context, organizational resource use efficiency can only be measured by the success of the management.

Financial Problems

In the analysis of the survey data, the second problem of the POs was determined as financial and this rate was found 21.4%. The fact that there is no Cooperatives Bank for the financing of the agricultural sector in Turkey and that the Agricultural Bank also serves non-agricultural sectors causes financial problems for the POs. That the government should create a low-cost, long-term, and easy financial system for producers and POs will be important in solving financial problems [24].

Table 9. Problems of POs

Problems	Number of members/partners	(%)
Managerial	94	26.1
Financial	77	21.4
Supervisory	66	18.3
Organizational Awareness, Education and Research)	58	16.1
Top Organization (Horizontal Integration and Inter- organizational Cooperation)	31	8.6
Legislation (Legal Problems)	14	3.9
Non-responders	20	5.6
Total	360	100

Source: Sağlam, U., İnan, İ.H., 2013 [24].

In Turkey, the other cooperatives excluding Agricultural Credit Cooperatives cannot benefit from agricultural loans. Because they do not have sufficient assets or capital stock to provide collateral for the credit. Thus, the crediting system should be created for the POs and the crediting system should be applied by cooperatives bank or Agricultural Credit Cooperatives.

Support payments for the agricultural sector must be performed through the POs. Some expenses of producer organizations should be subsidized by the state and producers should be supported indirectly. The tax exemption should be applied to the POs.

Finally, organizations must have sufficient and balanced capital for their development and continuity [29]. A strong financial structure means a strong PO, and a strong PO also means a strong economy.

Supervisory Problems

Supervision of cooperatives is important in terms of the quality of operated services in cooperatives. Supervision is also important for the development of a government-organization relationship. In Turkey, the supervision of cooperatives is carried out by more than one Ministry and even more than one supervision unit affiliated with the same Ministry. It is very important in terms of the quality of the supervision that supervision is carried out by specialized supervision cooperatives. For example, supervision cooperatives in Germany take an active role in the supervision and development of cooperatives. Such cooperatives to guide cooperatives should be established in Turkey [24] and [8].

By the item of the Constitution, "The government takes measures to ensure the development of cooperatives primarily aiming at increasing production and protecting the consumer by taking into account the benefits of the national economy", agricultural organization and especially cooperativeness will be encouraged and supported. However, the policies having been applied in this regard could not be effective in the formation of real cooperativeness. While important steps were taken regarding the autonomy of cooperatives, the expected improvements could not be realized due to the decrease in public support and applied policies.

It is also necessary to dwell on the relationship of agricultural organizations with politics. In principle, it is natural for agricultural organizations to be pertinent to politics. However, this interest should be limited to national policies and agricultural and producer problems.

62.5% of the producers noticed organizations as their own organizations, 7.8% of them as government-controlled, and 10.8% of them as state-run organizations. First of all, the producers should know that the organizations are their own and should play an active part in the formation of their national policies regarding the organization.

Organizational Awareness, Education and Research Problems

The existence of conscious individuals believing in the real benefits of the organization is important in the development of agricultural organizations. An effective organizational activity is possible with training and research to be made in this field. With the training activities to be conducted, organizational awareness and organizational activity will have developed in the agricultural sector.

For a strong and effective organization and cooperatives, producers must believe in and adopt this topic. In other words, producers' education is important for an active organization. Already, “Education” is one of the basic cooperativeness principles.

Although education activities are conducted by the government, every organization and especially the top organizations that want to be successful in their field should pay attention to "farmer education". Producers should be given the awareness of acting jointly not only via information but also through various training activities. These can be in the form of meetings, demonstrations of new products, and encouraging competitions [24].

Within the scope of the Agricultural Extension Development Project put into practice by the Ministry of Agriculture and Forestry, it should be benefited Agricultural Engineers and Veterinarians employed in towns and villages for informing the producers.

The number of institutions training on directly the PO is few in Turkey. Thus, the PO should be placed more in the curricula of faculties of agriculture and vocational high schools that give widespread education.

It is very important to carry out research that will produce solutions to the problems in the field of organization and to support them by producer organizations and cooperatives. In this regard, relevant research institutions, especially universities, should be made more active. Coordination should be ensured between ministries, universities and producers, and continuous and permanent education-extension projects should be developed.

Top Organization (Horizontal Integration and Inter-organizational Cooperation) Problems

The top organization of cooperatives states the vertical organization of cooperatives in the pyramid form from the bottom up from the unit cooperative to the national union in a country. In other words, top organization means the organization of cooperatives in the form of unions, central unions, and national unions [17].

In the top organization of agricultural cooperatives in Turkey, the authorization to determine the region where the unions will be established has been granted to the Ministry of Agriculture and Forestry. In this context, by coming together of at least 7 agricultural cooperatives, cooperatives unions were constituted, and by coming together of 7 cooperatives unions, national central unions were constituted.

There is complexity in the top organization of cooperatives in Turkey. Especially, instead of a top organization with the same name, Agricultural Development Cooperatives have a top organization in different regions according to their working subjects. Likewise, if an Agricultural Development Cooperative is engaged in animal husbandry activities, it must be a member of the top union of Animal Husbandry Cooperatives, and if the same cooperative is engaged in forestry, it must be a member of the top union of the Forest Cooperatives. However, the fact that the organization is a continuation of unit cooperatives instead of working subjects will also eliminate this complexity.

Real organization can only be with a strong top organization. The top organization has indisputable importance both for the continuation of unit organizations and for the protection of the rights of producers.

Cooperation between cooperatives is one of the basic cooperativeness principles. Especially cooperatives activating in the same field should be organized in the way unions, central unions, and national unions and should cooperate in the international field. In fact, professional organizations, cooperatives, and other producer organizations should act in unison.

Legal (Legislation) Problems

In the research, it was stated that one of the main problems of POs is legal problems. There are the POs established according to very different laws in the agricultural field in Turkey. For example, in addition to the cooperatives specializing on a product basis and having a rooted history, a different structure was supported by the government by being introduced the Producer Associations Law in 2004.

Organizations established by different laws are the biggest obstacle in front of a real and effective organization in the agricultural sector. Therefore, legal complexity needs to be eliminated.

The fact that cooperatives and other organizations in the agricultural field are legally related to different Ministries can also be considered a separate problem.

In that respect, first of all, the laws regarding agricultural cooperatives should be unified within the framework of Law No. 1163, and all the cooperatives and organizations related to agriculture should be connected to the Ministry of Agriculture, and Forestry [17].

Although agricultural organizations activate in almost the same fields, they are seen as rivals of each other, since they do not have clear-cut job descriptions. For example, while cooperatives also conduct activities marketing their products as well as the input procurement to their members/partners, other agricultural organizations can also activate in the same fields. While producer associations do not have product marketing authorization, the Stud Breeders Association also carries out the task of marketing products. For this reason, the duties of the organizations should be defined correctly, and applications to compete with each other should be avoided.

Appropriate, long-term, and consistent policies should be determined by the government, necessary legislative arrangements should be made, and above all, a civil organization should be adopted for agricultural organizations to be able to carry out salutary and relevant studies on their own duty fields. The legislation to be regulated should not be complicated, should be understandable, and easily applicable.

CONCLUSIONS

In the research, producer organizations were examined separately according to their success and Agricultural Development Cooperative was found as a successful producer organization. Stud Breeders Association ranked 2nd and Agricultural Credit Cooperatives ranked 3rd. Though the most unsuccessful one was the Irrigation Cooperative, the POs were generally successful in the research region.

As in other organizations, the most important factor f the success of the POs is the governing body. Managers who know the law, articles of association, and legislation well, establish good relations with their members/partners and have the ability to represent are successful. Members/partners should be interested in the works of organizations, support the management, participate in general boards and make the necessary supervision.

For organizational success, members/partners should also be provided with marketing services. The POs, especially cooperatives must implement the contracted production model with industrial organizations, procure input for members/partners and market their products. It would be the rightest choice for cooperatives established for economic purposes, to play an active part in this regard.

It was determined that the POs in the region have some organizational problems and these problems resulted from both inside the organization and outside the organization. Of these, managerial problems rank the 1st. This was followed by financing, auditing, training, superior organization, and legislation problems, respectively. Thus, the management of the organization must know well the aims, principles, and legislation of the organization. Managers should make an effort to fulfill organizational activities, inform their members/partners in all respect, and exhibit transparent management. Members/partners should also give support to the managers in organizational work, take over responsibility, and state their opinions openly by participating in the general assemblies.

As a result, the way to be developed, modern and social society is to be an organized society. Producers should know that the only way out is to act in unison and they should care about their organizations. In Turkey, where small-scale farms are common, modern and economical agriculture is only possible with producer organizations. For this reason, there is a need for producer organizations that are well-managed and whose members/partners give support.

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EVALUATION OF THE NITROGEN USE IN WHEAT CROP IN RELATION TO AMMONIUM NITRATE FERTILIZER

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Abstract

This study evaluated the use of nitrogen in wheat crop, in terms of Agronomic Efficiency (AE) and Partial Factor Productivity (PFP). The experiment was conducted in the specific conditions of the Banat University of Agricultural Science and Veterinary Medicine of Timisoara (BUASVM), Timis County, Romania. Nitrogen (N) was provided on the basis of ammonium nitrate, in the range 0 - 250 kg a.s. ha^{-1}, in 11 experimental variants (T1 to T11). The AE index varied between 14.631 (T2) and 9.138 (T11), with a maximum (27.211) corresponding to the N75 dose (T4). The PFP index recorded decreasing values from 90.497 (T2) to 16.725 (T11). The AE index variation in relation to N was described by the polynomial equation of degree 4 (R^2 = 0.975, p <0.01), and the AE index variation according to Y was described by a polynomial equation of degree 3 (R^2 = 0.722, p = 0.0233). In relation to the calculated progressive increase yield (ΔPY) the AE variation was described by a linear equation (R^2 = 0.780, p <0.001). The PFP index variation in relation to N was described by a polynomial equation of degree 3 (R^2 = 0.994, p <0.001), and in relation to N and Y, as simultaneous influence, was described in statistical safety conditions (R^2 = 0.885, p = 0.0144).

Key words: *Agronomic Efficiency (AE), mineral fertilizer, Partial Factor Productivity (PFP), Progressive Increase Yield (ΔPY), wheat*

INTRODUCTION

Agricultural production and productivity of agricultural systems are subject to changes of varying magnitude, in relation to ecological, economic and social elements that influence the functionality of agricultural systems [15, 34, 35, 37, 43, 45].
Particular attention has been paid to the evaluation of agricultural productivity in relation to fertilizers, due to the importance of nutrients in the quantitative and qualitative formation of production [7, 18].
Fertilizer utilization depends on soil conditions [24, 26, 29, 46], climatic conditions [16, 22], crop plants [25, 26] relationships of interdependence in soil nutrients [31], the role of nutrients in plant metabolism [5, 30, 51], fertilizer assortment [1, 6, 42, 50], agricultural technologies and practices [4, 48, 49].
The effectiveness of fertilizers has been studied and evaluated in relation to crop productivity, quality of agricultural production, yields, quality indices, but also in relation to some aspects of environmental quality [3, 32, 39, 41].
Among the nutrients, special attention has been paid to nitrogen (N), through different molecular, eco-physiological, agronomic, economic, environmental approaches, and various indices have been formulated that express the efficiency of nitrogen use [2, 10, 33].
The efficiency of nitrogen use varies in relation to different influencing factors, and has been studied in relation to different crops, plant density, soil and climatic conditions, elements of technology, etc. [8, 10, 40].
In order to improve the use of N, studies and approaches have been carried out in different directions, and it is of interest to improve the genetic potential of cultivated plants [21], [38], the adjustment of agricultural technologies by fertilization [14, 36], nutrient management [9, 12, 44], adjustment of the plants hydric regime [19, 27, 28], optimization of agricultural production systems

[23].

In the context of the interest for the analysis of the efficiency of fertilizer use, of the capitalization of nutrients from fertilizers, of the increased interest for nitrogen (N), the present study evaluated the efficiency of N use in wheat culture, based on two indices, Agronomic Efficiency (AE) and Partial Factor Productivity (PFP), under the conditions of mineral fertilization with nitrogen.

MATERIALS AND METHODS

The experiment on the influence of nitrogen fertilization on autumn wheat cultivation was organized within the Didactic and Experimental Resort (DER) BUASVM Timișoara, Timiș County, Romania. Alex wheat cultivar was cultivated, a productive wheat cultivar with good bakery quality indices. Nitrogen (N) was administered as granulated ammonium nitrate (GAN), with an active substance content of 33.5% N, of which 50% in ammonium form (NH_4^+), and 50% in nitric form (NO_3^-).

The fertilizer was applied in the spring, differentiated on 11 experimental variants (T1 to T11), in doses calculated to ensure nitrogen in the range 0 - 250 kg a.s. ha^{-1} (a.s. - active substance). The variation of N doses was achieved at a rate of 25 kg a.s. The experimental variants were placed randomly, in three repetitions, with a harvestable surface of 18 m^2. The agricultural year 2017 - 2018 was considered for this study.

To evaluate the efficiency of nitrogen (N) use in wheat crop, two indices were calculated, Agronomic Efficiency (AE) [13, 17], relation (1), and Partial Factor Productivity (PFP) [17], relation (2).

$$AE = (Y - Y_0)/F \qquad (1)$$

where:

AE – Agronomic Efficiency; Y – production for each variant fertilized with nitrogen (T2 to T11); Y_0 – production to the control variant (T1); F – dose of N corresponding to production Y.

$$PFP = Y/F \qquad (2)$$

where:

PFP – Partial Factor Productivity; Y – production for each variant fertilized with nitrogen (T2 to T11); F – dose of N corresponding to production Y.

Experimental data were analyzed by the Anova Test (Alpha = 0.001, $p < 0.05$) to assess the statistical safety of the data and the presence of variance in the recorded data set. The EXCEL computing module (Microsoft Office), the PAST software [20], and the Wolfram Alpha software (2020) [47] were used for mathematical and statistical data processing and analysis.

RESULTS AND DISCUSSIONS

Starting from the wheat production data [11], the efficiency of nitrogen use in wheat crops was evaluated, based on Agronomic Efficiency (AE) [13, 17], relation (1), and Partial Factor Productivity (PFP) [17], relation (2). The values obtained for the nitrogen use efficiency, based on the two indices considered (AE and PFP) are presented in Table 1.

Table 1. AE and PFP index values, wheat crop, Alex cultivar, under the influence of ammonium nitrate fertilizer

Experimental variants		Nitrogen use indices	
Trial	N (kg a.s. ha^{-1})	AE	PFP
T1	0	-	-
T2	25	14.631	90.497
T3	50	24.692	62.625
T4	75	27.211	52.500
T5	100	21.221	40.188
T6	125	19.827	35.000
T7	150	17.440	30.084
T8	175	16.305	27.143
T9	200	14.454	23.938
T10	225	11.848	20.278
T11	250	9.138	16.725

Source: original data for AE and PFP calculated based on N doses, and production data [11].

In the case of the AE index, increasing values were registered, starting from 14.631

corresponding to the N0 dose (T1), up to 27.211 registered at the N75 dose (T4), and the related production.

Starting from the N100 dose and the related production obtained (T5), there was a decreasing trend of AE values, associated with N and Y values used in the calculation, so that at N100 the AE value was 21.221 (T5), and at the maximum dose used in the study (N250) and related production, the value of AE was 9.138 (T11).

The PFP values registered a decreasing distribution in relation to the fertilizer doses, between 90.497 registered at N0 (T1, control) and 16.725 registered in the case of N250 (T11) and the related productions (Y).

The ANOVA single factor test confirmed the presence of the variance in the experimental data set, and statistical safety of the data (F> Fcrit, p <0.001, for Alpha = 0.001).

Agronomic Efficiency (AE) represents the productivity recorded as a result of nitrogen inputs (N), and varies differently in relation to N as an independent variable, respectively in relation to Y as an N-dependent variable. However, the expression of the production also depends on other inputs, elements of technology, the state of health of the plants, or on environmental factors during the vegetation period. The variation of AE was analyzed in relation to the nitrogen doses (N) and in relation to with production (Y).

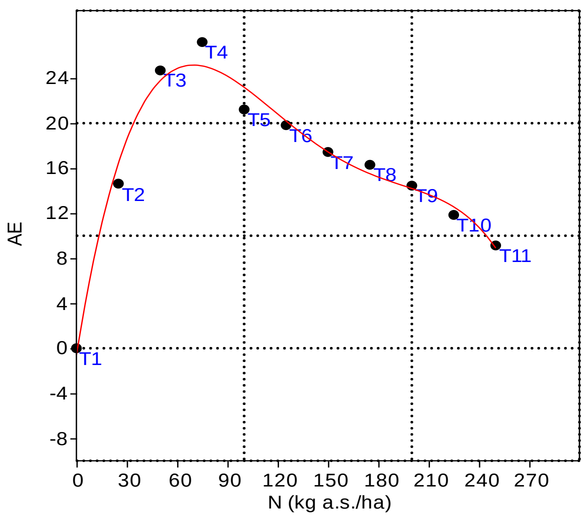

Fig. 1. Graphic distribution of AE values in relation to N, wheat crop, Alex cultivar
Source: original graph

In the case of the present study, the variation AE according to N was described by a polynomial equation of order 4, equation (3), in conditions of R^2 = 0.975, p <0.01, with the graphical distribution in Figure 1.

$$AE = -8.118E-08x^4 + 5.078E-05x^3 - 0.01119x^2 + 0.9302x - 0.5825 \quad (3)$$

where:
AE - Agronomic Efficiency;
x – nitrogen fertilizer (N)

The AE variation according to the recorded production (Y) was described by a polynomial equation of order 3, equation (4), in conditions of R^2 = 0.722, p = 0.0233, with the graphical distribution in Figure 2.

$$AE = 4.525E-09x^3 - 5.414E-05x^2 + 0.2059x - 226.6 \quad (4)$$

where:
x – recorded production (Y, kg ha^{-1})

The variation of AE in relation to progressive increase yield (ΔPY) was evaluated, where ΔPY was calculated according to equation (5).

$$\Delta PY = Y_i - Y_{i-1} \quad (5)$$

where:
ΔPY – progressive increase yield; Y_i – current production, at the dose of F_i fertilizer; Y_{i-1} – production at the previous dose of fertilizer (F_{i-1}).

From the calculation of the progressive increase yield (ΔPY) it was found the increase of ΔPY in the fertilization interval N25 - N75 (T2 to T4) with values between 365.78 - 868.63 kg (ΔPY = 365.78 kg corresponding to N25; ΔPY = 868.83 kg corresponding to N50; ΔPY = 806.25 corresponding to N75). Starting with dose N100 (T5) to N200 (T9), the progressive increase yield (ΔPY) registered positive values, but decreasing, from ΔPY = 356.25 kg (N100, T5) to ΔPY = 37.50 kg (N200, T9). From dose N225 (T10) to N250 (T11) the progressive increase yield (ΔPY) recorded negative values, ΔPY = -

225.00 kg at dose N225 (T10), respectively $\Delta PY = -381.25$ kg at N250 (T11).

In the case of Agronomic Efficiency (AE), as an index for expressing the efficiency of nitrogen use, there was a decrease in the values of variants T10 and T11 (table 1) and a deviation of the distribution from the model described by equation (4), figure 2. Phenomenon it is much better explained by the negative values recorded for ΔPY corresponding to variants T10 and T11.

The regression analysis facilitated the description of the AE variation in relation to ΔPY, equation (6), under conditions of $R^2 = 0.780$, $p < 0.01$. The graphic distribution is presented in Figure 3.

$$AE = 0.0125x + 14.817 \quad (6)$$

where:

x – progressive increase yield (ΔPY), calculated on the basis of equation (4).

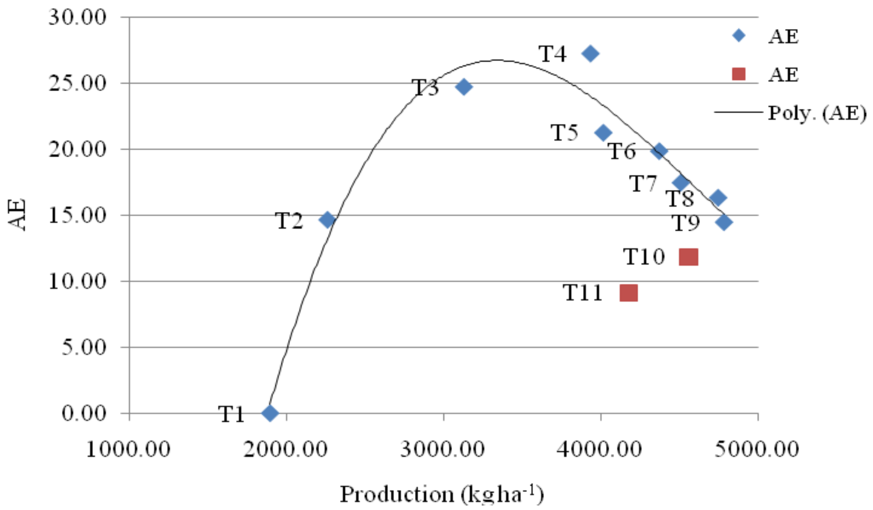

Fig. 2. Graphic distribution of AE values in relation to production (Y), wheat crop, Alex cultivar
Source: original graph.

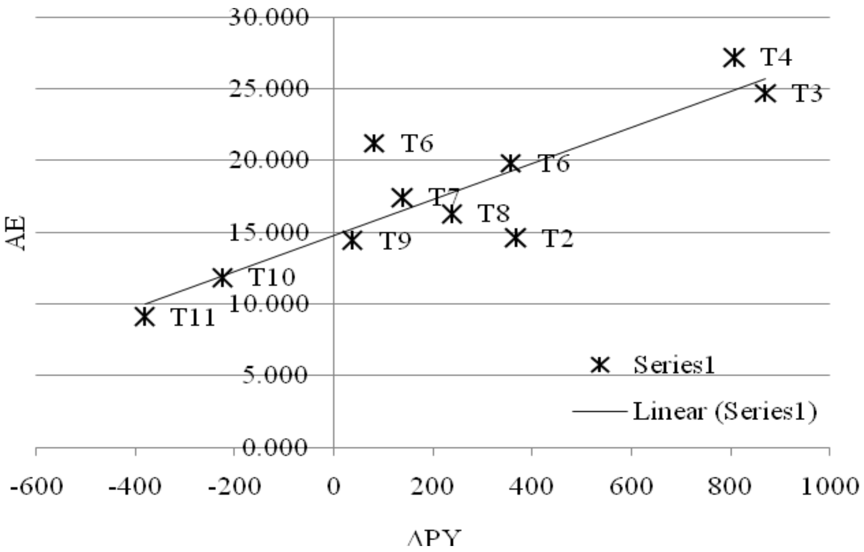

Fig. 3. AE variation in relation to ΔPY, wheat crop, Alex cultivar, nitrogen fertilization (ammonium nitrate)
Source: original graph

Similarly, the variation of PFP in relation to nitrogen doses (N) was analyzed, a variation that was described by equation (7), under conditions of $R^2 = 0.994$, $p < 0.001$.

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$$\text{PFP} = -1.296E-05x^3 + 0.006985x^2 - 1.345x + 118 \quad (7)$$

where:
x – nitrogen doses (N, a.s. kg ha^{-1})

Regression analysis was used to evaluate the variation of PFP in relation to nitrogen dose (N) and production (Y) as a simultaneous influence, and equation (8) was obtained, under conditions of R^2 = 0.885, p = 0.0144. The graphical distribution of the PFP variation in relation to N and Y is shown in the form of a 3D model, figure 4, and in the form of isoquants, figure 5. From the analysis of the values of the coefficients of equation (8), as well as of the graphical distribution models (figures 4 and 5), it was found that nitrogen (N) had a more pronounced contribution in the variation of the PFP index values, than the production (Y).

$$\text{PFP} = ax^2 + by^2 + cx + dy + exy + f \quad (8)$$

where:
PFP – Partial Factor Productivity; *x* – nitrogen dozes (N); *y* – production (Y); a, b, c, d, e, f – coefficients of the equation (8); a= -0.00903132; b= -0.00002297; c= 1.97376846; d= 0.05497934; e= 0.00025221; f= 0

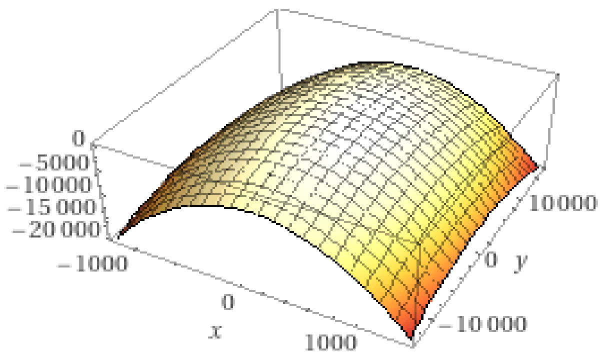

Fig. 4. 3D model of PFP variation in relation to nitrogen dose (x-axis) and production (y-axis)
Source: original graph

The efficiency of fertilizers has always been in the attention of farmers, researchers and decision makers, from different perspectives, such as agricultural technologies, agricultural profitability, fertilizer industry, environmental protection, satellite technology, imaging analysis, computer science, etc. [15, 33, 43]. All these approaches aimed at the efficiency of fertilization works through the level and quality of agricultural production, as well as increasing the efficient use of nutrients from applied fertilizers, in other words increasing fertilization efficiency, agricultural yields and economic efficiency [3].

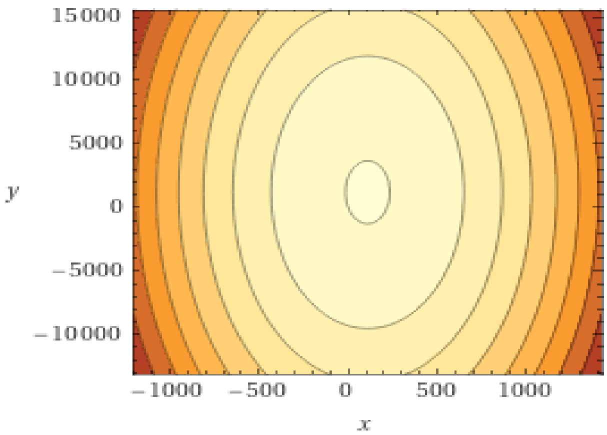

Fig. 5. Representation in the form of isoquant of the PFP variation in relation to the nitrogen dose (x-axis) and the production (y-axis)
Source: original graph.

Nitrogen was the nutrient for which special interest was given both in the number of studies and research, and in the approaches to assessing and directing the efficient use of nitrogen in relation to agricultural crops, based on various calculated indices [10].

In the present study, the variation of the efficiency of nitrogen use (N) from fertilizers (ammonium nitrate) in wheat crop was found, based on the two calculated indices, AE and PFP in relation to N and Y respectively.

Under the experimental conditions, the dose of N varied by a step of 25 kg ha^{-1}, and the corresponding yields were obtained (as a variable dependent on N). Doses of fertilizer quantitatively covered a wide spectrum of N, from 0 to 250 kg ha^{-1}.

Wheat plants benefited from a sufficient supply of N by fertilization, but the level of production, only from the N perspective, could not be higher. The level of production recorded showed that the N factor, used unilaterally, reached its potential and other factors of production need to be improved, in order to increase production and indirectly and to increase the capitalization of N from fertilization.

But in order for the production to be higher, in

the conditions of the cultivated wheat Alex cultivar, other inputs, or elements of technology, as factors influencing the wheat plants and culture, would have been necessary (eg grain density at sowing, time of sowing, fertilization with complex fertilizers, PK, plant health, density of harvestable ears etc.).
In the conditions of a higher production, on the background of a more efficient technology, in the conditions of the same doses of N, the indices AE and PFP would have registered other values, making the use of N from the fertilizer more efficient.
Therefore, increasing the efficiency of N use of fertilizers depends on the harmonization of different inputs and elements of technology, which make the use of N to increase, to be found in production and production quality indices.

CONCLUSIONS

The Agronomic Efficiency (AE) and Partial Factor Productivity (PFP) indices facilitated the evaluation of the use of nitrogen, provided by fertilization with ammonium nitrate, in wheat crop, Alex cultivar.
The two indices showed a specific variation in relation to the fertilizer dose (N) and the production (Y). The variation of the indices was expressed by polynomial equations, in conditions of statistical safety.
The expression of production (Y) also depends on other inputs, elements of technology, the health of crops, or environmental factors during the vegetation period, elements that make the use of fertilizers variable.
Single fertilization, only with N, is not enough. Balanced fertilization of crops is necessary to increase the efficiency of each nutrient, and as N is used in the highest amounts, and also presents the highest risks in relation to the environment, requires complex approaches to nitrogen use efficiency growth, from sustainable perspectives for farmers and the environment.

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WHEAT PRODUCTION VARIATION ANALYSIS IN RELATION TO THE EARS DENSITY AND CATEGORY AT HARVEST

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Abstract

The study evaluated the variation of wheat production in relation to the ears density and category at harvest moment. The study was conducted at the Didactic and Experimental Resort (DER), Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Timis County, Romania (BUASVM).. The 'Solehio' wheat variety was cultivated in non-irrigated technology conditions, on a chernozem type soil. At the harvest moment, determinations of ears density and category were made in 10 random locations within the crop plot. Three ears categories were identified, in relation to the main stem and tillering, on which they formed: main stem ear (MSE), tiller stem 1 ear (TS1E), tiller stem 2 ears (TS2E). The average wheat production (Y) was 5,247 kg ha^{-1}. Weak correlations were found between TS2E and MSE, in statistical safety conditions ($r=-0.634^{*}$, $^{*}p<0.05$). High variability was recorded in the case of the TS2E ears category (CV_{TS2E} = 3.2478), intermediate variability was recorded in the case of the TS1E ears category (CV_{TS1E} = 3.0096), and in the case of the MSE ears category the lowest variability was recorded (CV_{MSE} = 1.2538). From the analysis of the ears categories identified at harvest, the 'Solehio' wheat variety, a ratio of about 7:2:1 was found. The regression analysis facilitated the obtaining of equations that described the production variation in relation to the categories of recorded ears, in conditions of statistical safety (R^2=0.999, p<0.001). The variation of wheat production (Y) and production increase (ΔY) was simulated based on the increase of the MSE ears density at harvest. Thus, by increasing the density of ears in the MSE category between 10 - 40%, production increases (ΔY) between 371.98 kg ha^{-1} and 1,487.94 kg ha^{-1} would be possible, under the conditions of an adequate cultivation technology.

Key words: *main stem ear, model, plant population density, tillering, wheat ear categories, wheat production*

INTRODUCTION

Wheat is one of the main agricultural crops that provide important resources for human nutrition, for animal feed, for various industries, the importance of wheat being highlighted in numerous studies and research [20, 21, 40].
Due to the great diversity of genotypes, with different ecological plasticity, wheat is cultivated in different areas and agricultural production systems, with pedoclimatic conditions and specific socio-economic particularities [7, 10, 23, 30, 48].
Wheat production was studied in relation to economic profitability, agricultural product markets, marketing aspects, prices, and different influencing factors [13, 15, 17, 34, 35].
Wheat cultivation technologies are constantly improved in relation to eco-climatic conditions, agricultural systems, cultivated genotypes, inputs categories, yield level and quality, influencing factors [3, 4, 6, 37, 42].
The density of the plants population is important in capitalizing on technological inputs, environmental conditions, the formation of productivity elements and agricultural production, as well as the profitability of the wheat crop [5, 27, 28].
Wheat is a plant with variable tillering capacity in relation to the genotype, so that from a germinated grain a variable number of plants is formed (eg 3 - 5 plants), of which 2 -

3 plants are fertile [5, 41]. The importance of the density of the plant population, respectively of the ears, was studied and highlighted in the formation of wheat production [31]. Wheat tillering capacity has been studied both in terms of plant breeding and genotype production, as well as in terms of crop technologies and crop management [24, 41, 45].

At the same time, it is known that the ear in tillers is smaller compared to the ear formed on the main plant, and contributes differently to the formation of wheat grain production, in the context of wheat plants vegetations conditions [14, 16, 19]. In the context of different wheat crop technologies, fertilization optimization is important in relation to genotype, plant density, with different categories of fertilizers, methods and application techniques, ecological crop conditions, production and quality indices estimated [12, 18, 28, 38, 46]. The present study evaluated the way in which wheat production was formed in relation to the density of ears and in relation to the ears categories, depending on the main stem or tillers (tillers stem order 1 or 2), on which were formed.

MATERIALS AND METHODS

The study was conducted at Didactic and Experimental Resort (DER), BUASVM Timisoara, Timis County, Romania. The 'Solehio' autumn wheat variety was cultivated in the conditions of a chernozem type soil, in an unirrigated system. The agricultural year 2021 - 2022 was taken into account.

In relation to the purpose of the study, the density of ears at harvest was evaluated (ears number m^{-2}), as well as the ears number by categories, depending on the main stem or secondary stems (tillers of the 1st or 2nd order), on which the ears were formed. Determinations of ears density were made, in random 10 positions on the wheat plot, Figure 1. The ears samples were collected, and evaluated by categories: ears formed on the main plant (main stem ear - MSE), ears formed on plants resulting from tillering, respectively ears formed on grade 1 tiller stem (TS1E) and ears formed on grade 2 tillers stem (TS2E), Figure 1(b).

(a) (b)

Fig. 1. Image from wheat crop, 'Solehio' variety; (a) ears density at harvest; (b) ears categories: MSE - left side; TS1E middle position; TS2E - right side
Source: Original figure, photos of the author.

The harvest was made mechanized, and the value of production was used in the study, in relation to the purpose considered.

The ANOVA test was used for the general analysis of the recorded results. In relation to the purpose of the study, appropriate

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mathematical and statistical analyses were used (descriptive statistics, correlation analysis, regression analysis). Appropriate statistical safety parameters were used to confirm the safety of the results (p, correlation and regression coefficients r, R^2). The EXCEL calculation module (Microsoft Office), the PAST software [22], the Wolfram Alpha software (2020) [43], and the JASP software (2022) [25] were used for the mathematical and statistical processing and analysis of the recorded data.

RESULTS AND DISCUSSIONS

From the analysis of the ears density at harvest moment, figure 1, three types of ears were found, in relation to the type of plants on which they formed (main stem, and tillers stems).

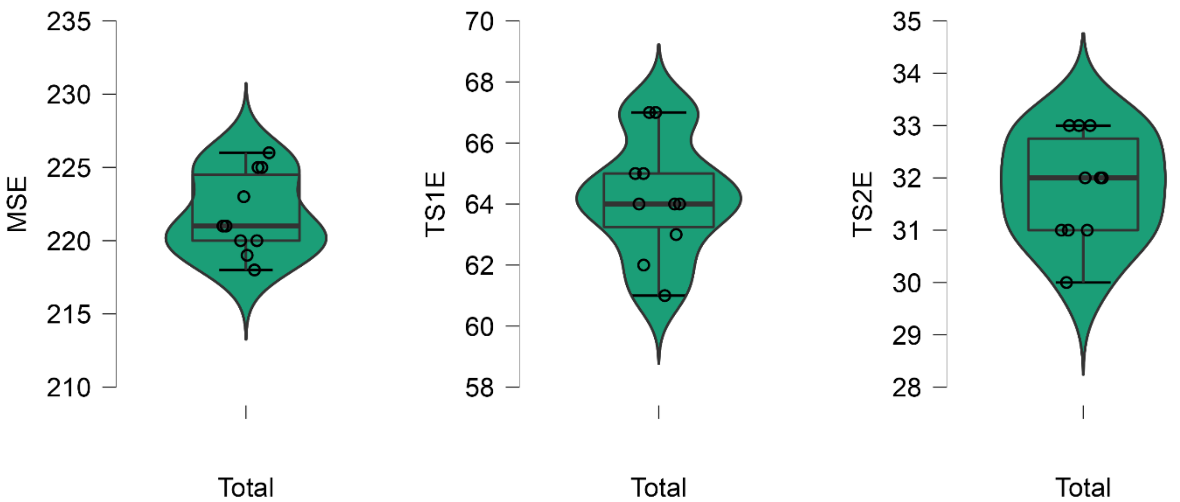
Thus, were found ears formed on the main stem (MSE), ears formed on plants resulting from tillering, respectively ears formed on tiller stem 1 (TS1E), and ears formed on tillers stem 2 (TS2E). The data recorded in the 10 samples, accompanied by the calculated standard error (SE) are presented in Table 1.

The values distribution, on the wheat ears categories determined, is presented graphically in Figure 2, in the form of a boxplot, with the marking of the recorded values in the variation interval.

Table 1. Values regarding the number of ears at harvest moment, 'Solehio' wheat cultivar

Trial	Wheat ear categories		
	MSE	TS1E	TS2E
T1	220	64	32
T2	225	63	31
T3	221	64	33
T4	226	65	30
T5	221	64	32
T6	219	62	31
T7	220	67	33
T8	225	61	32
T9	223	67	31
T10	218	65	33
SE	±0.88	±0.61	±0.33

Source: Original data, from the study determinations.



(a) (b) (c)

Fig. 2. Graphic distribution of the values of the ears number, 'Solehio' wheat variety; (a) MSE category, (b) TS1E category; (c) TS2E category

Source: original figure generated based on the recorded data.

Weak correlations were found between TS2E and MSE, in statistical safety conditions ($r = -0.634^*$, * $p < 0.05$).

According to the coefficient of variation (CV), the three categories of registered wheat ears showed different variability. High variability was recorded in the case of TS2E category ($CV_{TS2E} = 3.2478$), intermediate variability was recorded in the case of TS1E category ($CV_{TS1E} = 3.0096$), and in the case of MSE category the lowest variability was recorded ($CV_{MSE} = 1.2538$).

The regression analysis facilitated the description of the relationship of wheat production (Y) with the three categories of wheat ears, which contributed to its formation. Equation (1) was obtained, which described the variation of production (Y) in relation to the three categories of wheat ears (MSE, TS1E and TS2E), in statistical safety conditions, $R^2 = 0.999$, $p < 0.001$.

$$Y = 0 + 16.77116\,x + 6.413926\,y + 35.06729\,z \qquad (1)$$

where: Y – wheat production (kg ha^{-1});
x – ears MSE category;
y – ears TS1E category;
z – ears TS2E category.

Regression analysis was used to find the wheat production variation in relation to the three categories of wheat ears found, as a direct and interaction effect.

Thus, the variation of production (Y) in relation to MSE and TS1E was described by equation (2), in statistical safety conditions (R^2=0.999, p<0.001). The distribution of the production variation in relation to MSE and TS1E is shown in a 3D model (Figure 3), and in isoquants (Figure 4).

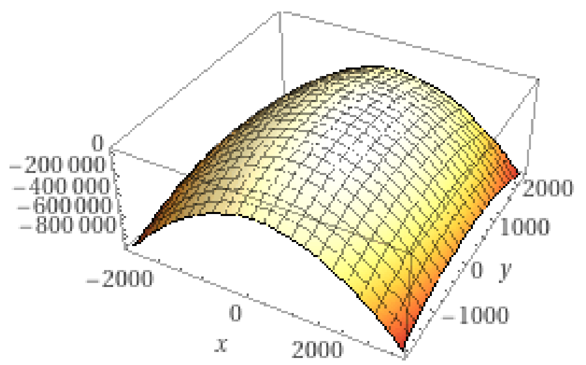


Fig. 3. 3D graphic distribution of wheat production (Y) according to MSE (x-axis) and TS1E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data.

The values of the equation (2) coefficients show the high weight of the MSE ears category in the wheat production formation, compared to the TS1E ears category (Fig. 3).

$$Y_{(\mathrm{MSE,TS1E})} = ax^2 + by^2 + cx + dy + exy + f \qquad (2)$$

where: $Y_{(\mathrm{MSE,TS1E})}$ – wheat production according to MSE and TS1E;
x – MSE, main stem ear;
y – TS1E, tiller stem 1 ear;
a, b, c, d, e, f – coefficients of the equation (2);
a = -0.08629274; b = -0.05729065;
c = 41.73967959; d = 19.08367872;
e = -0.05294840; f = 0

Also, from the analysis of the 3D graphic model (Figure 3), it was found the same.

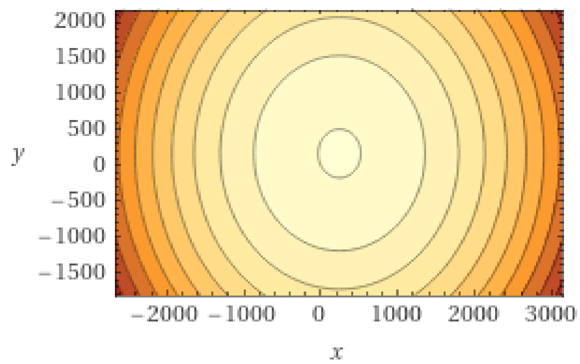


Fig. 4. Graphic distribution in the form of isoquants of wheat production (Y) according to MSE (x-axis) and TS1E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data.

Based on the values of the equation (2) coefficients, the optimal values were found for the two ears categories (MSE, TS1E) in the contribution of wheat production formation, 'Solehio' variety, under the study conditions. Thus, the values x_{opt} = 222.26 (MSE), y_{opt} = 63.84 (TS1E) were found.

The variation of wheat production (Y) in relation to the MSE and TS2E ears categories was described by equation (3), in statistical safety conditions (R^2=0.999, p<0.001). The graphical distribution of the production variation in relation to MSE and TS2E is presented in the form of a 3D model, Figure 5, and in the form of isoquants, Figure 6.

$$Y_{(\mathrm{MSE,TS2E})} = ax^2 + by^2 + cx + dy + exy + f \qquad (3)$$

where: $Y_{(\mathrm{MSE,TS2E})}$ – wheat production according to MSE and TS2E;
x – MSE, main stem ear;
y – TS2E, tiller stem 2 ear;
a, b, c, d, e, f – coefficients of the equation (3);
a = -0.07281554; b = -0.26985877;
c = 38.60225596; d = 61.13963681;
e = -0.19901650; f = 0

The values of the equation (3) coefficients were used to find the optimal values for the two ears categories (MSE, TS2E), in the contribution of wheat production formation, 'Solehio' wheat variety, under the study conditions. Thus, the values x_{opt} = 222.26 (MSE), and y_{opt} = 31.32 (TS2E) were found.

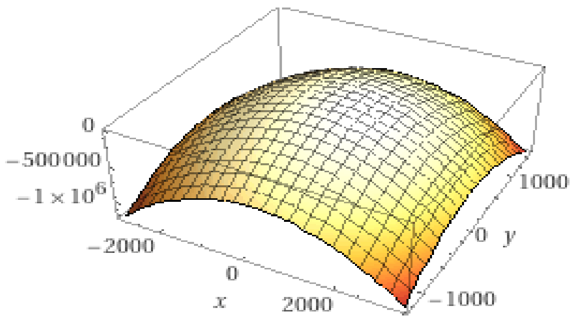


Fig. 5. 3D graphic distribution of wheat production (Y) according to MSE (x-axis) and TS2E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data.

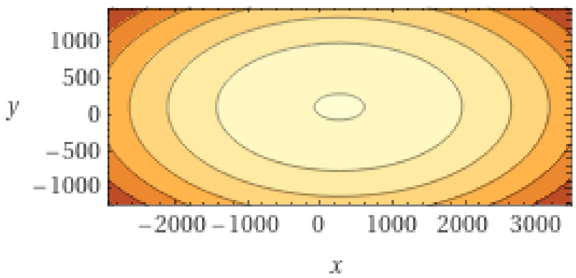


Fig. 6. Graphic distribution in the form of isoquants of wheat production (Y) according to MSE (x-axis) and TS2E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data.

The variation of wheat production (Y) in relation to the TS1E and TS2E ears categories was described by equation (4), in statistical safety conditions, (R^2=0.999, p<0.001). The graphical distribution of the wheat production (Y) variation in relation to TS1E and TS2E is shown in the form of a 3D model, Figure 7, and in the form of isoquants, Figure 8. Based on the values of the equation (4) coefficients, the optimal values were found for the two ears categories (TS1E, TS2E) in the formation of wheat production, 'Solehio' variety, under the study conditions. Thus, the values x_{opt} = 64.85 (TS1E), y_{opt} = 31.69 (TS2E) were found.

$$Y_{(TS1E,TS2E)} = ax^2 + by^2 + cx + dy + exy + f \qquad (4)$$

where: $Y_{(TS1E,TS2E)}$ – wheat production according to TS1E and TS2E;
x – TS1E, tiller stem 1 ear;
y – TS2E, tiller stem 2 ear;
a, b, c, d, e, f – coefficients of the equation (4);
a = -0.36778330; b = -1.82027964;
c = 76.62719589; d = 174.55860413;
e = -0.91284031; f = 0

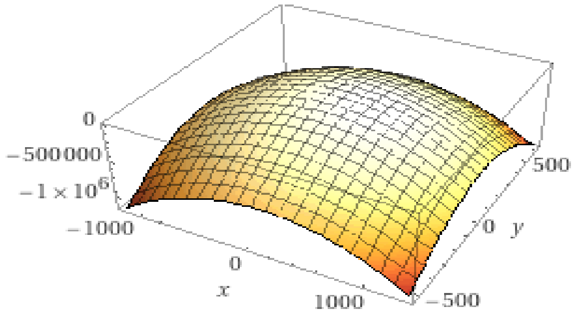


Fig. 7. 3D graphic distribution of wheat production (Y) according to TS1E (x-axis) and TS2E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data

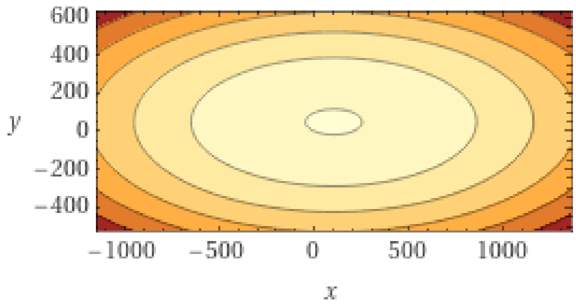


Fig. 8. Graphic distribution in the form of isoquants of wheat production (Y) according to TS1E (x-axis) and TS2E (y-axis), 'Solehio' wheat variety
Source: original graph, based on calculated data.

From the analysis of the ears categories identified at harvest in the case of the wheat crop studied, the 'Solehio' variety, a ratio of about 7:2:1 was found between the ears categories (MSE:TS1E:TS2E).
Starting from equation (1), the variation of production (Y) and the corresponded production increase (ΔY) were simulated based on the increase of the MSE category ears density at harvest. Ensuring a higher density of the MSE ears category at harvest can be achieved through a higher density of germinable seeds at sowing. Thus, keeping unchanged the other two categories of ears, TS1E and TS2E, an increase in production was obtained ΔY_I = 371.98 kg ha^{-1}, when increasing by 10% the category of MSE ears at harvest; an increase in production ΔY_{II} =

743.97 kg ha^{-1} at a 20% increase in the MSE category at harvest; an increase in production ΔY_{III} = 1,115.95 kg ha^{-1} at a 30% increase of the MSE category at harvest; an increase in production ΔY_{IV} = 1,487.94 kg ha^{-1} at a 40% increase in the MSE category at harvest.

The density of ears at harvest can be ensured from the time of sowing by the density of germinable seeds m^{-2} (eg 750 germinable seeds m^{-2}), and in this way the respective ears will be in the MSE category, so with the highest grain production ear^{-1}. This requires an appropriate cultivation technology, to control the growth of plants in height (eg growth regulators), to prevent the lodging phenomenon, and quantitative and qualitative depreciation of production [9, 11, 33, 36]. It is also necessary to adapt and optimize fertilization, in relation to the specific consumption of the cultivated genotype and the expected production, in the technological conditions of the agricultural system [8, 26, 46, 47, 49].

Monitoring and overall management need to be adequate for such wheat crop technology [29, 32]. This model of wheat technology involves certain costs related to the population of higher density plants since sowing (eg higher quantity of seed for sowing, different supplementary treatments), but predictably the technology is for a high production.

Alternatively, at more affordable costs, it is the way to for crop with a standard seed norm (in relation to the cultivated genotype, sowing season, etc.) and through the tillering capacity, can be ensure a certain density of ears at harvest [44, 50]. The wheat plants tillering, and the formation of ears, in relation to the plants categories (main stem or tillers) depends on several factors of influence during the vegetation period, so that the consideration of tillers for the production formation presents certain risks or uncertainties, with decreases in production [1, 2]. Thus, Abid et al. [1] observed the effect of water stress on wheat plant tillering (6 - 16%), and stem elongation (15-24%), with major implications on reducing wheat crop yield (72%).

In order to improve the values of the productivity elements at the wheat ear, 'Alex' variety, and production, Rawashdeh and Sala [39], used the foliar fertilization with boron and iron (on the background of mineral fertilization in the soil), and the obtained results were in statistical safety conditions ($p < 0.05$).

Considering the difference between the ears grain production capacity, in relation to the categories of plants (main stem, tillers stems), respectively the ears related to these categories of stems (MSE, TS1E, TS2E), it can be easily appreciated that a part of the technological level provided for wheat crop will be capitalized by a part of plants with a lower production capacity (about 30.21% in the present study) in relation to the main plants and the ears formed on the main plants (MSE).

The main plant will better capitalize on all production factors (most importantly inputs, with related costs), in relation to the plants resulting from tillering, including stressors and this will be reflected in the production of wheat grains, respectively in production at surface unit.

CONCLUSIONS

The population density of wheat plants and ears at harvest was an important factor in the quantitative formation of production in the context of the present study. The ears categories, in relation to the type of plant (main stem, tillers plants) are also an essential factor in the formation of wheat production. The ears numbers, by ear categories (MSE, TS1E, TS2E), depends on the cultivation technology, the germinable seeds density at sowing, and influencing factors.

Under the study conditions, a density of ears with an average ratio of 7:2:1 between ears categories (MSE:TS1E:TS2E) ensured an average production of 5,247 kg ha^{-1}. The production formation, in relation to the ears categories, and the density of ears, was described by different equations, in statistical safety conditions. The simulation of some higher densities of the MSE ear category at harvest moment, (considered possible through the density of seeds at sowing), led to production increases (ΔY) between 371.98 kg ha^{-1} and 1,487.94 kg ha^{-1}, under the conditions of an adequate technology.

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DETERMINANTS OF VEGETABLE CONSUMPTION AMONG HOUSEHOLDS IN RURAL PHILIPPINES

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Abstract

Despite the availability of vegetables, a large proportion of the Philippine population consumes an inadequate amount of vegetables. Low vegetable consumption is among the top risk factor contributing to several health problems. This study investigates the determinants of vegetable consumption particularly in Isabel, Leyte, Philippines using a cross-sectional data analysis. The descriptive analysis shows that the average daily vegetable consumption per capita is 48.2 grams lower than the recommended standard set by the World Health Organization (WHO) or Food and Nutritional Research Institute (FNRI). The regression analysis suggests that households who produce their own vegetables consume more vegetables. However, as income increases, vegetable consumption decreases because households opt to consume more meat products. Results of the study suggest that localization of vegetable supply is one of the feasible options that policymakers can consider in increasing vegetable consumption.

Key words**:** *food availability, vegetable intake, household characteristics, rural Philippines*

INTRODUCTION

Low fruit and vegetable intake is one of the main contributors of micronutrients deficiency in developing countries. According to the World Health Organization (WHO) an estimated 3.9 million deaths worldwide were attributable to inadequate fruit and vegetable consumption [28]. Fruit and vegetable consumption is undeniably an essential part of a healthy diet. A high vegetable intake decreases the risk for many chronic diseases such as cataract formation, chronic obstructive pulmonary disease, tuberculosis and hypertension [26]. The World Health Organization (WHO) recommended daily fruit and vegetable consumption for an adult is at least 400 grams per day [28].

People who eat more vegetables are likely to have a reduced risk of some chronic diseases. Vegetables are rich sources of vitamins, minerals and fiber. Consuming adequate and varied types of vegetables can provide essential nutrients. Vegetables are an essential component of a balanced diet. However, large proportion of adults in Asia consume an inadequate amount of fruits and vegetables [17]. Their results show that 63.5% of men and 57.5% of women consume an inadequate amount of fruits and vegetables. Many developing nations reported having low consumption of fruits and vegetables [10].

In the Philippines, previous studies show that vegetable intake is inadequate. The daily vegetable intake among Filipino is only 110 grams and made up 13 % of the daily food intake [11]. This included green leafy vegetables at 30 grams per day and other vegetables at 80 grams per day. The most commonly eaten vegetables are squash, string beans, gourds, eggplant, spinach, sweet potato and moringa [11]. The Filipino's average daily vegetable consumption is way below the recommended consumption of 400 grams daily [6]. This is not unusual because low vegetable intake is prevalent in low and middle income countries [4]. The below-average vegetable consumption is one of the factors contributing to the inadequacy of micronutrient needs of Filipinos. The government must continually initiate programs to improve the nutritional status of the Philippine population.

There are previous researches that identify the factors associated with vegetable intake. Factors like age, sex, per capita household income and education were positively associated with fruits and vegetable intake, whereas smoking habit showed a negative association with fruits and vegetable consumption [2]. Similarly another study found that age and sex were significant factors affecting fruit and vegetable consumption [18]. In addition, sex is related to fruit and vegetable consumption, with girls consuming more servings than boys [21]. Others found that participants increase in weight status as they age due to low fruit and vegetable consumption [12].

Low socioeconomic status is associated with less intake of vegetables. Dietary intake of vegetables is directly related to income [14]. Income is a significant determinant influencing vegetable consumption [14]. These findings were supported by previous studies showing that income has a positive or direct relationship toward fruits and vegetable intake [5] [8]. However, other studies found that there is no relationship between income and dietary intake. For example, a study suggested that parents' income was not significantly associated with a child's fruits and vegetable consumption [1]. Others reported that education, age, ethnicity, income, residence location, smoking status, and health condition were significant predictors of fruits and vegetable consumption [29]. The percentage of youth who consumed green vegetables and starchy vegetables decreased slightly with age [16].

In the Southern Philippines, low vegetable yields combined with distance to market have made vegetable unaffordable and inaccessible to many threatening household food security [13]. To address this problem, there have been innovations to intensity vegetable productions [3], [13], [24]. However, despite these local efforts, vegetable consumption appears to be low.

In the Philippines particularly in Leyte island, few studies investigate the determinants affecting vegetable consumption. Hence, it is essential to document information that will explain what factors contribute to vegetable consumption. Results of the study could provide valuable information to implement public health policies and dietary recommendations. A healthy diet is vital in a developing country like the Philippines, where the poverty level remains high [7], [20], [23]. Poor nutrition and lack of food access are among the most abject manifestations of poverty [27]. To add more information to the literature related to determinants of vegetable consumption, this study will examine factors affecting vegetable intake, particularly in the municipality of Isabel located in Leyte island, Philippines. It is necessary to investigate not only the current level of vegetable consumption but also the factors associated with vegetable intake. Results of the study will encourage the implementation of public policies for increasing fruit and vegetable intake.

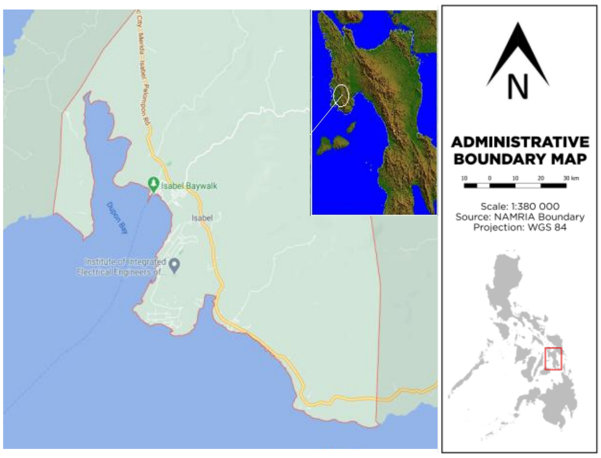
MATERIALS AND METHODS

Study site

The selected study site is in the municipality of Isabel, located in the northern portion of Leyte, Philippines. The municipal center of Isabel is situated at approximately 10° 56' North, 124° 26' East with an estimated elevation of 4.1 meters above mean sea level [19]. It is a coastal town with a land area of around 64.01 square kilometers with an estimated population of 46,915 [19]. Isabel is comprised of 24 villages or barangays. From these 24 villages, we selected two villages to serve as the sample of the study. Figure 1 shows the location of the study site in Isabel, Leyte.

Data Collection

Primary data was collected through face-to-face interviews with the household head or representative. This was done to explain questions that were difficult to answer and obtain the exact information needed for the study. The household survey was prepared with a structured questionnaire to investigate demographic, socioeconomic, family and lifestyle characteristics. Food intake was measured with a one-week dietary recall. A one-week dietary recall was used in reporting the total food consumed by the respondent. Simple random sampling was used to select the respondents included in the study. The total respondents of the study were 153 households.



Map 1. Location of the study site in Isabel, Leyte, Philippines
Source: [9], [15].

Data Analysis

Descriptive statistics were used to summarize the socio-demographic status of the respondents. Ordinary least square regression analysis was used to investigate the determinants of vegetable consumption. This is a common method for estimating the association of variables in linear model. The goal is to minimize the sum of the squares of the differences between the observed responses in the given dataset and those predicted by a linear function of a set of explanatory variables. The smaller the differences, the better the model fits the data. The regression model used in the study is specified as follows:

$$\mathit{vegconsump}_i = \beta_0 + \beta_1 \mathit{female}_i + \beta_2 \mathit{age}_i + \beta_3 \mathit{hhinc}_i + \beta_4 \mathit{hhsize}_i + \beta_5 \mathit{employ}_i + \beta_6 \mathit{educ}_i + \beta_7 \mathit{location}_i + \beta_8 \mathit{married}_i + \beta_9 \mathit{health}_i + \beta_{10} \mathit{catholic}_i + \beta_{11} \mathit{foodavail}_i + \beta_{12} \mathit{foodexp}_i + \beta_{13} \mathit{houseown}_i + \beta_{14} \mathit{homeprod}_i + e_i$$

where:

$\mathit{vegconsump}_i$ = is the estimated daily vegetable consumption measured in kilograms per capita

female_i = the sex of the household head, 1 if the head is female and 0 otherwise

age_i = age of the head in years

hhinc_i = is the average household monthly income measured in Philippine pesos categorized as low, middle and high income

hhsize_i = household size

employ_i = is a dummy variable for the employment status (1 if employed, 0 otherwise)

educ_i = level of educational attainment measured in years

$\mathit{location}_i$ = location of household (1 if upland area, 0 otherwise)

$\mathit{married}_i$ = dummy variable for marital status (1 if married, 0 otherwise)

health_i = reflects the perceived health status of the respondents (1 if they consider healthy, 0 otherwise)

$\mathit{catholic}_i$ = dummy variable for religion (1 for Catholic, 0 otherwise)

$\mathit{foodavail}_i$ = availability of food in the house measured as 1 food is always available and 0 otherwise

$\mathit{foodexp}_i$ = estimated weekly expenditure on food consumption

$\mathit{houseown}_i$ = dummy variable for household ownership (1 owned the house, 0 otherwise)

$\mathit{homeprod}_i$ = produce their own vegetable at backyard (1 if they produce, 0 otherwise)

e_i = remaining error term

The subscript *i* represents the surveyed respondents. Diagnostic tests were conducted including test for multicollinearity, normality of the residuals and heteroskedasticity.

RESULTS AND DISCUSSIONS

Socio-demographic profile of the respondents

Table 1 presents the socio–demographic characteristics of the respondents. More than half of the respondents were female, the rest were male. The age of the respondents ranged from 20 to 65 and the average age of the respondents was 44 years old. Close to 40% of the respondents have ages ranging from 36 to 45. Only 7% of the respondents are aged more than 65 years old. Most of the respondents were married (73%).

In terms of educational attainment, most of the respondents were able to reach primary level (38%) and secondary level (37%) (Table 1). Only 16% of the respondents indicated to have at least tertiary level of education but only 4% were able to graduate college (Table 1). More than half of the respondents were not able to attend college.

Table 1. Socio-demographic profile of the farmer respondents.

Profile of the Respondents	n	Percentage
Sex		
Male	42	27
Female	111	73
Total	153	100
Age		
20 - 35 years old	44	28
36 - 50 years old	59	39
51 – 65 years old	39	26
66 years old and above	11	7
Total	153	100
Average age (44 years old)		
Civil Status		
Single	12	8
Married	112	73
Separated	3	2
Widowed	11	6
Cohabitation	15	10
Total	153	100
Educational Attainment		
Primary Level	58	38
Secondary Level	56	37
Vocational	8	5
Tertiary Level	24	16
College Graduate	7	4
Total	153	100

Source: Authors' own calculation and analysis (2021).

Table 2 shows the household size and number of children at school. Close to half of the respondents (45%) have a household size ranging from 3 to 4 members. The average household size is composed of 5 members. For the number of children at school, results show that respondents have number of kids at school ranging from 1 child to 7 children. On average, two children are reported to be at school. More than half of the respondents have 1 – 2 kids at school.

Table 3 shows the monthly household income of the respondents. Sixty – three percent of the total household monthly income is below 5,000 pesos (USD 104.2). This is followed by income ranges from PHP 5,001 to PHP 15,000 (USD 104.2 - 312.5). The average monthly income of households is PHP 6,830 (USD 142.3).

This income level is relatively below the poverty line in the region according to the Philippine Statistics Authority (PSA, 2020).

Table 2. Household size and number of children at school.

Profile of the Respondents	n	Percentage
Household size		
1-2 members	23	15
3-4	68	45
5-6	34	22
7-8	17	11
9 or more	11	7
Total	153	100
Average 5 members		
Number of children at school		
None	32	21
1 – 2	78	52
3 – 4	31	19%
5 - 6	10	7
7 or more	2	1
Total	153	100
Average 2 kids at school		

Source: Authors' own calculation and analysis (2021).

Table 3. Estimated monthly income of households

Monthly Income (PHP)	n	Percentage
Below 5,000	96	62.7
5,001 – 15,000	37	24.2
15,001 – 25,000	13	8.4
Above 25,000	7	4.6
Total	153	100
Average monthly income = PHP 6,830 (USD 142.3)		

Note: 1 USD = 48 Philippine Peso (PHP)
Source: Authors' own calculation and analysis (2021).

In Eastern Visayas, Philippines where Leyte island is located, the estimated poverty threshold is PHP 10,408 per month (USD 216.83) [20]. This finding is similar to what was reported by other studies [22], [25]. This suggests that the respondents of the survey are living below the poverty line. Table 4 presents the average household food expenditure by income. The main food category is divided into three: vegetable, meat and rice. The beverages and other food items were excluded in the analysis. The results show that households whose income is below PHP 5,000 tend to spend an average of 79 pesos on vegetables, 226 pesos on meat and 407 pesos

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on rice. Household income below 5,000 usually produces vegetables at their backyard. Hence, their expenditure on vegetable is relatively low but their consumption is at par with other income groups. The average vegetable expenditure for households within the income range of PHP 5,001 – 15,000 is 130 pesos, 332 pesos for meat and 476 pesos for rice. Households whose income is above PHP 15,000 have relatively lower vegetable expenditure compared to household with monthly income of PHP 5,001 – 15,000.

Table 4. Estimated monthly income of households

		Weekly Food Expenditure (PHP)		
Income range (PHP)	**n**	**Vegetable**	**Meat**	**Rice**
Below 5,000	96	79	226	407
5,001 – 15,000	37	130	332	476
15,001 – 25,000	13	87	350	334
Above 25,000	7	88	660	540
Average		93	278	423

Source: Authors' own calculation and analysis (2021).

Table 4 also shows that as vegetable expenditure decreases, meat expenditure increases. This implies that households tend to consume more meat as income increases However, there is no clear trend for rice consumption. It fluctuates with changes in income level. On average, household vegetable expenditure is around 93 pesos. The average meat expenditure is 278 pesos and the weekly average rice expenditure is 423 pesos.

Commonly eaten vegetables and estimated vegetable consumption

Table 5 presents the most common type of vegetables consumed by households. The results indicate that most respondents prefer to consume moringa (75.8%) and squash or pumpkins (73.2%). Moringa or locally known as *malunggay* is commonly planted in the backyard. It is a popular vegetable among households in Isabel, Leyte, Philippines. For respondents who indicated they have no moringa plant mentioned that they usually ask for moringa leaves from their neighbour. Next to moringa, the most preferred vegetable is squash. The majority of the household respondents indicated that they eat squash every week as part of their weekly vegetable consumption. The next commonly eaten vegetable following moringa and squash include basella, eggplant, mixed vegetables, okra, carrots and cabbage. The mixed vegetables are locally known as *sari-sari* or assorted vegetables already cut and ready for cooking. Some households prefer to buy and consume mixed vegetables since this is composed of several types of vegetables. This is mostly composed of squash, cabbage, vegetable pear (locally knows as *sayote*), carrots and string beans (Table 5).

Table 5. Common type of vegetables preferred by the respondents.

Type of Vegetable	n	Percentage
Moringa	116	75.8
Squash	112	73.2
Basella	40	26.1
Eggplant	33	21.6
Mixed vegetable	32	20.9
Okra	27	17.6
Carrots	23	15.0
Cabbage	23	15.0
String beans	17	11.1
Cucumber	11	7.2
Sweet potato	11	7.2
Yautia and other rootcrops	9	5.9
Sponge gourd	8	5.2
Spinach (kankong)	7	4.6
Vegetable pear	6	3.9
Banana's heart	4	2.6
Bitter gourd	4	2.6
Bottle gourd	3	2.0
Mung bean	2	1.3
Winged bean	1	0.6
Fern	1	0.6
Jackfruit	1	0.6

Note: * multiple response
Source: Authors' own calculation and analysis (2021).

Table 6 presents the average daily vegetable intake of households or per capita disaggregated by income level. The results show that lower income household is associated with lower vegetable consumption. The average daily vegetable consumption of household is around 241 grams translating to around 48.2 grams per capita. This consumption is below the daily recommended intake of 5 to 6 serving (75grams per serving) or 400 grams of vegetables per person [28].

Table 6. Estimated daily vegetable consumption of households.

		Estimated Daily Vegetable Consumption	
Monthly Income	**n**	**Household (grams)**	**Per Capita (grams)**
Under 5,000	96	228	45.6
5,001 – 15,000	37	271	54.2
15,001 – 25,000	13	262	52.4
Above 25,000	7	197	39.4
Total		241	48.2

Source: Authors' own calculation and analysis (2021).

Determinants of vegetable consumption

To investigate the factors that influence vegetable consumption, Table 7 shows the results of regression analysis. The R-squared value of the estimation is at 0.456 suggesting that the model explains 45.6% of the variation in vegetable consumption. Robust standard errors were used because of the presence of heteroskedasticity. Results show that age, age-squared, general health, middle income, household living in upland, production, food expenditure, and vegetable availability significantly affect vegetable consumption. The results show that there is a negative relationship between age and vegetable consumption. This is similar to what was reported by Martin et al. (2011) [12]. However, there is nonlinearity involved. Results show that initially, vegetable consumption decreases as respondents get aged, however, there is a turning point showing that later on, as respondents become more health-conscious due to old age and health problems, then vegetable consumption starts to increase. Perceived health status has a significant positive relationship with vegetable consumption. This suggests that a person whose general health is in good condition consumes more vegetables. Estimates also revealed that a healthy person increases their vegetable intake by 0.774 grams compared to a person who rated themselves as not healthy. Meanwhile, middle income and high income households consume less vegetables than low income households. This is because most of the middle income households and high income households prefer to consume more meat than vegetables compared to low income households. This plausible because low income households are constrained with income and meat is expensive. Hence, low income household prefer to eat more vegetables. On the other hand, food expenditure is associated with an increase in vegetable consumption. Estimates revealed that a one-unit increase in food expenditure shows 0.001 grams increase in vegetable intake. Households from the upland location tend to produce vegetables in their backyard. This reflects the significant association of vegetable consumption and upland location. While households in the lowland area close to the municipality center tend not to produce vegetables because of limited space. In addition, vegetables in upland areas are cheaper compared to vegetables sold in the town market of Isabel, Leyte. Households who produce their own vegetable increase their vegetable consumption by 0.640. Households who indicated that food is readily available is positively associated with vegetable consumption.

Table 7. Determinants of vegetable consumption

Variables	Coefficient	Robust Std. Error
Female	0.0193	0.267
Age	-0.136***	0.0498
Age square	0.00125***	0.000473
Middle income	-0.518*	0.311
High income	-0.610	0.409
Household size	-0.000766	0.0749
Employed	-0.291	0.315
Secondary educ	0.137	0.260
Tertiary educ	0.319	0.402
College graduate	0.0176	0.680
Vocational	-0.0908	0.435
Upland	1.343***	0.326
Married	0.0729	0.264
General health	0.774***	0.243
Roman Catholic	-0.155	0.340
Food availability	0.761***	0.256
Food expenditure	0.00121***	0.000373
Own house	-0.279	0.535
Produce vegetable	0.640**	0.253
Constant	3.025**	1.219
Observations	153	
R-squared	0.456	

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Authors' own calculation and analysis (2021).

CONCLUSIONS

This study aims to investigate the determinants of vegetable consumption in Isabel, Leyte, Philippines. Results show that the average daily consumption per capita is 48.2 grams. This is below than the recommended intake of 400 grams by the World Health Organization (WHO). Results suggest that the selected respondents in Isabel, Leyte did not consume an adequate amount vegetable. Across income level, the estimated vegetable consumption is below the recommended standard. The regression results show that age, age-square, general health, income level, location, food expenditure, vegetable home production, employment status and food availability significantly affect vegetable consumption in Isabel, Leyte.

The results of the study suggest that promotion and localization of vegetable supply through backyard gardening could be one of the feasible approaches in influencing increasing vegetable consumption. Local government units may start a program on teaching households on small container gardening or cultivating vegetables with limited area. By producing vegetables in the backyard will increase the availability of the vegetables in their household. As reflected in the regression results, households who produce vegetables in their backyard tend to consume more vegetables. In addition, educational campaigns through seminars and capacity building activities designed to change behaviours are possible options to encourage people to consume more vegetables. This would motivate consumers to build a healthier lifestyle by consuming more vegetables. The policy makers may also improve vegetable consumption through the improvements of agricultural and food systems.

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DEVELOPMENT OF RURAL TOURISM IN UKRAINE IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract

The article outlines the key framework of the functioning of rural tourism in Ukraine in the context of sustainable development. It is analyzed the interpretation of the essence of sustainable tourism and sustainable development. The author's conceptual framework of sustainable rural tourism is proposed. It is given own vision of the essence of "sustainable rural tourism". Taking into account the concept of sustainable development, it was analyzed the main principles that will contribute to the development of rural tourism in Ukraine. The author's approach has been developed, which involves the provision of recreational services by the owner on the basis of a personal peasant economy (rural estate) in the field of rural tourism in Ukraine. As a result of the conducted research it was proposed the main directions of development of rural tourism for Ukraine, which would contribute to the successful development of this area in accordance with international quality standards.

Key words**:** *tourism, sustainable tourism, sustainable rural tourism, sustainable development, rural estate.*

INTRODUCTION

For the last decades, sustainable development has become a key element of the strategic policy of the world's states. The well-known Sustainable Development Goals also apply sphere of tourism, which is one of the leading and profitable branches of the world economy.
Considering the unique natural conditions, resources and potential opportunities for the development of the tourism sector, Ukraine cannot yet compete with the world's leading countries. That is why the priority directions of the development of state policy in the field of tourism should include a sustainable approach that will be supported at the local, regional and international levels. This will give an opportunity to create favorable conditions for the development of tourism in the long run in accordance with international quality standards and taking into account European values. This, in turn, will contribute to improving the quality of life, harmonious development and consolidation of society, the formation of Ukraine's image in the world.

As a result of difficulties in the relationship between man and the environment, the problem of implementing the concept of sustainable development becomes important. After all the sustainable development should focus on the process that harmoniously combines resource use, investment directions, aspects of technological development and institutional change with the needs of present and future generations.
The World Commission on Environment and Development in the report "Our Common Future" (1987) provides an interpretation of the concept of sustainable development. This concept means the development that provides the needs of the current generation, without losses for future generations for providing their own needs. It is also noted that the main direction of ensuring sustainable development are: formation of prospects for population development; preservation of the environment; solving problems related to energy, industry, human settlements and international economic relations in the aspect of environment and development [10].
Since the mid-90s of the last century, the sustainable development of tourism, which is

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based on the principles of sustainability, has become a priority for most of the world's countries [7].

The main vector of the development of sustainable tourism is the minimization of any unwanted impact that tourists may have on the natural, cultural, historical or social environment. The implementation of this principle is achieved through a balanced combination of the needs of tourists with the capabilities of the destination [2].

The proclamation by the United Nations General Assembly of 2017 as the International Year of Sustainable Tourism Development drew the attention of the world community to those types of tourism that are considered relatively more sustainable than others, including rural tourism. After all, this type of tourism in the future can become one of the important tools that will contribute to the sustainable development of rural settlements [6].

It is worth noting that the development of rural tourism in Ukraine is recognized as one of the key areas of state policy. This is stated in the Tourism and Resorts Development Strategy for the period until 2026. The implementation of this Strategy provides for the creation of favorable conditions for the development of tourism in accordance with international quality standards and taking into account European values, its transformation into a highly profitable, integrated into the world market competitive sphere. It provides acceleration of the socio-economic development of regions and the state as a whole, contributes to improving the quality of life, harmonious development and consolidation of society, popularization of Ukraine in the world [18].

Ukraine, like other member states of the United Nations, has joined the global process of ensuring sustainable development set out in the 2030 Agenda for Sustainable Development. Since 2015, a number of reforms have been launched in Ukraine aimed at implementing socio-economic transformations and strengthening the democratic system. The sustainable development goals integrated into public policy on the basis of “leave no one behind” [9].

Today, there are many definitions of the concept of "rural tourism", each of which combines different aspects and includes a multiplicity of functions regarding the provision of recreational services in rural areas. However, today's realities require rapid adaptation to modern world trends. This means that rural tourism must necessarily take into account the concept of sustainable development and be based on a balanced combination of ecological, economic and socio-cultural aspects of tourism development.

In our opinion, sustainable rural tourism is a leisure type of tourism that takes place in rural areas and is organized by people who are in family relations on the territory of a personal peasant economy (in a rural estate) in accordance with the concept of sustainable development. The provision of recreational services by the owner of a rural estate may also be related to using tourist resources and cultural and historical values of the countryside.

The sustainable development of tourism combines two key problems. The first problem is the need to develop profitable tourism, and the second – to take into account the limitations of available natural resources and their conservation [6]. It is worth noting that the concept of rural tourism is closely linked to the approaches of “sustainable tourism”, where tourism fully respects the principles of sustainable development. Within these principles, it also takes into account the UN Sustainable Development Goals [5]. The main goals of sustainable tourism development in Ukraine, which are directly related to rural tourism, are: creation of new jobs; reduction of water consumption; efficient use of energy; reduction of waste and emissions; ensuring free access to tourism for all; conservation of biological diversity; support for local business, economy and fair trade; protection of social and cultural values; environmentally friendly transport [8].

For Ukraine, the development of the field of rural tourism, in particular sustainable, should become a priority task. This is confirmed by the results of a sociological survey (we interviewed 326 respondents living on the territory of Ukraine). As a result of the conducted research, we can see that 92% of respondents are interested in recreation in the village. Also, a large number of respondents (95%) believe that it is necessary to develop rural tourism in Ukraine. It is also important that 54% of respondents want to start their own business in the field of rural tourism [13]. That is why it is necessary to develop rural tourism in Ukraine in the context of sustainable development. After all, it will have a positive impact on the development of other industries directly related to rural tourism and improve the well-being of local communities.

MATERIALS AND METHODS

Sustainable development has some characteristics that distinguish it from other forms of development which have emerged in recent decades. The main features of sustainable development are: direct connection with the environment; anticipating the needs of future generations; maintaining and improving the quality of life; equality of rights and opportunities for all; the precautionary principle; the need to correlate all actions with the impact on the environment [20].

In recent years, basic principles have been developed to identify the concept of sustainable tourism and ways to implement it. The Tourism Concern, together with the World Wildlife Fund (WWF), had proposed ten principles for sustainable tourism:

- conservation and sustainable use of resources. It is key and forms the long-term meaning of business;
- reduction of excessive consumption and waste. In the future, it will avoid the costs of repairing long-term damage to the environment. It will help improve the quality of tourism services;
- biodiversity conservation;
- integration of tourism into planning documents. Tourism development should be integrated into the national and local structure of strategic planning. It is also important to assess the impact of tourism on the environment;
- local economic development. Tourism should support a variety of local economic initiatives, take into account environmental costs, protect the local economy and avoid environmental damage;
- involvement of local communities. This creates benefits for communities and the environment, as well as improves the quality of the tourist experience;
- work with stakeholders and the public. It is an important component for coordinated planning and implementation of sustainable tourism projects, avoidance or resolution of conflicts around such initiatives;
- staff training. It is an important component of the success of implementation of sustainable development projects, as it improves the quality of the tourism product;
- responsible marketing. Providing tourists with complete and truthful information about leisure services. Enhancing the effectiveness of sustainable tourism projects for local communities and the environment;
- conducting research. Ongoing research and monitoring are important components in addressing the issues that arise in creating benefits for destinations, the sector and consumers [15, 16].

In the process of writing the article used general and special scientific research methods: analysis and synthesis – when choosing materials for research; generalization – for formulation the essence of the concept of “sustainable rural tourism”; comparative analysis – in the study of foreign experience in identifying the concept of sustainable tourism; retrospective analysis – to study the concept of sustainable development and to build a conceptual framework for sustainable development of rural tourism; strategic analysis – to assess the strategic directions and to build an integrated approach to the provision of rural tourism services in the context of sustainable development; framework analysis – to identify the main directions of rural tourism development in Ukraine in the context of sustainable development; graphic method – for building figures; induction and deduction – to summarize the results of the study and formulate conclusions.

RESULTS AND DISCUSSIONS

Human awareness and rethinking of the consequences of globalization processes on the environment has contributed to the formulation of the basic provisions of the concept of sustainable development as a paradigm of social growth in the XXI century. The concept of rural tourism is closely linked to sustainable tourism approaches, where tourism must take full account of current and future economic, social and environmental impacts.

Rural tourism is one of the perspective areas for the development of Ukrainian villages and raising the economic level of the regions of Ukraine. Today, this type of tourism activity operates exclusively at the personal initiative of the rural population, acting as one of the means of overcoming poverty in rural areas [19].

Development of rural tourism with the involvement of all the possibilities of the modern Ukrainian village (use of free living space of personal peasant economy, rich recreational and tourist resources of the region, recreation services that can be offered by the owner of the rural estate) opens up to the peasant considerable opportunities not only to provide for his family, but also to benefit the rural community. Today in Ukraine there are many rural areas that can provide tourists with proper quality recreation [4].

There are pure and mixed types of rural tourism. Pure rural tourism involves the provision of tourist services on the basis of a rural estate. In this case, this activity is the main source of income for the owners of the estate. Rural tourism of mixed type is the provision of hospitality services with conducting personal peasant economy (farming). In this case, income from hospitality activities, as a rule, will be a supplement to the main income from agricultural or other activities [11].

It should be noted that the main service of rural tourism is the provision of temporary accommodation to tourists on the basis of personal peasant economy. Rural tourism services are divided into basic and additional (Table 1). In addition to intangible services, tourists may be provided with other goods or material services (maps of the area, folk souvenirs, tourist equipment, etc.).

Table 1. Rural tourism services

Rural tourism services	
Basic services	- services for the organization of tourist accommodation; - services for the organization of tourist transportation; - catering services for tourists.
Additional Services	- excursion services; - services to attract tourists to agricultural work and crafts; - services of guides, guides-translators; - services to attract tourists to participate in folk rites and cultural events, as well as village festivals, fairs and other mass events; - car, boat, active-tourist equipment rental services; - consumer services; - the right to use private recreational lands; - others.

Source: [12].

The development of rural tourism has its own specifics due to the complex influence of various factors – historical, geographical, ethnographic, cultural, economic, social. At the same time, it remains one of the perspective areas of rural development in terms of improving market relations in Ukraine. Rural tourism in Ukraine is an integral part of the program of integrated economic and social development of the village [14].

The need to develop rural tourism in Ukraine is determined by the following factors:

- the growing demand of residents of Ukrainian cities and foreigners for recreation in rural areas;
- unique historical and ethnographic heritage of Ukrainian villages;
- rich recreational resources;
- ecological purity of the rural area;
- availability of free rural housing for tourists;
- availability of free labor resources to serve tourists;
- the traditional hospitality of the owners and affordable price for rest;
- a variety of additional excursion services to the liking of tourist [1].

Rural tourism in Ukraine can be one of the important tools for sustainable development of rural settlements. The sustainable development of rural tourism involves the balance of three main components of life: economic, ecological and social. This means that it is necessary to find the optimum in each decision-making case regarding a certain field of activity. Based on this concept, we should outline the conceptual framework for sustainable development of rural tourism (Figure 1).

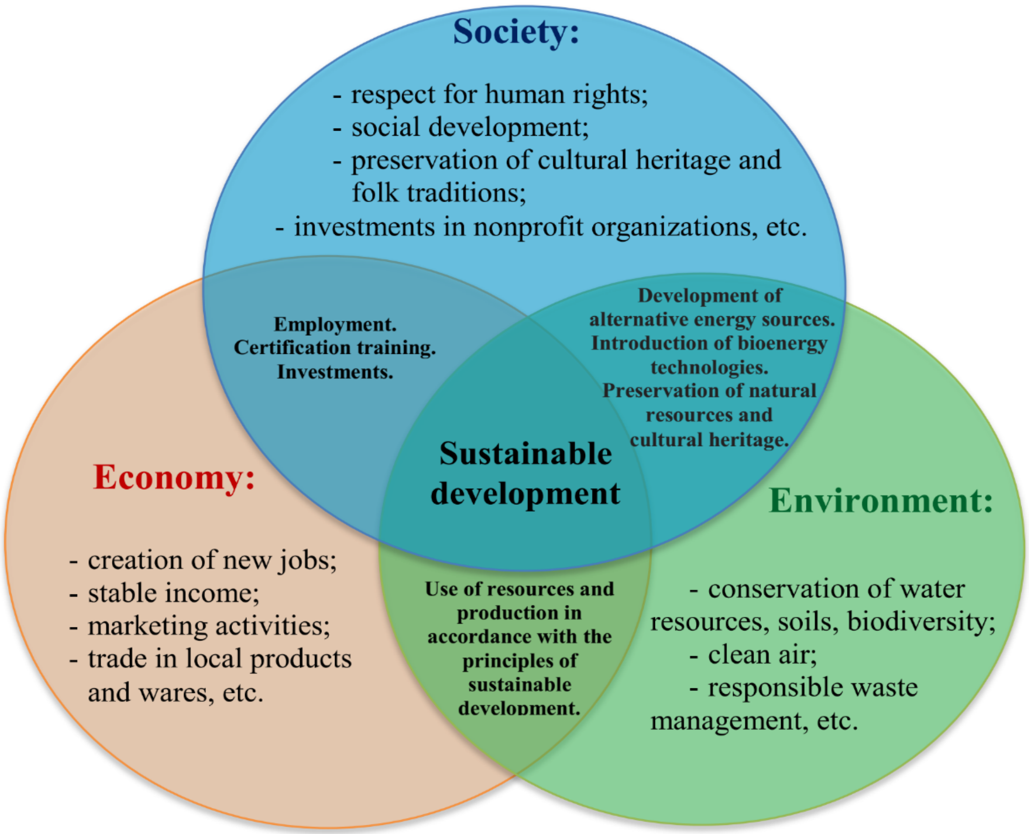

Fig. 1. Conceptual framework for sustainable development of rural tourism
Source: Developed by the authors.

The active participation of the rural population is essential for the implementation of effective approaches and ways to develop sustainable rural tourism. Ultimately, it will help improve the standard and quality of life of the rural population, preserve natural resources, cultural heritage, the local economy growth and maintain ecological balance.

In order to meet the criteria of sustainable development, rural tourism must be based not only on environmental protection. It should also combine other key principles of development that relate to the economy, environment, population and institutional environment (public institutions) (Figure 2) [6].

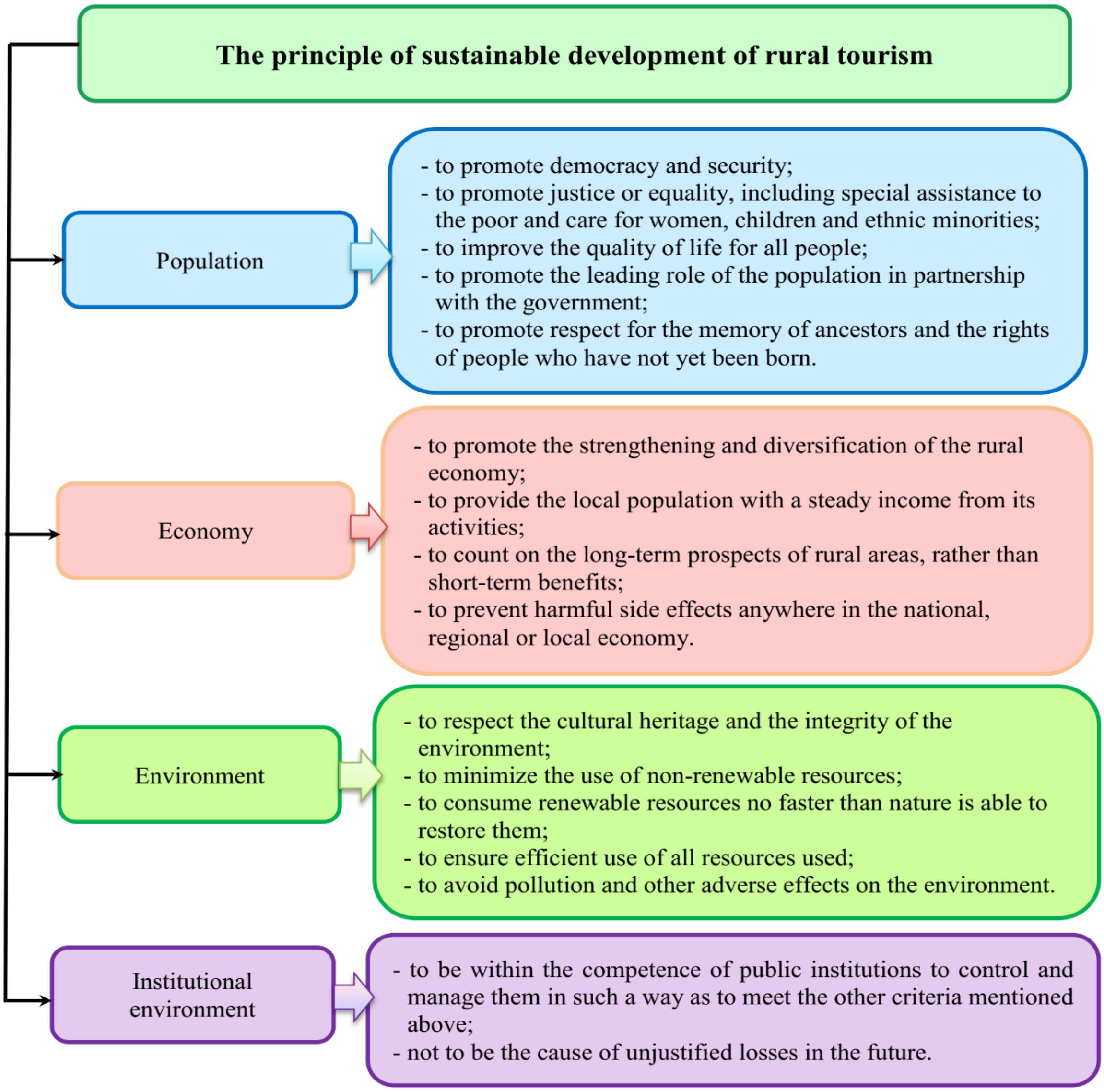

Fig. 2. The principle of sustainable development of rural tourism
Source: Developed by the author on the basis of [6].

It should be noted that the development of rural tourism in Ukraine today is not based on the principles of sustainability, because it clearly does not take into account such conditions:

- responsible waste management;
- taking measures to adapt to climate change;
- development of plans and implementation of measures to find alternative energy sources;
- clear norms and rules for providing quality food (encouragement of organic food production);
- support for sustainable land management which traditionally processed by humans;
- advanced training of the local population;
- compliance with sustainable development goals, etc.

The provision of recreational services by the owner (owner of a rural estate) must take into account the concept of sustainable development, which is based on the preservation of natural resources and cultural values of rural areas and reduction of unwanted impact on the environment. A comprehensive approach to the host's provision of holiday services to the tourist in the field of rural tourism, taking into account a sustainable approach, is shown in Figure 3.

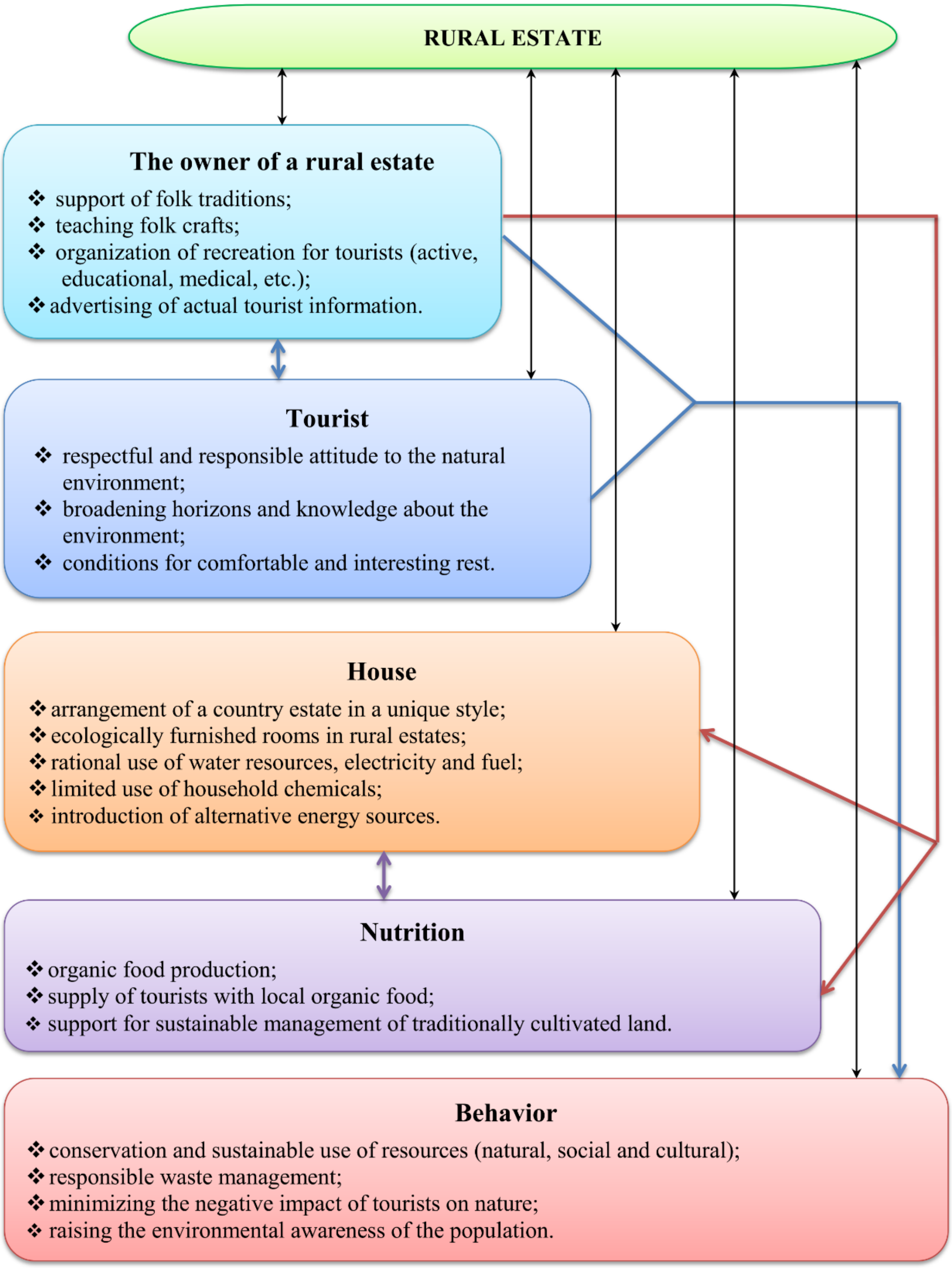

Fig. 3. Integrated approach to the provision of rural tourism services in the context of sustainable development
Source: own representation.

Providing tourists with rural tourism services, taking into account the concept of sustainable development, means that the owner of the rural estate and the tourist must be environmentally friendly and protect all available natural resources and cultural values of the area.

Rural tourism should be developed in a purely rural environment. This type of tourism has a positive impact on solving socio-economic problems of the village, as it expands the employment of the rural population, both in the productive and non-productive sectors, which in turn promotes rural development and stimulates the development of services and local infrastructure, raises the cultural standard of living and environmental awareness of villagers [14].

Thus, rural tourism is not a separate phenomenon, but it is a part of the complex socio-economic development of the village. Sustainable rural tourism in Ukraine can only be realized if it benefits local people, tourists, the economy and the environment of rural areas and is integrated into other areas of rural life.

The advantages of tourism development in rural areas of Ukraine are:

- ecologically oriented way of life among the population (recreation in clean natural areas, consumption of ecologically clean products, etc.);
- socio-economic development of rural areas;
- increasing sources of income and the number of jobs in rural areas;
- improvement of housing stock, communal arrangement of territories and rural infrastructure;
- formation of a stable public position on the preservation of the natural environment and rational use of nature;
- restoration of ethnic and cultural features (traditions, rituals, folk crafts);
- formation of the cultural and educational level of citizens;
- improving the scope of tourist services in rural areas: transportation, trade, utilities and household services, entertainment and leisure organization [17].

Based on our study, we can identify the following main areas of rural tourism in Ukraine (Figure 4).

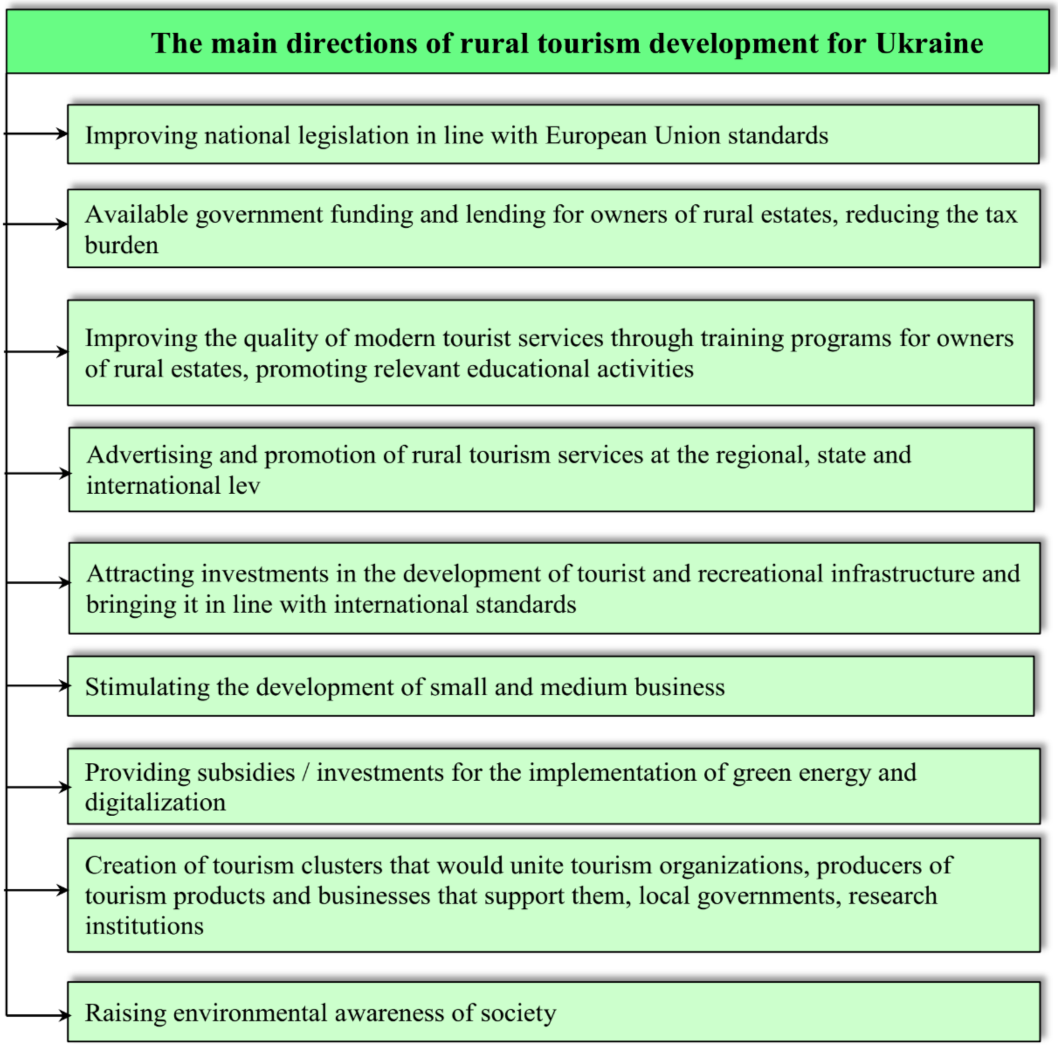

Fig. 4. The main directions of rural tourism development for Ukraine
Source: own representation.

Rural tourism is a guarantor of stability and viability of rural areas, an important alternative for agriculture, as well as a factor in the development of local communities. Today the state support the development of rural tourism is also important. It includes attracting foreign investment, preferential long-term lending to property owners, improving the activities of travel agencies to promote rural estates, etc. [3].

Thus, rural tourism in Ukraine is one of the priority areas of effective development of united territorial communities, an innovative form of entrepreneurship aimed at increasing employment and income of the rural population, creating a favorable socio-economic environment in rural areas on the basis of market relations. The provision of recreational services by the owners of rural estates to tourists should be based on the principles of sustainable development.

CONCLUSIONS

Modern world trends in the development of the tourism sphere indicate the growing interest of tourists in recreation, which is directly related to nature. That is why, when talking about the prospects for the development of rural tourism in Ukraine, we should focus on the experience of the leading states of the European Union, where this type of tourism is successfully developing. Taking into account national traditions, various natural conditions and resources, we can say that in Ukraine there is a significant potential for the development of rural tourism, as well as opportunities for its successful implementation.

The development of sustainable rural tourism today must take into account the key criteria that are require the formation and promotion of a tourism product aimed at a specific consumer, who today is more informed about the principles of sustainable development, determining the priorities of human civilization. The formation of a tourist product in accordance with the consumer needs requires the introduction of an effective system of advertising and marketing at the regional, national and international levels.

Sustainable rural tourism must be based on sustainability criteria, which means that it must be environmentally friendly in the long run, economically viable and socially equal for local communities.

The growing popularity of tourism (in particular rural) in Ukraine and the world can have a positive impact on solving problems of socio-economic development of territories by using the significant tourist potential of the region. In particular, it can be an incentive to build tourism infrastructure that fully meets the needs of tourists, to start a business activity in the field of tourism and expand the activities of existing tourism businesses, as well as it can be partially contribute to the development of community infrastructure.

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THE ROLE OF LAND RESOURCES IN THE FINANCIAL PROVISION OF RURAL AREAS OF UKRAINE

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Abstract

The article describes the role of land resources in the financial support of rural areas of Ukraine. To determine the importance of land resources in the financial sustainability of rural areas, a detailed analysis of their financial potential in the budget system was carried out. It is determined that one of the main sources of filling rural budgets of Ukraine is the payment for land, which averages 46.4% of revenues from the total amount of local taxes and fees. In order to identify the spatial uneven distribution of land resources and tax revenues from land payments, have formed three clusters of rural communities depending on the share of land fees in total local tax revenues. The results of the cluster analysis showed the presence of a significant financial potential of land resources in the majority of rural territorial communities of Ukraine. This potential can be realized by implementing the experience of communities where the share of land fees reaches more than 70% of the total amount of local taxes while a high level of total revenues. To analyze the impact of land use efficiency on rural finance, it is proposed to establish a link between land resources and budget indicators. With the help of correlation-regression analysis on the example of rural territorial communities of Cherkasy region of Ukraine, a direct and close relationship between the land area of territorial communities and local taxes and fees was revealed. The results of such an analysis of the impact of land resources on the efficiency of budgetary processes make it possible to respond appropriately to the land management system and land use efficiency

Key words: *land, resources, financial, provision, territorial community, rural areas*

INTRODUCTION

The administrative reform in Ukraine has led to a number of transformational changes, including in the sphere of decentralization of the state's power and financial powers in favor of local self-government [10].

Territorial community as the main representative of the local community in the political arena is characterized by attachment to specific settlement. The division of settlements into urban and rural in Ukraine determines the main features of territorial communities, the difference in their level of development and capacity, infrastructure provision. The concept of "rural territorial community" is cardinal differs from the category of "urban community" and is characterized certain distinctive aspects of development that are unique to rural areas [1].

The structure of rural areas is complex multifunctional formation, so the definition the main priorities of its development are, first, to clarify the specific features of these territorial communities as a system of local self-government in agricultural areas [9]. At the same time, the main strategic task of forming effective local self-government is the modernization of the system of territorial organization of power, especially in rural areas. Achieving these goals is impossible without the proper level of financial support for these territories and sufficient sources to fill rural budgets.

The indicators of the implementation of rural budgets reflect the general socio-economic condition of the respective territory and its potential for sustainable development. The presence of sufficient resources in local budgets is a guarantee that the rural territorial community can provide better, more diverse services to its residents, implement social, and infrastructure projects, attract investments and finance other activities for the comprehensive development of the community.

Because credit and investment mechanisms have not yet been widely used in the budgetary system of local self-government, funds from local and state budgets are considered as budgetary resources [8].

Budget sources can be formed both from the internal resources of the united territorial community (UTC) and from the resources attracted from outside. External sources of budget funds are the state budget. In particular, external budget subventions may include targeted subventions from the state budget, including in the framework of state or regional targeted programs, investment projects (programs), or financing of UTC projects from the State Fund for Regional Development.

Examples of budget resources of internal origin are revenues from taxes and fees, sale and lease of communal property [16]. At the same time, the internal financial support of the budgets of territorial communities largely depends on the resource potential of these communities.

Land resources are an important component of the resource potential of rural territorial communities in modern conditions [2]. Their effective use will allow to increase the revenues to the local budget in the form of land fees. Such payment includes land tax and rent for communal land. Land tax is a tax payment levied on a landowner or land user, the amount of which directly depends on the size of the land, the marginal appraisal rate and the purpose of the land. Land rent is a payment made by a lessee to a landlord for the use of a land plot in accordance with a land lease agreement. In recent years, there has been a steady trend of increasing the share of rent and a decrease in the share of land tax revenues in the structure of land payment, which is explained by the increase in the cost of renting land.

Many scholars argue that the land tax can be considered by local authorities as the most effective in terms of on the possibility of expanding the tax base and the impact on rates, the importance of its role as a regulatory and incentive tax [3, 5, 6, 7].

Therefore, the urgent issue is the transformation of priorities in financial support for the development of territorial communities and the transition to the effective use of their land and resource potential. And it is in this aspect that the recent transfer of a large part of state lands outside settlements to the ownership of communities is a mechanism for strengthening the land resource potential of the community budget.

MATERIALS AND METHODS

For Ukraine, 2020 has become a key year in the formation of the basic level of local self-government. Thus, on June 12, 2020, the Government approved a new administrative-territorial structure of the basic level. In accordance with the orders of the Cabinet of Ministers, 1,469 united territorial communities have been formed in Ukraine. Among them, 1,058 are distinguished, which are characterized as rural, i.e. they have all the characteristics of rural territorial communities, and which are relevant features of development, demographic situation, problems of funding and organization.

Determining the role of land resources in the budget system of rural areas requires a detailed analysis of their financial potential in the context of achieving their financial capacity.

Analysis of the effectiveness of the formation and use of financial potential should be based on the assessment of budget potential as its main component.

This component of financial potential is studied on the basis of the analysis of sufficiency of own financial resources of local budgets, and also financial capacity of a rural community at the expense of own resources, in particular land.

To analyze the impact of land use efficiency on the financial provision of rural areas, we propose to establish a relationship between land resources and budget indicators by assessing various estimates and statistics. Thus, it is recommended to use economic and mathematical methods of analysis that allow to identify the relationship between factor and result indicators, in particular correlation-regression analysis [11, 12]. This analysis provides identification of the main factors of dependence that reflect the quantitative assessment of the degree of their relationship.

The research was conducted on the basis of statistical indicators of rural areas of Cherkasy region and estimated data of personal research. Cherkasy region was chosen as a model region as the central region of Ukraine, which is a typical rural region with developed agricultural production. The list of land use features has a wide range, which is described by a set of indicators. But consider only those that best reflect the role of land in budget financing. Namely, the area of rural territorial communities and volume of local taxes and fees.

Correlation-regression analysis established the relationship between the indicators that characterize the above factors [13]:

$$y = ax + b, \tag{1}$$

y – the area of rural territorial communities;
x – the local taxes and fees;
a, b – constant coefficients of a linear equation.

Analysis of the role of land resources in the financial support of the territorial community also involves a detailed and phased study of the level of provision of the latter with budget funds, and their dependence on the amount of land.

RESULTS AND DISCUSSIONS

Research on the role of land resources in financing the development of rural areas should be carried out by monitoring the processes of spatial inequality in the distribution of land resources and economic activity in rural communities. Analyzing the impact of decentralization processes on the development of united territorial communities of Ukraine, we note the spatial uneven distribution of rural UTC in terms of area and share of land payment in general local tax revenues (Table 1).

Table 1. Characteristics of rural territorial communities of Ukraine depending on the share of land payment in general local tax revenues, 2021

Indicator	Group of territorial communities, %		
	less than 33	33-67	more than 67
Number of territorial communities	220	757	81
Average area of the territory, sq. km	265	387	327
Average amount of local taxes, thousand UAH	18,456	19,310	23,825
Average amount of payment for land, thousand UAH	4,532	9,301	18,820
The total amount of payment for a land plot, billion UAH	4.0	14.6	1.9

Source: formed by the author according to State Statistics Service of Ukraine.

The results of the cluster analysis allowed to distinguish three groups of rural territorial communities depending on the share of land fees in the total local tax revenues. The analysis of the main indicators in these groups showed that the largest number of rural territorial communities (757) was in the group with the share of land fees in total local tax revenues in the range of 33-67%. This indicates a significant share of revenues from land payments to the local budget. And accordingly, about the role of land resources in filling the rural budgets of communities [4].

At the same time, during our assessment it was found that in most cases UTC, which fell into the group with the share of land fees in total local tax revenues in the range of 33% are not provided with appropriate planning and cartographic materials, relevant land management and urban planning documentation [10, 14, 15].

However, despite the decentralization of budgetary resources, local budget revenues have not yet become the basis for the financial independence of local governments. As intergovernmental transfers continue to play a dominant role in the structure of local budget revenues [10]. Thus, in the communities of Cherkasy region of Ukraine in 2021, the share of local taxes and fees in the revenues of the general fund varied from 14.6% to 56.7% (Table 2).

It should be noted that in almost half of the rural territorial communities of Cherkasy region (24 out of 50) in the structure of revenues from local taxes and fees payment for land is more than 50%.

Table 2. Indicators characterizing the role of land resources in the formation of the budget of rural territorial communities of Cherkasy region, 2021

№	Territorial communities	Average area of the territory, sq. km	Share of local taxes and fees in general fund revenues, %	Total revenues to the general fund, thousand UAH	Local taxes and fees, thousand UAH	Payment for land, thousand UAH	Share of land payment in general local tax revenues, %
1	Irkliivska	926	36.4	104,000.0	37,864.9	17,379.7	45.9
2	Chornobaivska	616	40.3	148,000.0	59,618.6	28,585.0	48.0
3	Palanska	488	30.8	112,000.0	34,455.0	11,396.6	33.1
4	Drabivska	481	40.9	93,980.0	38,430.2	17,192.2	44.7
5	Mankivska	474	37.3	121,000.0	45,103.5	19,131.8	42.4
6	Moshnivska	457	35.3	53,850.8	18,992.3	7,350.3	38.7
7	Katerynopilska	442	40.7	81,672.7	33,256.9	19,404.8	58.4
8	Shramkivska	425	47.1	65,758.2	30,962.1	16,544.2	53.4
9	Bobrytska	386	47.7	34,790.5	16,609.1	10,488.2	63.2
10	Lysianska	381	35.4	72,355.8	25,608.9	10,864.3	42.4
11	Novodmytrivska	359	33.6	79,959.7	26,835.1	15,684.4	58.5
12	Stepanetska	359	14.6	121,000.0	17,712.6	9,432.6	53.3
13	Vodianytska	326	44.6	35,942.7	16,012.6	7,865.0	49.1
14	Ladyzhynska	323	27.2	67,414.4	18,351.3	9,230.0	50.3
15	Dmytrushkivska	309	32.0	52,683.7	16,872.0	6,711.3	39.8
16	Helmiazivska	307	43.4	55,070.3	23,926.5	13,472.3	56.3
17	Rotmistrivska	307	35.1	40,726.7	14,295.8	5,670.8	39.7
18	Lipliavska	300	38.9	24,888.4	9,680.5	4,516.0	46.7
19	Vilshanska	281	45.3	36,168.4	16,386.8	7,894.8	48.2
20	Babanska	277	40.5	42,058.8	17,053.9	8,924.6	52.3
21	Selyshchenska	275	38.2	35,801.8	13,686.4	7,770.8	56.8
22	Steblivska	260	33.3	45,792.5	15,263.7	8,142.9	53.4
23	Ruskopolianska	245	28.1	80,050.5	22,514.9	5,768.9	25.6
24	Pishchanska	244	38.5	39,334.6	15,129.6	8,964.6	59.3
25	Mykhailivska	229	31.1	37,642.6	11,709.1	6,029.5	51.5
26	Lypianska	223	56.7	23,652.7	13,418.0	8,897.4	66.3
27	Nabutivska	217	45.9	27,664.2	12,700.5	7,926.1	62.4
28	Medvedivska	209	52.2	16,368.9	8,548.4	5,836.8	68.3
29	Berezniakivska	208	43.1	18,079.0	7,791.9	3,718.6	47.7
30	Mliivska	206	46.8	26,057.3	12,205.3	5,738.3	47.0
31	Sahunivska	205	38.0	22,723.0	8,643.1	4,326.8	50.1
32	Leskivska	204	32.4	34,131.3	11,044.4	3,626.3	32.8
33	Vynohradska	198	47.3	27,251.6	12,881.2	6,503.5	50.5
34	Balakleivska	196	19.3	52,496.9	10,127.7	3,348.8	33.1
35	Bilozirska	192	31.2	36,963.0	11,546.2	4,999.7	43.3
36	Butska	189	44.1	31,418.9	13,865.2	7,162.1	51.7
37	Bashtechkivska	186	52.0	29,829.8	15,519.6	8,336.7	53.7
38	Budyshchenska	184	35.7	38,050.5	13,580.7	6,459.8	47.6
39	Mokrokalyhirska	180	47.0	29,557.2	13,896.1	8,805.9	63.4
40	Zorivska	176	45.4	28,453.5	12,905.4	7,557.2	58.6
41	Chervonoslobidska	169	35.3	92,085.7	32,460.9	14,195.2	43.7
42	Ternivska	161	36.9	21,545.6	7,953.0	2,992.2	37.6
43	Ivankivska	157	51.6	25,669.9	13,238.4	7,071.4	53.4
44	Stepankivska	146	28.3	40,549.2	11,481.7	5,219.5	45.5
45	Shevchenkivska	140	40.0	20,139.2	8,056.8	3,256.6	40.4
46	Velykokhutirska	136	53.4	23,278.0	12,423.9	7,765.8	62.5
47	Buzhanska	130	42.9	21,274.5	9,117.7	5,340.6	58.6
48	Voznesenska	110	40.3	27,465.6	11,070.2	5,448.5	49.2
49	Matusivska	99	41.5	18,479.7	7,677.9	2,614.9	34.1
50	Yerkivska	51	19.8	36,461.9	7,224.6	2,349.6	32.5

Source: author's elaboration.

The results of correlation-regression analysis of the impact of the rural territorial community area on the amount of the local taxes and fees showed a close relationship between factor and performance characteristics (multiple correlation coefficient R = 0.78).

Figure 1 shows a scatter plot and a linear trend of such dependence. The coefficient of determination (0.61) shows that 61% of all changes in local taxes are due to changes in the area of communities, i.e. the accuracy of selection in the regression equation is sufficient.

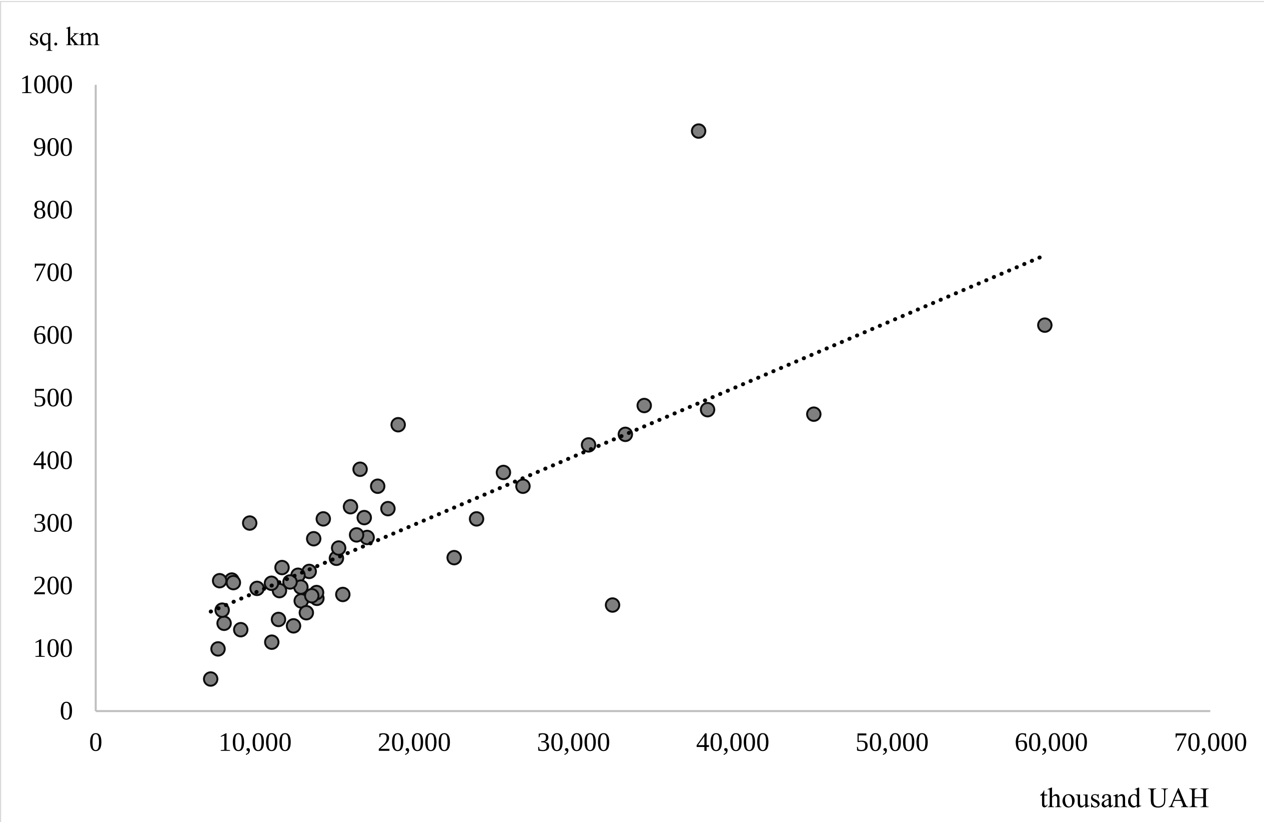

Fig. 1. Correlation dependence of the area of rural territorial communities and volume of local taxes and fees
Source: author's elaboration.

In general, determining the impact of land resources on the efficiency of budget processes and, accordingly, the financial capacity of rural communities makes it possible to respond accordingly to the system of land management and efficiency of their use. Thus, using the equation of dependence of land resources and budget indicators, it is possible to purposefully control the financial support of the budget in the process of its organization and planning.

CONCLUSIONS

Based on the analysis and data on the impact of the area of rural territorial communities to volume of local taxes and fees, it is determined that the planning of the budget process and the development of financial support for rural communities should take into account the land and resource potential of these communities.

It is established that the payment for land is an important source of revenue for local budgets with significant unused reserves. Analysis of the dynamics of revenues from land fees to local budgets during the reform period shows a tendency to increase. At the same time, a broad-based assessment of the impact of fiscal decentralization processes on the full use of the potential of land payments to generate local budget revenues requires additional analysis of all factors that determine the size of their revenues.

It is important to increase the efficiency of land use administration from the point of view of financial filling of the budget of rural territorial communities. In particular, to increase tax revenues from land payments, it is necessary to take into account changes in factors affecting its value: data of the state land cadastre, registration of ownership, land use rights and land lease agreements, accounting for quantity and quality of land, zoning of settlements, regulatory and monetary valuation of land. Identifying such reserves will allow adjusting local land management policies and calculating promising revenues.

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ANALYSIS OF INVESTMENT EFFICIENCY IN THE AGRICULTURAL SECTOR OF UKRAINE ON THE BASIS OF SUSTAINABLE DEVELOPMENT

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Abstract

In the article we study the specifics of assessing investment activity in the agricultural sector of Ukraine's economy in terms of ensuring high efficiency of state regulation in this area. We have identified and substantiated the need for the use of special indicators to assess the impact of public policy on the investment process in agriculture in general and on the investment policy of agricultural producers. It is determined and substantiated that the most significant influence on the regulation of investment activity in the agricultural sector of Ukraine is exerted by the volume of state funding of investment management bodies and the level of financial incentives for investment. According to the results of the study, we substantiated the need to increase the efficiency of reforming the agricultural sector of Ukraine and the need and attraction of additional investment resources to ensure the implementation of the process of improving the functioning of agricultural producers in Ukraine.

Key words: *agricultural sector, agricultural enterprises, investment activity, strategic management accounting, management system*

INTRODUCTION

Agricultural production is one of the most important sectors of the national economy of Ukraine, as it has a significant share in the structure of exports, and also plays a key role in ensuring food security. At the same time, intensive and effective development of this area is impossible without a significant amount of investment, the main purpose of which is to increase the overall efficiency of agricultural enterprises. It should be noted that after signing the Association Agreement with the European Union, Ukrainian agricultural enterprises managed to significantly upgrade their production base and achieve high production efficiency due to entering new solvent markets. However, such an upgrade has become more possible for large agricultural holdings and large farms. At the same time, a significant number of small agricultural enterprises are in dire need of investment.

The key problems of agricultural production in Ukraine are the low level of labor productivity and significant material costs for production. This is due to the long-term underfunding of the agricultural sector and the unprofitable management model, which was focused on significant government subsidies.

Therefore, in order to restructure the system of agricultural production, it is necessary to make changes, first of all, in the technical equipment of enterprises. In addition, in order to achieve high competitiveness in the world market, it is necessary to focus on the production of biologically clean products and the introduction of resource-saving technologies in the production process. With the appropriate level of funding, this will allow in a relatively short time to transfer the agricultural sector of Ukraine to a qualitatively new level of its development. That is why, as well as taking into account the best world experience, we state that the issue of determining the basic principles of investment activities of agricultural enterprises and identifying promising areas of capital for these investments is especially relevant in today`s realities.

Studies of the intensification of investment processes in the agricultural sector in the context of improving the efficiency of investment activities of agricultural enterprises are widely disclosed in the works of researchers such as O. Agres [1], I. Balaniuk [3], O. Binert [4], Y. Chaliuk [6], A. Marcuta [16], A. Popescu [17-26], T. Shmatkovska [27-29], O. Vovchak [39], Y. Yanyshyn [41], and others. It should also be noted the significant contribution to the study of issues related to the nature, mechanisms, and features of formation, as well as ways to improve investment at the level of individual territories and the agricultural sector as a whole, which was carried out in O. Apostolyuk [2], A. Boiar [5], M. Dziamulych [7-14], T. Kravchenko [15], R. Sodoma [30-33], O. Stashchuk [34-36], I. Yakoviyuk [40], O. Yatsukh [42], I. Zhurakovska [43] and others.

MATERIALS AND METHODS

The interaction of the resulting indicator (Y) with the factor features (X_1, $X_2 \ldots X_n$) is traditionally reflected by us by constructing a linear multifactor regression equation determined by the formula:

$$\hat{Y} = \widehat{a_0} + \sum \widehat{a_i} x_i$$

Note that the simplest mathematical model that uses the closeness of the relationship between two variables is linear regression:

$$y_t = ax_t + b, \quad \mathrm{t} = 1, \ldots, \mathrm{n}$$

where:

$a = r\frac{\delta_y}{\delta_x}$ – coefficient characterizing the angle of inclination of the regression line to the axis *OX;*

$b = \bar{y} - a\bar{x}$ – coefficient characterizing the distance from the regression line to the axis *OX;*

x – known variable (*predictor*), taken at time *t;*

y – unknown or predicted variable *(predictor), taken at the appropriate time t;*

$\bar{y}$ and $\bar{x}$ – the average values of statistical series are compared to variables;

r – correlation coefficient;

δ_y and δ_x – root mean square deviations of statistical series are compared to variables;

n – standard deviations of statistical series of comparable variables; *n* are the length of statistical series.

In order to optimize the calculations in the research process was used an effective means of avoiding cumbersome calculations, namely the package "Data Analysis" software MS Excel, which allows high-quality economic and mathematical calculations, and builds multifactor linear and nonlinear econometric models.

RESULTS AND DISCUSSIONS

The investment activity of agricultural enterprises is an integral part of their overall financial activity, so the criteria for assessing the effectiveness of investment are based on generally accepted approaches to the level of their profitability. However, the specifics of investments in agriculture in Ukraine are a significant amount of public funding for the agricultural sector, which is manifested in direct subsidies for agricultural production and targeted funding for agricultural development programs. As a result, state aid accounts for a significant share of the overall structure of investment in Ukraine`s agricultural sector.

Therefore, the evaluation of the effectiveness of agricultural enterprises in terms of studying the overall effectiveness of investment in agriculture should be carried out by determining the ratio of performance of agricultural enterprises to total direct and public investment (Fig. 1).

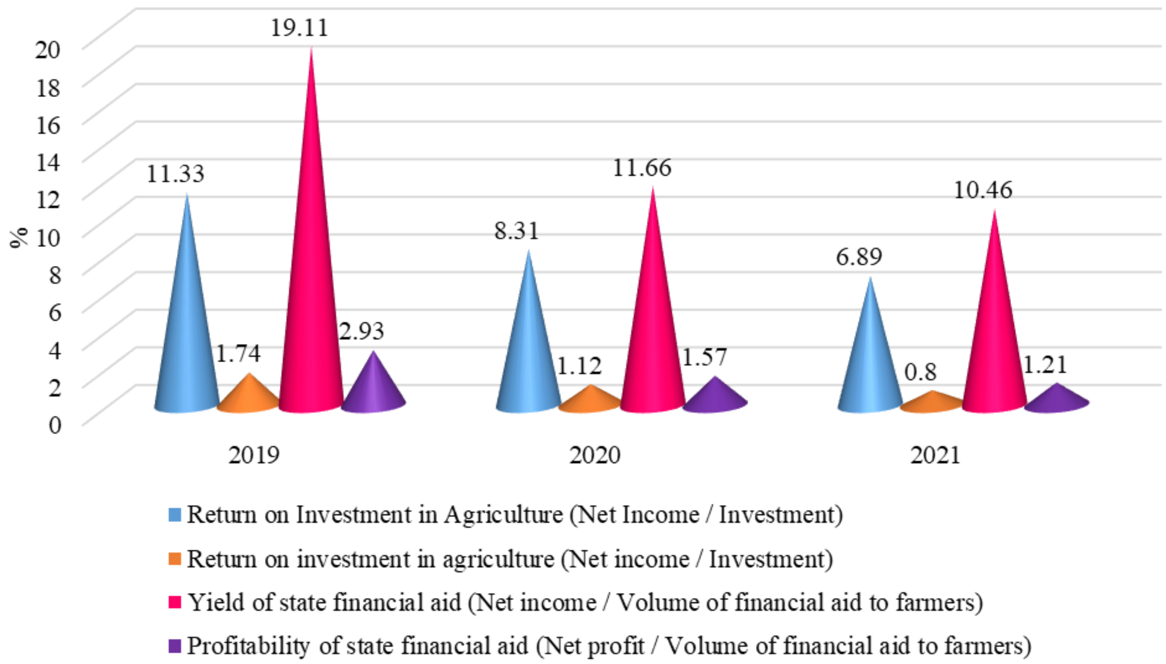

Fig. 1. Indicators of profitability and profitability of agricultural enterprises of Ukraine for 2019-2021
Source: calculated and constructed according to data [37].

As we can see from Fig. 1, during the analyzed period the level of profitability and profitability of investments in the agricultural sector of Ukraine gradually decreased. At the same time, this applied to both direct investments of enterprises and state funding of targeted programs for the development of the agricultural sector. However, the main reason for this was not objective economic factors, but the negative impact of the COVID-19 pandemic, which hit all sectors of the economy. As a result, despite rising market prices for agricultural products during the same period, return on investment fell due to constant restrictions on the movement of capital and material resources in the fight against the pandemic.

It should also be noted that at the same time in the national economy of Ukraine there were no macroeconomic trends that could hinder the return on investment or artificially limit their profitability due to the adverse effects of environmental factors. On the contrary, if we evaluate the dynamics of the Doing Business rating published by the World Bank, we will see that in the analyzed period Ukraine`s position on ease of doing business was constantly improving, and in 2020 it took the highest place for the entire rating period (Fig. 2).

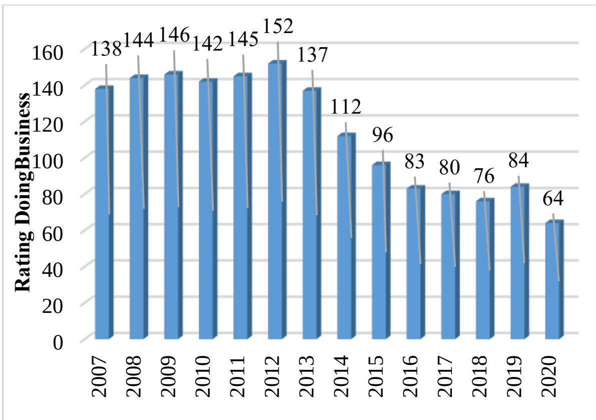

Fig. 2. Changing the position of Ukraine in the Ease of Doing Business Index for 2007-2020.
Source: [38].

It should be noted that determining the effectiveness of commercial investments is based on the analysis of net indicators of their profitability and profitability. At the same time, assessing the effectiveness of public investment in agriculture is more difficult, as they are not implemented through direct financing of enterprises, but through integrated distribution through specialized programs to support the agricultural sector. In this regard, the funds received by different companies are different in volume, and some share of business entities remains outside the target programs. Therefore, to increase the reliability of assessing the effectiveness of public investment programs in agriculture, it is necessary to use an indirect assessment of investment performance using specialized coefficients.

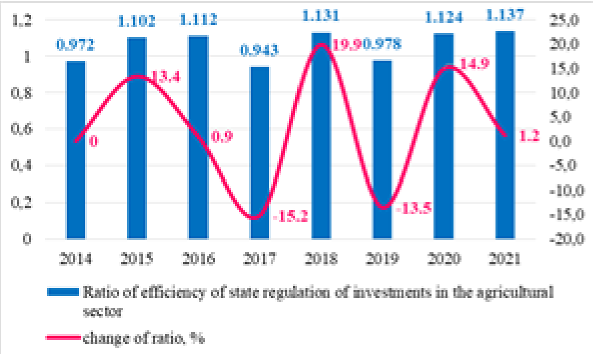

Fig. 3. Dynamics of the coefficient of efficiency of state regulation of investments in the agricultural sector in Ukraine for 2014-2021.
Source: calculated and constructed according to data [37].

One of such important indicators is the efficiency of state regulation of investment and the agricultural sector, which is the ratio of changes in investment in agriculture to the rate of change in expenditures on the financing of state institutions involved in regulating investment processes in agriculture. The critical value of this indicator is 1, and its dynamics are shown in Fig. 3.
The dynamics of this indicator show that during the analyzed period the overall level of impact of public financial assistance on investment activity in agriculture was positive. The values of this coefficient fell below the critical level only in some periods, and over the past two years, it has had a steady upward trend. This indicates a generally active influence of state regulation on investment activity in the agricultural sector. In addition, it should be noted that an additional incentive to increase this indicator was the adoption in 2021 of the Law on Private Land Ownership, which led to an additional influx of financial resources into the agricultural sector.
It is also advisable to use for the analysis of the coefficient of efficiency of public investment, which is the ratio of the rate of the overall growth of investment in the agricultural sector to the rate of increase in public funding for agriculture in the country. At the same time, the efficiency of public investment on this indicator is determined by its excess over the normative value, which is equal to one. The dynamics of this coefficient are shown in Fig. 4.

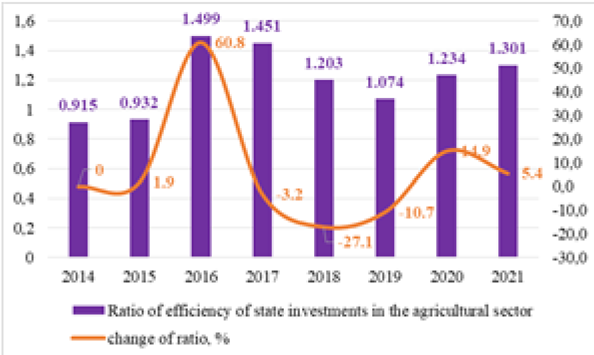

Fig. 4. Dynamics of the efficiency ratio of public investment in the agricultural sector in Ukraine in 2014-2021.
Source: calculated and constructed according to data [37].

As we can see, during the analyzed period, the level of efficiency of public investment in agriculture was unstable. In particular, its gradual decline in 2017-2019 led to a fall to almost a critical value of 1,074. However, since 2020, this coefficient has started to grow dynamically due to the wide entry of Ukrainian enterprises into the EU market as a result of the Association Agreement. This opening of markets gave a significant increase in sales of agricultural enterprises in Ukraine, which affected their financial performance, including – increased financial return on investment, including – public investment in agricultural production under targeted support programs.
The coefficient of investment efficiency of VAT refunds to agricultural enterprises is the

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ratio of the rate of change of investments in agriculture to the rate of change of the total amount of VAT refunds to agricultural enterprises. The critical value of this indicator is 1. Its dynamics are shown in Fig. 5.

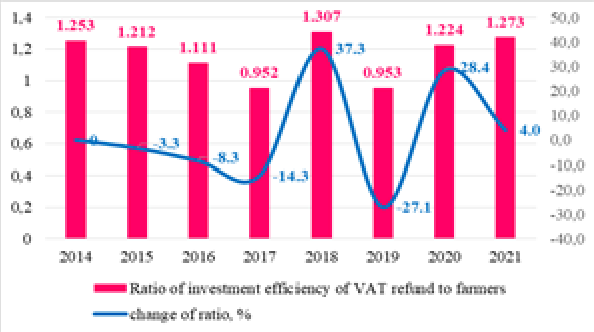

Fig. 5. Dynamics of the coefficient of investment efficiency of VAT refund to agricultural enterprises for 2014-2021.
Source: calculated and constructed according to data [37].

As can be seen from the analysis, in 2014-2017 the dynamics of this ratio was declining, due to the large-scale consequences of the economic crisis of 2014-2015 due to Russia`s military invasion of Ukraine. However, since 2018, the total amount of VAT refunds to agricultural enterprises began to increase, which indicates the intensification of export activities in the agricultural sector. At the same time, increasing the amount of refund of this tax significantly contributes to the replenishment of the working capital of agricultural producers, which directly affects the efficiency of their activities and increases the number of financial resources available for investment.

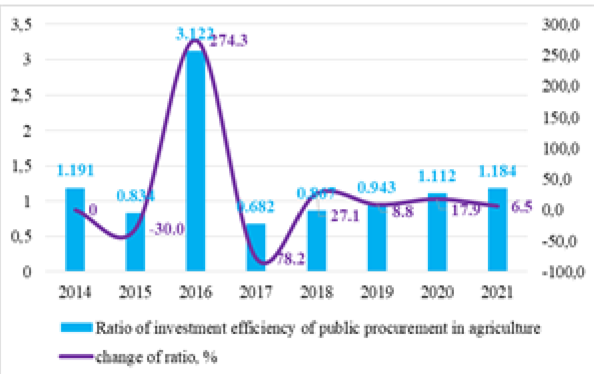

Fig. 6. Dynamics of the coefficient of investment efficiency of public procurement in agriculture for 2014-2021.
Source: calculated and constructed according to data [37].

The investment efficiency ratio of public procurement is determined by determining the ratio of the growth rate of investment in the agricultural sector to the overall rate of change in public procurement funding for agricultural producers. The critical value of this indicator is also 1. Its dynamics are shown in Fig. 6.
During the analyzed period, the dynamics of this coefficient were unstable. In addition to its sharp growth in 2016 due to increased investment in agriculture after the crisis of 2014-2015, in general, the value of this indicator was lower than critical, which indicated insufficient funding for public procurement in agriculture. At the same time, since 2017 it has been growing steadily due to the increase in the total volume of agricultural support programs, which include financing the targeted purchase of agricultural products, in particular – to replenish the State Reserve of Ukraine.
For a more detailed assessment of the effectiveness of the state`s influence on investment activity in agriculture, a correlation-regression analysis of the relationship between key indicators of the analysis. The resulting indicator is the total volume of investment in agriculture in Ukraine, and the factors considered above are the coefficients discussed above. The initial data required to build a regression model are given in Table 1.
The results of the regression calculation performed in the Microsoft EXCEL program are given in Table 2.
The regression analysis shows that the value of R2 is 0.5253. This indicates the existence of a close relationship between the overall level of return on investment in agriculture and the effective effectiveness of certain instruments of state regulation of investment activities. Based on Fisher`s criterion, it can be concluded that there is a stable relationship between indicators, as its actual value is 19.92, which exceeds the minimum allowable value.

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Table 1. Indicators for the analysis of the dependence of the profitability of investments in the agricultural sector on the effectiveness of their state regulation in 2014-2021.

Indicators	Legend	2014	2015	2016	2017	2018	2019	2020	2021
Total investment in agriculture, million USD	Y	2,357	1,834	2,419	2,975	2,919	2,710	2,911	3,098
Efficiency coefficient of state regulation of investments in the agricultural sector	X_1	0.972	1.102	1.112	0.943	1.131	0.978	1.124	1.137
Efficiency coefficient of state investments in the agricultural sector	X_2	0.915	0.932	1.499	1.451	1.203	1.074	1.234	1.301
Coefficient of investment efficiency of VAT refund to agricultural enterprises	X_3	1.253	1.212	1.111	0.952	1.307	0.953	1.224	1.273
Coefficient of investment efficiency of public procurement in agriculture	X_4	1.191	0.834	3.122	0.682	0.867	0.943	1.112	1.184

Source: own calculations.

Table 2. The results of regression analysis of the dependence of the return on investment in agriculture on the effectiveness of their state regulation

Regression parameters	Regression options				
	Plural	Y from X_1	Y from X_2	Y from X_3	Y from X_4
R^2	0.5253	0.4068	0.3588	0.3057	0.2681
Fisher`s criterion	19.92 $F_{min} = 4.22$	17.15 $F_{min} = 1.25$	13.98 $F_{min} = 1.25$	11.00 $F_{min} = 1.25$	9.15 $F_{min} = 1.25$
Coefficients for variables, $b^1 – b^4$	X_1: $b^1 = 0.919$ X_2: $b^2 = 1.228$ X_3: $b^3 = 4.141$ X_4: $b^4 = -0.127$	X_1: $B^1 = 0.995$	X_2: $B^2 = 0.405$	X_3: $B^3 = 2.501$	X_4: $B^4 = 0.261$
Probability of error, $P^1 – P^4$	X_1: $P^1 = 0.357$ X_2: $P^2 = 0.237$ X_3: $P^3 = 0.346$ X_4: $P^4 = 0.583$	X_1: $P^1 = 0.001$	X_2: $P^2 = 0.001$	X_3: $P^3 = 0.004$	X_4: $P^4 = 0.005$

Source: own calculations.

According to the results of the analysis, the level of influence of the effectiveness of state regulation in the area of financing investment management bodies and financial incentives for investment is the highest compared to the effectiveness of other tools. At the same time, the increase in state budget expenditures on investment management bodies, as well as direct financial assistance to agricultural producers have a high positive impact on the dynamics of return on investment in agriculture.

CONCLUSIONS

Thus, in the studied period, the relative quantitative growth of investments in agriculture in Ukraine is fixed. At the same time, it should be noted that the weakness of state regulation of investment activities in agriculture is the lack of a balanced long-term policy of economic development and stable regulatory and legal support for the functioning of this area.

According to the results of the application of modern methods for the analysis of the profitability of the main economic instruments for state regulation of investment activities in agriculture, it was found that they did not fully contribute to increasing the economic efficiency of agricultural enterprises and have significant development potential. The level of influence of the effectiveness of state regulation with the use of such means as financing of investment management bodies and financial stimulation of investment development is the highest compared to the effectiveness of other instruments of state regulation.

According to the study, it can be argued that effective reform of the agricultural sector of the economy can be carried out only through a significant increase in investment activities of enterprises, as well as through the overall increase in investment resources that will be available to these entities. At the same time, there is a need to accumulate not only commercial and banking capital, but also to rely on targeted public investment in reforming priority areas of agricultural production. In addition, the increase in investment activity of agricultural enterprises will result in increased investment attractiveness in rural areas, which will contribute to their socio-economic development.

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RESPONSE OF VEGETATIVE GROWTH OF TOMATO (S*olanum lycopersicum* L. VAR. MIRA) DUE TO PGPR (PLANT GROWTH-PROMOTING RHIZOBACTERIA) COMBINED WITH COMPOST AND NPK FERTILIZER

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Abstract

This study aims to determine the growth response of tomato (Solanum lycopersicum L.) plants after the application of PGPR combined with compost and NPK fertilizer on vegetation. The tested parameters include the plant height, number of leaves, wet and dry weight, and root volume of plants. The method used was a non-factorial trial with five treatments and replications, whereby P0 was a control, P1 was given PGPR, P2 composted fertilizer and PGPR, P3 NPK and PGPR, and P4 was given only NPK. Analysis of Variance (ANOVA) was performed on the data and continued with the Least Significance Different Test (LSD). The results showed no significant difference in the plant height, number of leaves, wet and dry weight of PGPR treatment plants with a combination of compost fertilizer and NPK; hence PGPR was used to compensate for NPK. Although the root volume parameters showed significant differences, which was evident in the application of NPK in combination treatment of PGPR, compost fertilizer, or NPK..

Key words: *fertilizer, PGPR, tomato*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a horticultural commodity with high economic value because it is rich in vitamins and minerals [16]. Therefore, they are widely used as a daily side dish, a mixture of cooking spices, processed industrial products, or consumed fresh. Furthermore, the variety of benefits possessed by tomatoes is an attraction for farmers and the community to cultivate for commercial purposes.

The use of fertilizers is one of the efforts that enhance crop production. Fertilization is the addition of plant nutrients into the soil to make it fertile. According to Government Regulation No. 8/2001, fertilizers are classified into inorganic and organic fertilizers [10].

Inorganic fertilizers increase productivity, but continuous use reduces soil quality [5]. According to Kartika et al. [7], organic fertilizers are used to increase the efficiency of using chemicals, hence reducing the impact of environmental pollution due to the use of chemical fertilizers. However, using organic fertilizers alone will not produce optimal crop production. This is because the nutrient content produced by organic and inorganic fertilizers is not equivalent. Therefore, through the help of certain effective microbes, organic fertilizers that are not wholly decomposed are broken down and made useful by plants.

The current developments in biotechnology have boosted public awareness, which promotes the development of more environmentally friendly products, such as biofertilizers. This fertilizer contains live microorganisms that bind or facilitate the availability of certain plant nutrients in the soil [2]. Furthermore, the biofertilizers are Plant Growth-Promoting Rhizobacteria (PGPR) or root bacteria, currently studied and developed to assist agriculture. PGPR is a rhizosphere bacterium that positively affects plant growth [11]. These bacteria can colonize plant roots to absorb microbial secretions that are beneficial for root growth and prevent pathogen invasion [14].

Various studies have proved PGPR to be a plant growth supporter. However, the use of local rhizosphere bacteria in combination with organic and inorganic fertilizers for the growth of tomatoes has not been reported.

Therefore, this study aims to determine the growth response of tomatoes (*Solanum lycopersicum* L. Var. Mira) due to the application of PGPR combined with compost and NPK on the vegetation. The parameters considered were the growth curve, plant height, number of leaves, wet and dry weight, and plant root volume.

MATERIALS AND METHODS

The study was conducted from November 2019 to January 2020 at the Kalasey Biological Agency Laboratory Greenhouse, the Center for the Protection and Testing of the Quality of Food Crops and Horticulture (BPPMTPH), the Regional Agriculture and Livestock Service North Sulawesi Province, and the Advanced Laboratory. Department of Biology, Faculty of Mathematics and Natural Sciences, Sam Ratulangi University.

This study is a nonfactorial experiment with five treatments and replications. The five treatments were P0 (garden soil as a control), P1 (garden soil plus PGPR), P2 (garden soil plus compost with PGPR), P3 (garden soil plus NPK (5 g) with PGPR), and P4 (garden soil plus NPK (5 g) without PGPR). Each growing medium (polybag) was filled with 5 kg soil at a 4:1 ratio of garden soil to compost for P2 treatment. Every five days, up to 5 mL of PGPR was administered.

The plant height was measured from the soil surface to the tip of the growth point after transplanting into the medium [6]. Data on plant height (cm), number of leaves (strands), wet and dry weight (g), and root volume (mL) were collected on the last day of observation (40 DAP). Wet weight data were collected by gently taking plants from a medium cleansed with running water until all soil was discharged and dried. Furthermore, the root volume was calculated by inserting the roots into a measuring cup with a predetermined volume of water. Hence, the increase in water volume after insertion is the root volume value [8]. Finally, the wet weight of plants was measured by weighing all cleaned plants using an analytical balance, while dry weight was measured by placing the plants which were previously enveloped in an oven at 70°C. After which, it was weighed daily until a constant weight was obtained. Hence, the last constant weight is plant dry weight data [9].

Analysis of Variance (ANOVA) was conducted on the collected data at a 95% confidence level and continued with the Least Significant Difference (LSD) test with a 95% confidence level ($\alpha = 0.05$).

RESULTS AND DISCUSSIONS

Growth Curve

The test results on tomato plants treated with PGPR in combination with compost and NPK reveal a range of growth curves, as shown in Figure 1. Generally, the vegetation pattern was close to the sigmoid curve. However, until the last day of observation, there was no aging phase due to the plant having passed the generative period, namely inflorescence [10].

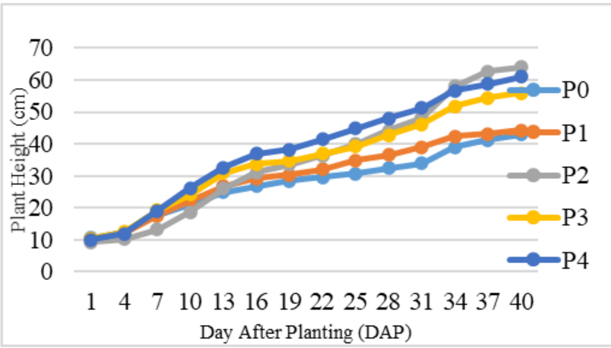

Fig. 1. The growth curve of tomato plants treated with P0 (garden soil as control), P1 (garden soil plus PGPR), P2 (garden soil plus compost with PGPR), P3 (garden soil plus NPK with PGPR), and P4 (garden land plus NPK).
Source: own calculation.

During the 40-day observation period, all treatments demonstrated a logarithmic phase that was estimated to have begun at 4 DAP, as the treatment was performed after the plants were 22 days old. The linear phase began when the growth rate began to slow between 7 and 40 DAP. Furthermore, the ANOVA test on tomato plant height from 1 to 4 DAP showed no difference in height between treatments; hence, PGPR combined with compost and NPK did not affect variations in the growth curve up to 4 DAP. Variations in growth patterns started at 7 DAP until the last day of observation (40 DAP).

Plant Height

Observational data on tomato plant height after 40 DAP received treatment showed that PGPR combined with compost (P2) produced the highest yield with an average value of 64.1 cm, followed by treatment with NPK alone (P4) with an average value of 61.02 cm, a combination of PGPR and NPK (P3) with an average value of 55.88 cm, and treatment with PGPR alone (P1) with an average value of 44.32 cm and the lowest plant height was observed in the control treatment (P0) with an average value of 43.02 cm (Figure 2).

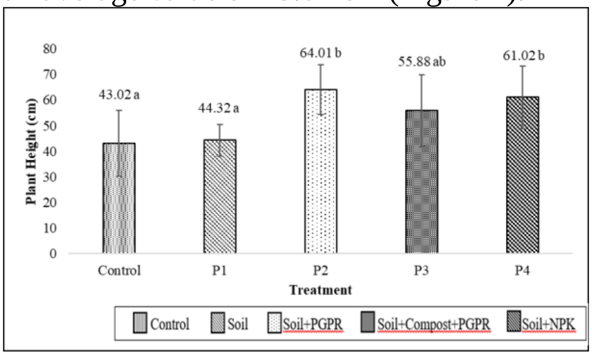

Fig. 2. Tomato plant height after treatment of several combinations of fertilizers on the 40th day of the study.
The numbers, followed by the same letter, do not differ significantly based on the 5% LSD test.
Source: own calculation.

The results of the ANOVA test showed that the treatment had a significant effect on plant height. In addition, statistical analysis of LSD (α 0.05) showed that treatments P3, P4, and P2 were significantly different from treatments P0 and P1.

The combined provision of PGPR with compost replaces synthetic NPK fertilizers. Furthermore, PGPR enhances the absorption of compost nutrients by plants, except compost provides nutrients for the microorganisms contained by PGPR; thus, these fertilizers and compost work synergistically to support plant growth. The administration of PGPR increases plant height. It is shown in Iswati's research, which states that 12.5 ml doses of PGPR have a significant effect on tomato plant height [6].

Number of Leaves

The number of tomato plant leaves observed after 40 DAP obtained the highest value in treatment P2. The average number of leaves was 15.4 strands, followed by P4, P3, and P1, respectively, with 14.2, 9.8, and 7.8 strands. The lowest was observed in treatment P0, which produced 7.4 strands (Figure 3). The Anova test showed that the treatment increased the number of tomato plant leaves. Also, statistical analysis of LSD (α 0.05) showed that treatments P2 and P4 differed from P0 and P1, while each was not significantly different from treatment P3.

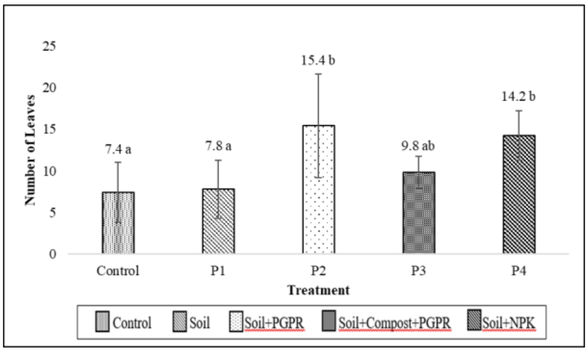

Fig. 3. Number of leaves of tomato plants after treatment of several combinations of fertilizers on the 40th day of the study.
The numbers, followed by the same letter, do not differ significantly based on the 5% LSD test.
Source: own calculation.

Febriani et al. [3] stated that the treatment without PGPR generated the least number of leaves. Iswati's research [6] discovered that the administration of PGPR at a concentration of 7.5 mL affects the number of leaves on tomato plants. There is a difference with the research in which the provision of PGPR without a combination of planting media does not affect the number of leaves. On the other hand, the PGPR and compost fertilizer treatments impacted the number of leaves, with the highest average number of leaves being 15.4. However, it was not significantly different from the NPK treatment alone (14.2 strands).

Gross weight

These results showed that the highest wet weight was discovered in treatment P4 with an average of 55.54 g, followed by treatment P2 and P3 of 47.59 and 35.01 g. ANOVA was conducted on the wet weight data and continued with a 0.05 LSD test. Figure 4 shows the experimental data on the wet weight of plants. These three treatments were not statistically significantly different. The lowest wet weight was discovered in the control treatment with 15.51 g, followed by PGPR of 16.80 g. There were no significant differences in the combined PGPR and NPK, but it tends to be higher than the control. It is possible to observe significantly different data when the concentration is increased.

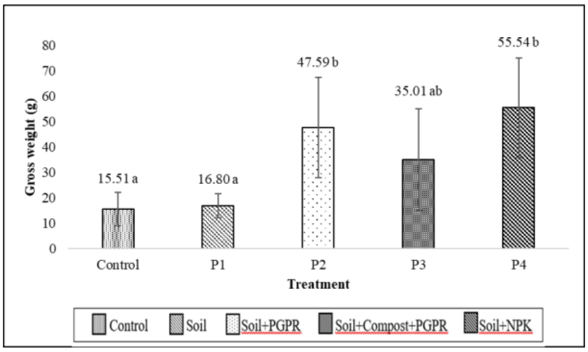

Fig. 4. Gross weight of tomato plants after treatment of several combinations of fertilizers on the 40th day of the study.
The numbers, followed by the same letter, do not differ significantly based on the 5% LSD test.
Source: own calculation.

In general, the application of PGPR when combined with compost compensates for the wet weight yield produced by the administration of NPK. Research conducted by Syamsiah and Rayani [15] states that PGPR application with a concentration of 0.75% affected the fresh weight of chili plants. The wet weight is used as a plant growth parameter because it results from occurring processes in plants. Also, according to Salisbury and Ross [13], it is stated to be the plant's total weight, which shows the results of metabolic activity. Hence, the metabolic activity of plants treated with PGPR increases, especially when combined with compost.

Dry Weight

The lowest average dry weight resulting from PGPR treatment alone was 1.48 g, followed by tomato plants without treatment at 1.58 g. However, the tendency of an increase in dry weight in both treatments was not statistically significant. Furthermore, an increase in the combined treatment of PGPR was not significantly different from PGPR combined with compost. This shows that PGPR application results in a better dry weight when combined with compost or NPK. Meanwhile, the highest weight was obtained in the treatment, with NPK alone being 5.92 g. It was not significantly different from PGPR treatment combined with compost or NPK. This shows that PGPR needs to be combined with compost to achieve a good dry weight. Therefore, its combination with compost replaces NPK fertilizer as a source of plant nutrition.

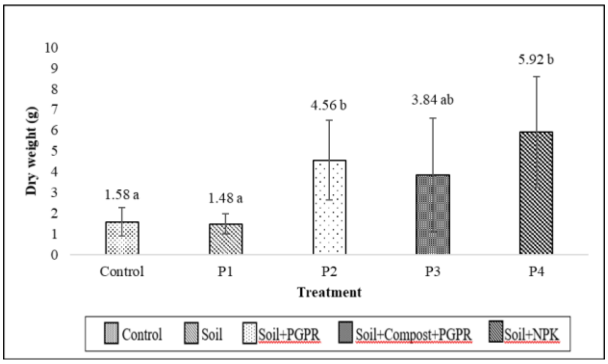

Fig. 5. Dry weight of tomato plants after treatment of several combinations of fertilizers on the 40th day of the study.
The numbers, followed by the same letter, do not differ significantly based on the 5% LSD test.
Source: own calculation.

Plant dry weight illustrates the amount of photosynthate used to perform body metabolism, which determines the high productivity of [1]. In addition, Saharan and Nehra [12] stated that PGPR application to plants replaces chemical fertilizers, pesticides, and hormones that are useful for growth, thereby increasing plant dry weight.

Root Volume

Tomato plants treated with NPK had the highest average root volume of 10.6 mL, followed by PGPR and NPK treatments with an average root volume of 6.4 mL, while untreated plants produced the lowest root volume (2.6 mL) than those treated with PGPR alone (3.6 mL).

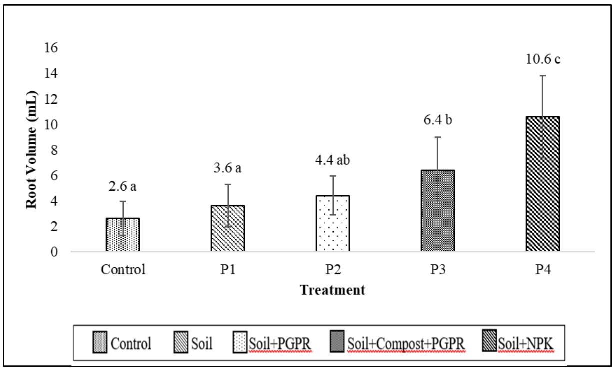

Fig. 6. Root volume of tomato plants after treatment of several combinations of fertilizers on the 40th day of the study.
The numbers, followed by the same letter, do not differ significantly based on the 5% LSD test.
Source: own calculation.

After being analyzed with the LSD 0.05 test, it was observed that the root volume in control was not significantly different from those administered PGPR alone or in combination with compost. This shows that the application of PGPR or its combination with compost has not been able to increase root volume.

However, given the tendency for therapy to increase root volume, it is probable that the PGPR concentration was insufficient. According to Iswati [6], the administered dose of PGPR is directly proportional to the length and number of roots of tomato plants.

The results also showed that NPK treatment as a positive control generated the highest root volume, which implies that the administered dose of PGPR could not compensate for the increase in root volume of tomato plants. Furthermore, there is a possibility of increasing the volume of plant roots due to the low need for water and nutrient absorption. Gardner et al. [4] stated that plants experience greater root growth under water stress conditions than when water needs are met. This is because plant roots are planted vegetative organs that grow and develop correctly when the supporting factors for growth are met.

However, there is a tendency that the use of PGPR increases root volume, although the difference is not significant, especially when combined with compost or NPK fertilizers.

CONCLUSIONS

Based on the research conducted, tomato plants treated with PGPR showed a good growth response with a combination of compost and NPK fertilizers. PGPR administration on the growth pattern is almost close to the sigmoid curve. Furthermore, its treatment combined with compost fertilizer and NPK generated the highest yield on the parameters of plant height and number of leaves.

Furthermore, the combination of PGPR and compost produce indistinguishable results from NPK in terms of wet and dry weight. Finally, the highest root volume was produced by the application of NPK.

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RESPONSIBLE INNOVATION IN AGRICULTURE: A CASE STUDY FROM NORTH MACEDONIA

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Abstract

We investigate how successful is the Responsible Innovation in the North Macedonia. In order to examine this issue in a country-specific context, a two-fold approach was used. First, a typical case of a micro-company engaged in innovative agriculture was presented. Second, data was collected with a semi-structured questionnaire through a Focus Group Discussion (2021). We applied the Innovation Spiral as a theoretical foundation to examine the practice of innovation in each of its seven phases i.e. initial idea, inspiration, planning, development, realisation, dissemination and embedding. We also assessed the development of the Agriculture Knowledge and Innovation System (AKIS) in the country with the particular case study. We have found gaps, opportunities, constraints and blind spots in the responsible innovation process related to the inclusion of the AKIS members and their interaction in the co-innovation processes.

Key words: *Innovation spiral, Agriculture Knowledge and Innovation System (AKIS), responsible innovation, agriculture, qualitative research*

INTRODUCTION

The basic environment for research, innovation and technology development in North Macedonia is slightly improving, generally as a result of the international support programmes and the general national infrastructure to support these processes. However, much work lays ahead for the agriculture sector in order to reach the technological developments in the EU Member States based on innovations. Innovation does not occur in isolation, but several factors play a key role, such as policy, legislation, infrastructure, funding and market developments [5], including the Agriculture Knowledge and Innovation System (AKIS) settings (i.e. the AKIS actors, their organisation(s) and the knowledge flows between them) [12].

The role of education system in North Macedonia is not significant in facilitating innovation and technology transfer to the agriculture sector, although many university professors and researchers have gained significant research experience from participating in EU and other international projects. Even though there are structural funds such as the Instrument for Pre-Accession Assistance for Rural Development (IPARD) for enhancing the innovation and technology development process, the capacity of the agriculture sector to adopt innovations and to transfer technology is generally lacking. Individual farmers, have developed insignificant capacity to adopt innovations and new technologies. Farmers' cooperation is encouraging the transfer of knowledge, but insufficiently since there is a little number of small and dysfunctional cooperatives with limited resources. Small agri-businesses adopted innovation at some extent, but it is still below the global developments. Clusters in the country developed in their own way, but generally they have a lack of potential for innovation, new products and services development. The foreign direct investments rarely enter the agriculture sector and even more rarely as greenfield investments, and also they are still below the expectations of the public and policymakers.

For improving the general infrastructure in the country for innovation and technology development in the agriculture sector, an optimism is observed with initiating the Smart Specialisation Strategy (S3) in the country. There are other strategies that support innovations and technology transfer, but their enforcement is still relatively low.

The evidence addressing the level of development and integration of the national AKIS for fostering responsible innovation in the country is very scarce. Few technical reports exist [8], [9], [10], upon which this study builds forth on, but herein, we try to add the academic component that is missing in the previous studies. Thus, the *aim* of the research is to *investigate how successful is the responsible innovation in agriculture in post-transition settings, in this case, in the context of the Republic of North Macedonia.* Better understanding of the AKIS in different innovation phases will provide a groundwork for proposing improvements and facilitation of innovations in agriculture by designing proper research, innovation and technology transfer strategies.

In this regard, we first present the theoretical concepts that frame the research, along with explanation of the methods of data collection and analysis. Next, we present the results following a discussion. Finally, we present the conclusions and recommendations for improving the general infrastructure to support the responsible innovation development in the agriculture sector.

MATERIALS AND METHODS

Theoretical framework

The theoretical foundation for this study rests on three essential concepts: The Innovation Spiral, AKIS and the Responsible Innovation (RI)/Responsible Research and Innovation (RRI) concepts. The Innovation Spiral is applied to describe the innovation process with a given case study in the agriculture sector and to identify bottle necks, pull and push factors in the research, innovation and technology transfer. The Innovation Spiral [15] as presented in Figure 1, distinguishes different phases, such as: (i) the invention or formation of new ideas (such as, initial idea and inspiration to innovate), (ii) innovation or conversion of new ideas into practical applications (such as, planning, development and realisation of the innovation), and (iii) diffusion or the spread of new applications across the potential users (such as, dissemination and embedding of the innovation).

Each phase prioritises other activities, and usually involves other actors. The shape of the spiral shows that the idea usually starts off small and spreads to involve more actors as the process of innovation progresses. Furthermore, knowledge processes and innovation are rarely linear, which explains why the model is shaped like a spiral. The phases can even be repeated more than once.

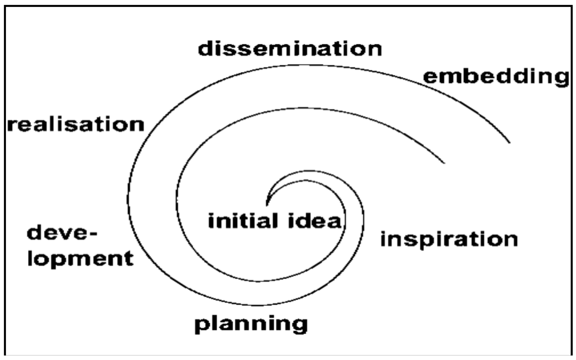

Fig. 1. Innovation Spiral
Source: Wielinga et al. (2008) [15].

The concept of AKIS is used to identify and assess the capacities of the agriculture innovation actors involved in the research, innovation and technology transfer in North Macedonia. It is a useful concept to describe a system of innovation, with emphasis on the organisations and stakeholders involved, the links and interactions between them, the institutional infrastructure with its incentives and budget mechanisms [4].

AKIS is the combined organisation and knowledge flows between persons, organisations and institutions who use and produce knowledge for agriculture and interrelated fields, as represented in Figure 2.

AKIS actors use and produce knowledge for agriculture and interrelated fields (value chains, rural actors, consumers, etc.). Although different components of AKIS, extension/advise, education and research, are often stressed, it is important to realise that there are many more actors in the food chain which directly influence the decision making of farmers and their innovations.

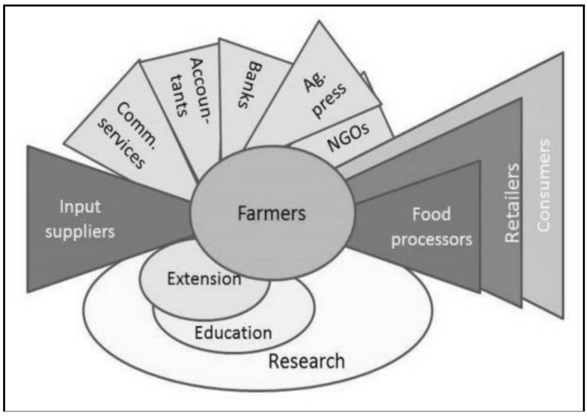

Fig. 2. Agricultural Knowledge and Innovation System
Source: SCAR AKIS (2021) [4].

Finally, Responsible Innovation (RI) and Responsible Research and Innovation (RRI) are two concepts or interlinked discourses that have emerged in parallel in the European research and innovation policy [14]. These concepts present a system of making new technologies that work for society without causing more problems than they solve. They consider a balance of economic, socio-cultural and environmental aspects in innovation process [1]. Inspired by Gremmen et al. [11], we use these concepts to investigate how successful is the country in contemplating the Green Agenda for the Western Balkans [2]. We also strive to find out the epistemology of the innovation of the given case study i.e. is it more aligned with RI or RRI concept.

Data collection methods

First, a typical case of a micro-company engaged in innovative agriculture was presented using a desk research method. A Content Analysis [13] included review of several online sources, including media, fan pages and official pages. The content analysis provided enough data to present the case study in the framework of the Innovation Spiral. Second, a Focus Group discussion with the AKIS actors was organised during 2021, to elaborate the selected case study. A semi-structured questionnaire was used to guide the discussion. The questionnaire was designed in the framework of Innovation Spiral and AKIS, in order to identify the gaps, opportunities, constraints and blind spots in the innovation process, including the (un)functionality of the national AKIS.

In particular, it was discussed how the given case study compares with opportunities for cooperation and interaction between different entities of the agricultural research, development and knowledge-based system in the country (i.e. governance arrangements, mechanism of collaboration and interaction, solutions to overcome gaps and issues in the collaboration etc.); how it compares with the most relevant domain/fields of technology and innovation potential in the agriculture sector where the country has comparative advantage; how it compares with opportunities to improve green and clean technology and innovation transfer in the domestic agriculture sector, and how it compares with other countries in regard to responsible innovation in agriculture.

Data analysis methods

The study is based on a qualitative analysis, which is heavily dependent the researchers' analytic and integrative skills to examine the collected data. The emphasis in this research is to understand the responsible innovation process within a given AKIS settings, as an important issue in the implementation of the Green Agenda for the Western Balkans. The collected data was examined to find patterns and draw conclusions in response to the research aim in line with the synthesis method. Finally, the SWOT analysis provided a good framework to summarise the internal strengths and weaknesses and external opportunities and threats of the responsible innovation in a country-specific context.

RESULTS AND DISCUSSIONS

Agriculture in the country is considered as very traditional, mainly characterised with a low productivity. Innovations are necessary for creating added value in agriculture. The gross value added of agriculture in North Macedonia is just one third of the European average [3]. There are different actors in the national AKIS that could play an important role in the responsible innovation process. It is of essential importance to identify bottle necks, pull and push factors in the research, innovation and technology transfer and to identify and assess the capacities of the innovation actors involved in the process so to understand the current situation and thus, to propose measures for improvement of the innovation processes in agriculture. This section first presents a showcase of a responsible innovation process (i.e. where does it occurs and how it develops, as well as which actors are included in the process). The section further develops in addressing stakeholders' opinions on if the given case study is typical example of responsible agriculture innovation and which conclusions could be derived from the given case study to improve the AKIS settings and responsible innovation process in the national agriculture. The section at the end summarises important notions on the AKIS structure and necessary interactions to support responsible innovation in agriculture.

The case study results: What are AKIS settings for responsible innovation?

This case study is a showcase of a typical agricultural innovation in the country involving a micro-company engaged in modern agriculture and responsible innovation. The case study is analysed through the each of the phases of the Innovation Spiral [15]. Akvaponika was one of the 130 domestic companies or consortia supported by the Fund for Innovation and Technology Development (FITR), within the first public call of the Economic Growth Plan of the Government of the Republic of North Macedonia (Public Call of 28.04.2018 – 11.06.2018), and the eleventh project in the agricultural field. The company received two funding supports in 2018 and 2020. This micro-company received the monetary assistance to develop a business model for green salads production in glass houses and for introducing a bio-coal into the production of baby green salads [6]. The owners of the company had developed a business model of "seed to shelf" and they truly believe that their business will be sustainable both in economic and environmental terms. Yet, without the governmental support, their concept of developing domestic branded organic vegetable products would have remained to be just an interesting idea. The innovation process of this particular case study is presented trough the innovation spiral (Table 1).

Table 1. Innovation process for the "Akvaponika" case study – the innovation spiral phases

Innovation phase	**Description of the innovation process at certain phase**
Initial idea	The owners considered that the problems with the conventional agricultural production should be overcome with **modernization of the agricultural production** and with building a **new business model** with considering the **environmental impact** of the production and in establishing **close relationships to consumers**.
Inspiration	Support by the **FITR**: -First public call of the Economic Growth Plan of the Government of the Republic of North Macedonia (Public Call of 28.04.2018 – 11.06.2018). -Another financial support by FITR within the programme Action for Positive Climate Change (Public Call of 06.03.2020 – 20.07.2020), for introducing a bio-coal into the production of green salads.
Planning	A **three years of practical experience and learning** of the processes for aquaponics growing of plants and fish in a small greenhouse, designed for domestic purposes within the close family members to the company's founders that was exclusively funded by owners' capital.
Development and realization	**-New production line of organic baby salads** (arugula, lettuce, spinach and chard) whose **leaves are not larger than 10 centimetres**, and which are **immediately washed and packed** after being harvested (on the fields). -The products are **promptly distributed**, and by **shortening the value chain**, this market channel provides traceability and brings the freshness from the fields to the consumers' plates (in this way, a maximum quality is achieved, but also the confidence of the customers in organic production is increased). -The company started to **develop an online shop** to respond and adapt to the changing behavior of consumers caused by the COVID-19 pandemic (also **supported by FITR** within the programme COVID-19 measures: Organic online-green antivirus shield COVID-19, Public Call of 29.05.2020 – 03.07.2020).
Dissemination	-The company now cultivates **1 ha of arable land**, which is just below the average farm size in the country. -The organic products are **sold in the largest cities of the country**, mainly **through supermarkets** (such as, Tinex, Reptil and Markt), as well as through the **online shops (**Paket.mk, Domato.mk etc.). -The company is in the process of developing **own online shop**.
Embedding	**-Positive example** that should encourage other farmers to think about **responsible innovation**, including organic agriculture production and new business models within short supply chains. -Increasing the **awareness of the consumers** in encouraging their **healthy eating habits.** -Developing **consumers' habits** of a greater **responsibility for the environment**.

Source: Results from the research, 2021.

In regard to the main actors included in the innovation process, the micro-company has collaborated with the FITR that provided financial support (on three instances), predominantly in the initiation and development phase of the innovation. However, FITR is not responsible to monitor the innovations it finances, and does not keep record on projects' performance. On the other hand, there is a media coverage on how FITR considers and promote this project to be successful. In regard to the interaction between the micro-company with consumers, the company is directly selling to consumers if they visit the farm near Skopje (the capital of the country), establishing close relations with customers. In addition, the micro-company is developing a trade mark under the name 'Green Republic'. With the development of the online shop, the micro-company may reach a wider network of customers and become more recognised in the country.

Encouraging the growth of small companies is very important for the development of the national economy, and Akvaponika is a notable example of how the state should support a family owned businesses in agriculture. Nevertheless, in this case, the process of innovation involves an insufficient number of actors necessary for successful implementation of all phases of the innovation process (Table 2).

Besides the micro-company that is the key actor in the innovation process, the following actors also appear. FITR, whose role is to serve as a leading government institution in supporting start-ups and innovative companies, including those engaged in agriculture. Balkan Biocert is a certification body that was the first of a kind accredited and authorized Inspection and Certification body in Macedonia by the Institute for Accreditation of the Republic of Macedonia and the Ministry of Agriculture, Forestry and Water Economy of the Republic of Macedonia (MAFWE). The final actor is the consumers that are not only the final value chain actors, but were also active participants in the development of the business model of this micro-company, especially for developing of the online marketing strategy.

Table 2. Key actors involved – a reflection of the Innovation Spiral and AKIS

Name of the actor	**Actor type**	**Repre-senting sector**	**Role of the actor in the innovation process**
Akvaponika Ltd.	Micro-company	Private	Came up with the idea for the innovation, and implemented the innovation. Participates in changing the traditional agricultural practices, and raising the consumers' awareness and habits on sustainable environment and healthy eating habits.
FITR	Governmental institution that supports innovations	State	Financially supports innovations.
Balkan Biocert	Certification body	State	Issues certificates for organic production.
Consumers	Final users	Private	Final chain actors in the value chain, consulted in the process of creating a marketing plan and developing the online shop.

Source: Results from the research, 2021.

Although there are different actors involved in the innovation process, still this representation reflects the imperfect settings and interactions of the national AKIS.

Finally, the case study is analysed within the framework of the SWOT analysis (Table 3), which reflects the innovation process in different phases along the AKIS.

According to the SWOT analysis, the case study exhibits more positive than negative internal factors that affect the responsible innovation process.

In fact, the owners succeeded to realise the responsible innovation resulting in innovative agriculture production and innovative business model that may inspire other people to get involved in sustainable agriculture production and short-supply chain with innovative business approach.

The final beneficiaries are the consumers that would get healthy products and clean environment.

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Table 3. SWOT analysis of the responsible innovation case study – a reflection of the Innovation Spiral and AKIS

Strengths	**Weaknesses**
-Realisation of a business idea into a micro-business, involving in innovative agriculture production and business model. -Inspiration to other people to get engaged in agriculture, and modernise the agriculture production in a sustainable manner. -Inspiration of a short-supply chain developed, with developing close customer relations. -Consumers' benefiting from the healthy food with no harm to the environment.	-The business had not produced sufficient profit to cover its expansion and adapting to the needs of the changing market without further support by FITR. -There are just few external actors/stakeholders involved in the innovation process.
Opportunities	**Threats**
-Available financial support from a public institution (in this case FITR) that supports innovations and technology development during different phases of innovation development (initial businesses development, improvement of the businesses, adaptation of the businesses to the changing environment due to internal and external factors etc.). -Development of a trade mark. -Reach more customers with the online shop and thus, further develop the business.	-If the projects' selection by FITR (or other public institutions) is not done on objective basis (under true merits of the applicants), this selected case study and other supported projects are doomed to failure, and many other prospective projects may be financially hindered to progress.

Source: Results from the research, 2021.

On the other hand, a major weakness is that this innovative investment is not self-sufficient form the initiation phase and after and requires constant external support to cover the investment expansion and adaptation to the changing market and new circumstances. Another drawback is that not many actors were involved in the innovation process and key AKIS actors were missing, such as interconnections with the scientific institutions.

In regard to the external factors, this particular case study benefited from the opportunities offered by the FITR i.e. financial support during different phases of innovation development. However, it should be taken into consideration that these funds are available only for registered companies and not to individual farmers. This macro-company develops a trade mark, which will help the company to get exclusive rights to use the mark, preventing others from using the same or similar mark. Protecting the intellectual property rights of the responsible innovation is creating comparative advantage of the business. Another business opportunity created by this innovative company is the inception of its online shop, which is intended to expands the business and reach different segments of customers. This initiative also shows how this company is adapting to the changing market and circumstances, considering that the online shop was initiated during the COVID 19 pandemic. Considering that this kind of responsible innovation investments in agriculture require initial support funding and that the country is not corruption-free, the major threat occurs if the projects' selection by FITR (or other public institutions that supports agriculture innovation investments) is not done on objective basis i.e. under the true merits of the applicants. Hence, this selected case study and other supported projects are doomed to failure, as well as many other prospective investments may be hindered to be initiated since initial funding support is not available to them.

The SWOT analysis presented here shall serve in future national policy planning in regard to responsible innovation, by emphasizing the strengths, fixing the weaknesses, taking advantage of the given opportunities and avoiding the threats.

Focus Group discussion results: Is AKIS supporting responsible innovation?

The Focus Group discussion conducted in 2021 [7] aimed to learn about the organisation of and interactions between agriculture research capacities, advisory/extension services and the business sector. This knowledge allowed evaluation of the extent of innovation and knowledge transfer in the agriculture sector. The discussion was lead with a semi-structured questionnaire, covering issues on: **(**i) How the presented case study in the previous section compares with opportunities for cooperation and interaction between different entities of the agriculture research, development and knowledge-based system in the country? (ii) How the presented case study compares with the most relevant domain/fields of technology and innovation potential in the agriculture sector where the country has comparative advantage? (iii) How the presented case study compares with opportunities to improve green and clean technology (responsible innovation) and innovation transfer in the agriculture sector in the country? and iv) How the case study compares with other countries in regard to responsible innovation in agriculture? The summary of the discussion of the Focus Group has resulted in the following.

How the case study compares with opportunities for cooperation and interaction between different entities of the agriculture research, development and knowledge-based system in the country?

The focus group participants emphasised that the case study is very interesting, however it has a weak network of actors included in its process of development so to provide its sustainability. Therefore, the discussants questioned the sustainability of the innovation project and viewed the project in reflection to many other cases in the country that were initiated and established because there was an external funding available, in this case, the FITR.

All the discussants agreed that what is missing for innovation projects to be sustainable is an inclusion of all relevant actors and segments in the entire innovation process. In this regard, the representative from the National Federation of Farmers (NFF) stressed that it is important for this firm (Akvaponika Ltd.) to establish strong relations with other actors in the chain, such as: other farmers producing same or similar products (salads in this case), farmers' associations (to support their networking activities), advisors (to provide advices on the possible opportunities and risks), experts from academia and other consultants (for developing of sustainable business plans), funding partners (Governmental grants are often the easiest source of funding, with the least control of realisation). In conclusion, the representative from the MAFWE emphasized the need of the country to establish a system for collaboration and connection of the stakeholders in the entire innovation spiral in order to build sustainable innovation projects.

How the case study compares with the most relevant domain/fields of technology and innovation potential in the agriculture sector where the country has comparative advantage?

Considering that the country has a comparative advantage for organic production, introducing new technologies and innovations in this production is expected to bring success in creating competitive agriculture. However, considering many weaknesses that the country experiences at institutional level, the supply of the organic products is often limited to the domestic market. In this regard, all discussants agreed that for this particular case (and similar cases to it), there is a risk that at one point, the supply may overreach the market demand.

How the case study compares with opportunities to improve green and clean technology (responsible innovation) and innovation transfer in the agriculture sector in the country?

The selected Macedonian case study was perceived by the discussants as a positive example in improving green and clean technology in the country. However, on the other side, the case study was perceived as a weak example in regard to innovation transfer, considering the low number of stakeholders included in the project. The discussants emphasised that it is important that successful cases should be used as positive examples and inspiration to other farmers. However, the representative from the National Extension Agency expressed his concern in the difficulty to inspire a large mass of agriculture producers in rural areas because they are casted out from the modern markets. But, the representative from the National Federation of Farmers expressed optimism to use positive innovation examples for increasing the visibility of the innovation to generate possibilities and opportunities for innovations even in the urban areas.

How the case study compares with other countries in regard to responsible innovation in agriculture?

The discussion was continued with comparison of the Macedonian case study with a Serbian and EU case studies in responsible innovation so to benchmark the innovation position of the Macedonian case. The same questions were used for the follow-up discussion using the case studies from Serbia and EU countries. In summary, the discussants pointed out that compared to the Macedonian case, the Serbian case have a more developed system and network for innovation. However, it should be considered that Serbian farms are much larger. Even in the case of Serbia, it has been evident that in order for a larger innovation development processes to take place, there is an inevitable need for inclusion of much more stakeholders. All of the discussants agreed that it is important that these stakeholders come from different fields of expertise, as in the EU's case, where each stakeholder contributed and played a certain role in providing expertise or funding. It was agreed that participation of many stakeholders from the private sector is one of the missing links, which is essential in supporting larger innovation breakthroughs. However, there is always a risk of coordination and information asymmetries when larger number of different actors are involved. This could result in braking the trust. Lack of trust and social capital in the country is often pointed out as impediments of joint investments. Finally, all discussants agreed that the country is far behind the EU countries and other Western Balkan countries in regard to developing innovations in the agriculture sector.

Gaps, opportunities, constraints and blind spots in the innovation process

Innovations in the country are initiated and established only when supported by external founding (in this case, FITR) and sustainable only upon duration of the project. There is a missing inclusion of all relevant AKIS' actors and segments in the innovation process. However, successful cases may be used as positive examples and inspiration to other farmers, taking into consideration the risk of supply overreaching the demand for such innovation at certain point of time since the country is very small. The presented responsible innovation through the case study is actually not eligible under the current IPARD settings in the country. FITR, so far, is the only institution to financially support innovations, including the agriculture sector. However, FITR do not support smallholders since they are not registered entities.

There is a lack of inspiration and weak capacity for planning in the innovation process, which along with lack of finance, are main obstacles for starting a project with a sound idea. Even when initial ideas and inspiration are present, the innovation process still underperforms in the development, realization and embedding of the innovation phases, which are perhaps the weakest parts in the spiral. It is also necessary to connect all the phases and find means to motivate AKIS actors for a more active involvement in research and innovation. The initial idea, inspiration and planning should be two-folded i.e. from the bottom-up or coming from the producers and processors, and from the top-down or coming from the Government to the related stakeholders/actors. Responsible innovation in agriculture in the North Macedonia should be also further stimulated by supporting young people during their high-school education, and preferably in primary and pre-school education.

AKIS in the country is not a formalized system, but there are different levels and layers of formalization and completeness. Cooperation and interaction between the component parts of the AKIS system like the advisory services, the research community, the private sector and the policy makers in the field of innovation, research and technology transfer, present deficiencies. Links between science, advisory services and the private sector exist, but the interactions and cooperation are not sufficiently coordinated.

The enhancement of responsible innovation requires initiatives for coordination to join together fragmented and isolated actions. The research and education system involved in AKIS lacks encouragement and reward system. The IPARD programme speeds up investments in agriculture but needs to be further utilized, with more targeted measures for smallholders to get engaged in responsible innovation. The lack of infrastructures and weak financial support of research, technology and innovation are key problems for responsible innovation development.

As a post-transition country, North Macedonia is far behind the EU countries in regard to developing responsible innovations in agriculture. The adoption of the Smart Specialisation Strategy that helped other post-transition countries to strengthen their innovation position brings optimism for the country to enhance the responsible innovation in agriculture.

CONCLUSIONS

Following the *aim* of the research, which was to *investigate how successful is the responsible innovation in agriculture in post-transition settings,* we have found gaps, opportunities, constraints and blind spots in the responsible innovation process related to the inclusion of the AKIS members and their interaction in the co-innovation processes.

Although there are different actors involved in the innovation process, still this representation reflects the imperfect settings and interactions of the national AKIS. All relevant actors need to be included in responsible innovation projects and strong relations with other actors in the chain need to be established, such as: other farmers producing same or similar products (salads in this case), farmers' associations to support their networking activities, advisors (advices on the possible opportunities and risks), experts from academia and other consultants (for developing of sustainable business plans), the responsible governmental institutions (MAFWE as the key actor for setting the appropriate policy environment), funding partners (Governmental grants are often the easiest source of funding, with the least control of realisation) etc.

Lack of inspiration and weak capacity for planning are obstacle for starting responsible innovation projects. Even when initial ideas and inspiration are present, the responsible innovation process still underperforms in the development, realization and embedding of the innovation phases, which are perhaps the weakest parts in the spiral.

The results and conclusions of this paper shall serve further for creating national strategies for improving the responsible innovation in agriculture, following three strategical issues, such as:

(i) A good implementation of the spiral of innovation needs a *better functioning AKIS structure* and institutional interventions at the critical phases of the innovation spiral like the development and realization phases;

(ii) A *better collaboration between all actors in the responsible innovation process* could be achieved if the EU's IPARD measure for innovation and knowledge transfer is accredited and implemented, and if there is a programme under the FITR to support innovations in a small-scale agriculture, and

iii) A proper education is needed to generate ideas and stimulate innovation.

Similar experiences are expected in other Western Balkan countries. Thus, the method of presenting certain case studies can contribute in determining the knowledge base on factors affecting the responsible innovation processes, important for development of the agriculture sector in the region.

Moreover, the methodological approach developed here, has been proven as an effective mean for representation of the phases in the responsible innovation process, which may have a wider applicability in other related researches.

Successful cases may be used as positive examples and inspiration to other farmers to innovate in responsible manner.

Creating a culture and effective system for innovation in a country-specific context is an investment that enhances productivity, well-being and a sustainable path for the future.

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CULTURE AND EDUCATION IN THE ROMANIAN RURAL SPACE

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Abstract

In the context of the restrictions imposed by the pandemic, access to education and culture was predominantly online. Those responsible for cultural activities in the rural environment ensured access to the culture and traditions specific to the rural area. In this sense, we proposed an analysis of cultural support activities for education in the rural environment during the pandemic period. The present work was structured in three parts, namely: One part in which those responsible for cultural activities are identified, the links between them and the state's contribution to the development of culture, a second part in which we analyzed the specific cultural activities of each institution and the correlation with the results obtained in the educational system in the established area. The last part of the research was dedicated to the conclusions obtained from the analysis.

Key words*: *education, culture, partnerships, rural environment

INTRODUCTION

In an era of rapid technological changes, new ways of cultural production, consumption and dissemination, access to cultural content create great opportunities to promote cultural heritage at home and abroad as a prerequisite for sustainable development. (Tomuletiu and Moraru, 2010), presents the results of a research carried out in 61 Romanian villages whose objective is to capture the specific characteristics of rural education forms and institutions [13]. In the presented study, it was shown that the research depends on factors such as: the experience and degree of studies of the local educational staff, the logistics of the local educational institutions, the specific search methods used by each institution, the interferences with the city community (rural-urban interrelationship). Rural education in the research carried out by (Biriescu and Băbăita, 2014)[4] is one of the important factors in regional development. The authors proposed a software capable of analyzing the performance of the education system in regional development based on major indicators of efficiency and effectiveness. Fanea-Ivanovici (2018) analyzed the main opportunities of the digitalization process of cultural content with an emphasis on Romania and to highlight the main areas in which the country is still lagging behind [7]. The published article discusses the technical endowment of access to broadband Internet services and the use of these resources by households in urban and rural areas to existing digital cultural content. He also emphasized the importance of open access, e-accessibility, digital archives, e-museums, e-libraries, etc., as well as the main national and European strategies and agendas on which Romania based its cultural digitization and preservation priorities heritage.

Preda and Toma believe that the development of rural education is a strategic objective in Romania, especially because of current challenges such as: the decrease in the number of students, poverty, lack of infrastructure, etc. Thus, the pressure on the sector was even greater during the pandemic, when the rural education infrastructure was not ready to cope with the demands. The research carried out (Preda and Toma, 2021) aimed to analyze the quality of education in the rural environment with a case study in Argeș county, through a survey among 107 teachers from 7 secondary schools and 1 high school, located in five rural villages. The results highlighted the needs of rural teachers to ensure a good education, the needs of students to learn, the measures to be implemented in terms of curricula, teaching methods and learning techniques [10].

MATERIALS AND METHODS

The analysis of the activities in the rural environment requires the identification of those responsible and the links between them. The research carried out by us was carried out in three cultural units in the town of Răcari and is based on the analysis of cultural activity during the pandemic period. The research considered the interaction between cultural institutions in Răcari Dâmbovița (Răcari Village, Ghergani Village) and the institutions responsible for education. Thus, data on the cultural activities carried out in the localities were analyzed and correlated with the results obtained in the educational activities.

The data collection for the elaboration of this paper was made from the data archive of the culture units as well as from the data provided by the National Institute of Statistics. For the quantitative indicators, the amount for the period 2020-2021 and the average level was calculated according to the formula:

$$\bar{X}_i = \frac{\sum \bar{X}_i}{n},$$

where:

$\bar{X}_i$is the indicator analyzed in the period 2020 – 2021,

-n the number of years. In order to identify the differences (positive or negative).

The comparison method between the levels of the indicators from 2021 to 2020 was used. The results were interpreted and presented, and finally the main conclusions were formulated.

RESULTS AND DISCUSSIONS

The COVID-19 pandemic has led to the closure of schools in 20 countries and the closure of preschools in 19 countries in Europe and Central Asia. This affected a total of 49.8 million children, from preschool to high school, who had a very disruptive last semester of school (if there was one at all), culminating in the closing schools [14].

The pandemic has deeply affected education and aggravated the existing social inequities in the region. Children from low-income families, children living in rural areas with poor infrastructure, children from ethnic and linguistic minorities, children with disabilities, migrant and refugee children, children in conflict with the law, children and young people who do not attend educational institutions, boys and girls living in difficult conditions or in abusive homes already faced significant barriers to participation in education and learning and had less education and social advantages than their peers [5].

At the village level, cultural activities were also disturbed primarily by the lack of access to education. In this sense, the presented research represents an analysis of the efforts of those responsible for cultural activities at the village level. Stoyanova-Toneva mentioned that cultural heritage, insofar as it is preserved, in symbiosis with the history of each region, has the potential to become a successful tool for the social and economic development of rural communities [12].

The village is essentially identified with the constitution of society and human civilization, it is the place where culture was born, where strong values and traditions are conserved and survive that need to be discovered, brought to light and preserved. It cannot be an analysis of the village as a social system, as a type of civilization, be conceived without taking into account its culture, because through its culture, the village universe has become a specific environment of existence, differentiating itself from other social universes [6]. Stoyanova-Toneva mentions that cultural heritage, insofar as it is preserved, in symbiosis with the history of each region, has the potential to become a successful tool for the social and economic development of rural communities [12].

The main level of education that can be followed in rural schools is from early childhood education to primary and lower secondary education (very rarely secondary education cycle 2, as high schools are usually in urban areas [10].

Culture, at the village level, is mainly supported by three institutions: school, library and church. In the locality where I did the research, culture is promoted by the mentioned cultural institutions with the indirect support of the local administration. In the cultural structure analyzed, the cultural center is represented by the Theoretical High School as the main responsible for culture and tradition in the region. As an organization, the high school has in its composition schools and kindergartens, where they start the road to culture according to Table 1, annually over 600 children.

Table 1. Structure of students enrolled in educational institutions

	Răcari School		Ghergani School		Colacu School	
Years	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
No. of scholars	311	319	169	160	140	137
%	50.16	51.78	27.26	25.97	22.58	22.24
Total	2020			2021		
	620			616		

Source: Processed from the 2021 high school archives [1].

Education and culture are directly supported by institutions of worship and culture, such as the church and the library. They interact permanently with the educational program of the High School under the direct coordination of the Local Administration. As shown in Figure 1 the flow of cultural activities, the Local Administration as a territorial administrative unit has as its objective, in addition to maintaining the cultural center, awarding, sponsoring and supporting participation in cultural activities.

Behind these important actors that support the cultural system and cultural activities at the rural level, there are coordinating institutions organized according to the urban type. Thus, the library is coordinated and financed in cultural activities by the Târgoviște Library, and the cultural activities promoted by the church are financed and coordinated by the Archdiocese of Târgoviște.

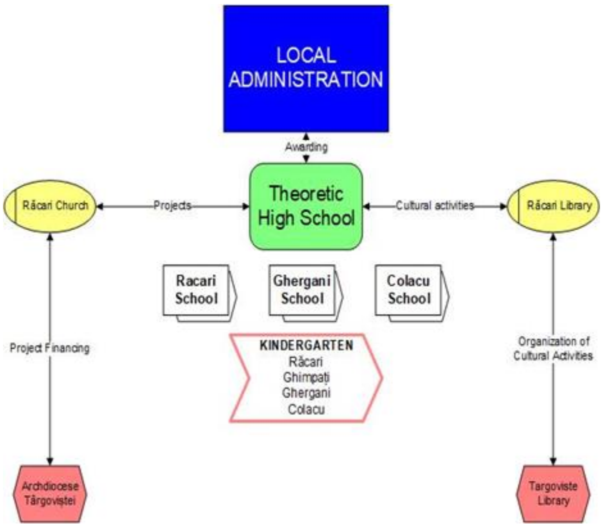

Fig. 1. Flow of cultural activities
Source: Own determinations.

According to Figure 2, public expenditure for education, the state as the general administrator of cultural activities has realized the importance of these cultural activities, registering a slight increase in the budget allocated for education by a percentage of approximately 1% in 2020 compared to 2017.

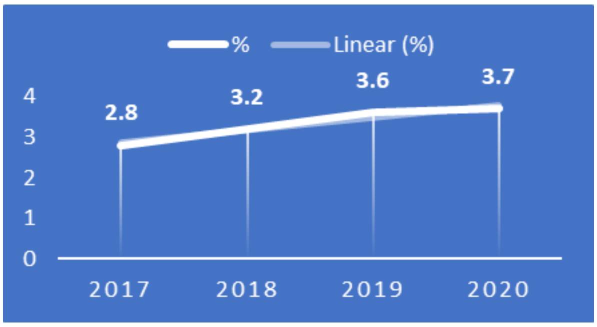

Fig. 2. Share of public costs for education in the total budget
Source: Processed based on NIS, 2022 [8].

The pandemic period (March 2020 – December 2021) had a negative impact on cultural activities in the countryside. However, the institutions responsible for culture have started a series of activities to counteract the effects of the imposed restrictions. Of these, we mention the implementation of two projects by the educational institution in partnership with the library and a number of 2 partnerships of religious institutions with the objective of supporting the access of the rural population to culture and tradition.

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Educational units

As shown in Table 2, the target group targeted by the projects supported more than 100 students in dropout reduction, counseling and educational guidance. Statistically, POCU covered 48.86% of the target group in high school educational subunits (4th and 8th grade students), while ROSE covered over 90% of 12th grade students. The projects enabled an introduction to e-learning as a worldwide requirement and were accompanied by evaluation activities offering prizes, diplomas and certification of participation.

Table 2. Cultural activity of the High School institution

Project/ Activity	Part	Total Schools Răcari, GherganiCls. IV, VIII	Total High School Cls. XII	%
Bucuriei School POCU	43	88	-	48.86
ROSE	58	-	63	92.06

Source: Processed from the 2021 high school archives [1].

The Școala Bucuriei (Bucuriei School) project had as its general objective the prevention of early school leaving for 480 children and students belonging to vulnerable groups from disadvantaged communities in Dâmbovița county through integrated programs of counseling, remedial education and non-formal activities, oriented to their specific needs, programs oriented to 108 parents/guardians, as well as improving the skills of 75 pre-university teachers working in vulnerable communities [11]. The main activities carried out within the project during the 3 years of implementation are: counseling and educational orientation, remedial education, thematic workshops of non-formal education (health, hygiene, sports; independent living skills; local history, traditions, crafts; human rights and democracy; chemistry and green energy; entrepreneurship and initiative; forum theater), professional training programs, educational actions in the community.

ROSE is a cultural initiative to reduce dropout in secondary and tertiary education and aims to increase the pass rate of the baccalaureate examination. The project is supported by a project financed with more than 200 million euros by the International Bank for Reconstruction and Development (IBRD) [9].

In the book Education by E-Learning Ben-Oni Ardelean presents the fact that the beneficiaries of education are no longer the same as those of the 20th century, and the institutions providing education are fighting a huge struggle to bring a generation that no longer exists, trying to preserve methods and practices which were effective in the past but which prove to be ineffective in the present [2]. In this sense, the cultural activity carried out in rural educational units, supported by the ROSE project, implemented on a group of over 90% of 12th grade students, brought, according to the data from the archives of the High School, presented in Table 3, a baccalaureate pass rate of over 70%. Considering the difficulty and support of the courses and training, both the professionalism of the teachers and the support programs offered by the cultural institutions completed the pass rate with almost 70% of the students who failed in previous years.

Religious holidays at the rural level are key calendar points where traditional cultural elements of customs are intertwined with the traditional Christian gastronomic art. The pandemic period significantly slowed down these processes in the physical environment. The promotion of religious holidays was the subject of the analysis of the project presented in Table 3.

Table 3. Baccalaureate exam enrollment and passing statistics

Year	Current enrolled	%	Past year enrolled	%	Total enrolled
2017/2018	63	56.76	48	43.24	111
2018/2019	81	77.88	23	22.12	104
2019/2020	64	64.00	36	36.00	100
2020/2021	77	59.69	52	40.31	129

Source: Processed from the 2021 high school archives [1].

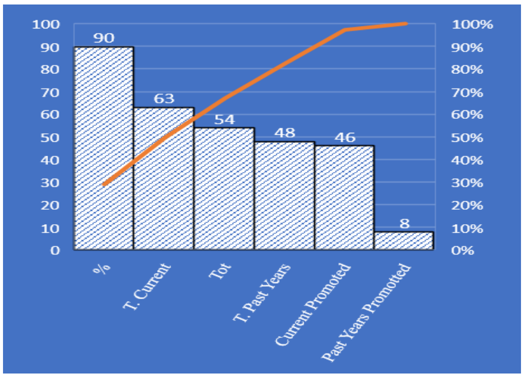

Fig. 3. Baccalaureate Promotion Rate
Source: Processed from the 2021 high school archives [1].

Cultural units

Currently, the Church carries out social assistance activities through its own system, with the organizational support of the laws issued by the state, promoting the social policies and social protection measures that we find throughout society, making available the human and logistical resources at its disposal. We can mention that within the church social service, projects are carried out that have as a source of achievement and financial resources that are currently modest. That is why the Church invites the state and at the same time proposes that the national social assistance system be put at the service of the Church. The Church offers, through its clerical staff, the mobilization and training of people as a community in direct involvement in solving problems that may arise.

In this case, a number of partnerships were identified that positively influenced culture and tradition. Among these partnerships we mention those with the schools coordinated by Răcari High School, also presented in Table 4.

The partnerships had as a target group the participation of almost 200 students from the educational units. The participation was about 55% of the children enrolled at Ghergani, and about 35% at the Răcari School. The cultural contribution during the pandemic was aimed at knowing the specific moral values of the church, and was achieved by fulfilling the following specific objectives:

- Knowledge of important Christian holidays;
- Preservation of religious and cultural traditions, by highlighting students' talents in church painting;
- The cultivation of moral-religious components.

In order to carry out the proposed activities, visits were made to places of worship, conversations, readings by trainers and teachers, artistic and plastic activities as well as charitable activities. The evaluation of the participants was based on an exhibition of the completed works. Also, multimedia materials (videos, photos) were made, which were posted on the websites of the participating institutions.

It should be noted that these cultural activities of the cult institution motivated some of the participants to participate in the Olympics organized by the Ministry of Education. Participation in the Olympiad brought a surplus of cultural value by obtaining the second prize at the county session of the Religion Olympiad.

Table 4. Cultural activity of the Church institution during 2020 - 2021

Project/Activity	Participant	%	Awards
Partnership School Ghergani	90	55	Diplomas
Partnership School Răcari	100	37	Diploma
Religion Olympiad	1	-	Place II/ County

Source: Processed from the 2021 high school archives [1].

CONCLUSIONS

Compared to the data presented in the present research we can conclude: The digitization of education actually brings a challenge to the entire education system, not just distance education [3]. At the level of the analyzed locality, three institutions responsible for cultural activity were identified. With the emergence of restrictions imposed by the pandemic, all cultural institutions suffered, but according to the analysis, solutions were identified to support the educational process through access to culture. The activities undertaken at the local level by those responsible for cultural activities were integrated into projects and partnerships with the educational unit. Although with a slight increase in investment in culture, the state reacted positively, increasing the budget allocated to education. Under these conditions, from budgetary and European sources, two projects were financed that had a positive impact on education and culture. The two projects allowed access to new forms of education, prevented the increase in school dropouts, and increased the passing rate of the baccalaureate exam. At the same time, religious institutions facilitated access to traditions and spiritual values manifested through partnerships with educational institutions. Thus, knowledge was encouraged and rewarded with second place at the county religion Olympiad.

As a general conclusion, by encouraging access to culture while preserving traditions, it is possible to reduce school dropout, avoid illiteracy, successfully pass exams and create Olympians. They will totally bring a rural development based on culture with the preservation of traditions and with an emphasis on the acceptance of new elements in the educational process.

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THE MAIN CHALLENGES IN EDUCATION IN THE CONTEXT OF THE DIGITAL TRANSFORMATION OF LEARNING

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Abstract

In a society dominated by technology and undergoing a profound digital transformation in all sectors, we cannot deny the influence of ICT in education in all its forms. Educational models based on technology will dominate society in one form or another, and the Internet, along with traditional methods, can make education more effective, but what remains for us to know is "how". The paper studied the main characteristics of different types of learning systems (e-learning, online learning, blended learning, etc) in order to make a critical review on the connection between ICT-based tools and education. The main purpose was to point out the emerging learning models specific to the new architecture of educational paradigms and to identify the factors influencing their implementation.

Key words*: *education, ICT-based tools, digital generation

INTRODUCTION

Transformations within education systems have occurred along with the emergence of computers and the Internet. Due to this fact, the promotion of new forms of computer-assisted learning has gained momentum in recent decades. Thanks to the emergence of ICT that can be successfully used in the educational space, the status of the traditional system and the architecture of educational paradigms take on a completely different shape, giving a new form to actual learning systems: distance learning, online learning, hybrid learning (blended learning), e-learning, etc [15].
Keith Tyler-Smith stated in 2010 [24] that online learning "can more easily address individual learning styles, needs & expertise and perhaps it's greatest strength its convenience of time & place access... can involve technical and digital literacy issues that can act as significant barrier to learning... is more isolating and requires more self-reliance, independence and self-direction on the part of the learner".

However, the integration of ICT in the classroom and learning environment has increased year by year. In the pre-pandemic period, however, the distinction between traditional learning (face-to-face or FTF) and distance or online learning was quite blurred. We had forms where FTF learning was supplemented with online learning to provide flexibility in the teaching and learning process and forms where online distance learning was supplemented with FTF or synchronous learning to omit the downside of the online learning environment. Blended or hybrid learning has been introduced in several educational institutions to improve the quality and flexibility of learning and to increase cost efficiency. The pilot projects demonstrated the effectiveness of these forms of learning both in the context of the change of generations, and especially of promoting the idea of flexible learning and work [25][12].
However, the extent of the impact of these learning systems on pupils and students could only be observed during the pandemic period when various forms of online learning were implemented quickly and under precarious conditions. Until then the impact was

analyzed from the perspective of necessity and utility by different individual projects.

Since 2020, for the first time, the online learning wad raised at institutional level. Everyone became aware that we need to define not only online education systems, but also their specific tools. Thus, decision-makers and society were "forced" by the current conditions to express their opinion on different forms of learning, which almost led to the division of society through arguments for and against.

After two years of the pandemic many questions still remain unanswered: What type of materials should be used according to each type of learning? What is the content and what does tech support do? What is the role and degree of involvement of the teaching staff? How important is it for the teacher to interact with students face-to-face and for students to interact with each other and at what level of learning? How well can a discipline be transposed and transmitted digitally? What are the digital tools to support communication, interaction, active learning? ... and the questions can go on.

MATERIALS AND METHODS

In this paper, we analyzed the relation between the technologies provided for education and the present educational systems. We emphasize the main challenges from the field by looking on the subject from multiple points of view: the evolution during Covid period, the needs of teachers, pupils and students and the links between technology and education.

RESULTS AND DISCUSSIONS

Education in the context of COVID-19

COVID-19 has forced schools around the world to invest in various forms of digital learning so that they can continue to educate their students without a physical presence. Schools have had to think about how to incorporate different forms of digital learning into a curriculum which was specific to traditional (FTF) learning. They appealed to teaching methods specific to different educational models such as "online learning", "blended learning" or "e-learning". Although these approaches sound the same, they use different teaching strategies and techniques [11]. However, we must understand that the selection between the methods of "e-learning", "online learning", "blended learning" or "face-to-face learning" are real challenges for a society with many professor which don’t know what student-centered or competence-centered means.

Before the pandemic, we could encounter teachers that used in the classroom different types of technologies (like interactive presentations, software, virtual travels, etc) or universities/schools which offered 100% online classes, while models such as flipped learning or hybrid (blended learning) were rarer and generally in lower classes or during extracurricular activities.

Online education, as we have become accustomed to it during the pandemic, has been a mixture of models based on the use of the Internet. Lectures, assignments, tests were activated on virtual platforms and classes were held synchronously. Although this model is usually assimilated with the idea of distance education (asynchronous), it has been promoted in the pandemic through synchronous education at all levels of education.

Actually, during the pandemic we can say that we had several forms: 100% online with materials transmitted with the help of the media; the second stage, in which flipped learning tools were applied, through which the lessons were done online but additional digital materials were transmitted to the students; the third stage in which specific blended learning or hybrid methods were applied whereby part of the lessons were done physically and others online.

As seen from the state of knowledge in the field, technology is critical to student learning, especially in today's times and post-pandemic world. The whole society has undergone accelerated digital transformations at a very high level compared to a few years ago. The importance of the Internet, digital devices and WiFi in education and every aspect of academic life has proven profound [19]. However, the infrastructural problems were obvious: limited access to digital tools; low bandwidth speed; lack of digital courses; and so on.

On the other hand, there are studies that indicate that hybrid or blended learning improves the learning outcome for theoretical knowledge more than face-to-face learning or e-learning alone [3][1][2]. In 2021, Şentürk [18] recommended that blended learning (FTF plus online learning) be included in schools and to be complemented with project-based learning, collaborative learning, differentiated teaching and reverse learning.

Given that many politicians, teachers, pupils and students claim that we cannot completely return to "life before the pandemic", a multitude of questions remain: Are these models the new post-pandemic educational paradigms?; What is the user's perception of the educational model on its effectiveness?; Which educational model is better and for which age groups? and last but not least Should we consider changing traditional models when many decision-makers and parents consider online learning a failure?.

Education and digital generation

The XX-XXI centuries capture profound changes in human society, from industrialization processes to the penetration of digitization in all socio-economic sectors. Today's information society or knowledge-based society is in continuous transformation thanks to emerging technologies and tools that change relationships and ways of working and living together. Given that, thanks to current digital technologies, any educational activity and many work activities can take place from any place and more and more emphasis is placed on how these technologies can influence learning models.

In the present we have access to new levels of connectivity through mobile networks and smartphones. “Devices like the iPhone and iPad (and their equivalents) provide a "full office" in one's pocket, with email, camera, GPS, books, news networks, and almost any "cloud" (Internet-based) service wanted” [16]. Actually, today if a device does not contain internet access it is not considered modern or innovative. People of all ages and organizations access and depend for their work on mobile applications such as Facebook, LinkedIn, YouTube, WhatsApp, Instagram, etc., which are integrating us all into a true digital media culture. In many cases, the consequences of all these societal changes are directly visible: the sales of printed books, newspapers, CDs and DVDs has decreased; the postal, banking, financial and administrative services have more and more digital products; the required number of employees in some areas was reduced, etc.

In these conditions, both students and teachers have to face the challenges of digital and mobile technologies. If at the level of the teaching profession this means attracting youth to the field and redefining the necessary basic skills, at the level of students it means lifelong learning to be able to use the new applications and devices that appear at a remarkable speed.

We may say that is almost certain that in the future the jobs and services will depend on the developments of digital technology. But how much should we know? What digital skills are needed in today's society? The pandemic has shown us that it is not enough to know how to work on a computer in Word or talk to friends on WhatsApp, we need to know more, better, more completely. But what are the ICT tools that will help us in the future to work, to learn, to relax or, simply, to participate in society?

Taylor and Ferrari (2012) [22] specified, for example, that nowadays it is necessary to have digital skills, informational skills and media skills to be able to create and live in a digital society. In other words, digital skills transcend IT skills. Another approach indicate that digital literacy has a functional dimension (skills and competencies that enable individuals to read, write and interact across a wide range of platforms, tools and media) and a critical dimension (digital resources often function as a means of social control and social exclusion) [13] [21]”.

In order to understand how to adapt in the future, we must first of all understand the current changes, especially in the conditions where there has been talk for some time of a new generation of students (Generation Z, 1995-present) which is and will be social-digital. According to Hietajärvi et. al (2015)[9], this difference between generations creates a gap between the expectations of this socio-digital generation and the educational offer in the educational system. Also, there are studies which indicates that this new generation will present changes in the structure of mnemonic processes due to the new phenomenon of "clip thinking" (the child is processing fragments of visual images not logical associations of text) [20]. So the problem of the last decade is not only the fact that the specialized literature points to changes in the way of understanding information at the student level, but especially the fact that their IT and media skills are overestimated [10], which was actually also seen in the pandemic. For example, Erstad [7] stated as early as 2015 that among high school students: only about 50% are able to perform complex searches on the Internet and structure information to reach a goal, and they are generally at high school level; about 32% are only able to generate search queries and to select the required source (this level was reached also by around 40% of secondary school students).

Pupils and students need to integrate into the collaborative vision of this digital age and to do so they require the following basic skills:

-the ability to create content complementary to the ideas of others;

-the ability to collaborate (adaptation and flexibility);

-critical thinking;

-communication at team level;

-creativity.

They must be able to use the various web tools for their own learning purposes. We refer here to: social networks (Facebook, Myspace, Linkedin, etc.); blogs, wikis; resource lists (social bookmarking); media services (Youtube, Itunes, Slideshare, Scribd, etc.), podcasts, vodcasts; virtual realities and communities (Second life etc); applications such as Office and Google docs; Web 2.0 tools (Moodle, LMS, open sources).

Rudd et al. [17] drew attention as early as 2006, however, to some problems raised by this digital evolution. This said that the role of teachers and students has changed, putting the one who has the information in the center, with many students not wanting to know the answer to the questions Why? and How?. Thus, the boundaries between "teachers" and "pupils" became blurred, as pupils/students also became creators, editors, tutors - roles that must belong to the teacher. To these are added other problems such as: the tendency to take unverified information, adolescent self-destructive behavior, cyberbullying, etc.

In other words, educating this digital generation does not mean teaching them to use media tools because they already know, but giving them skills in understanding and using them correctly and training them in the use of digital culture tools needed in the labor market and in life every day, that is, to offer them concrete elements of digital literacy.

Education and ICT-based tools

During the pandemic, many teachers pointed to the lack of technology in schools as a problem, but at the same time, 20% of them consider it important to use digital technology in teaching [14] In these conditions, we initially considered that, in order to achieve to effectively link education and technology, it is necessary to understand how it can contribute to the creation of learning experiences. The opportunities created by technology are multiple: access to the Internet allows pupils/students to attend online courses that they would otherwise not be able to afford; there are a multitude of high-quality online mentoring or counseling offers that are not geographically limited; online collaboration platforms and mobile networks allow pupils/students to work on joint projects from anywhere in the world; virtual laboratories (chemistry, biology, etc.) offer unique learning experiences. and so on.

The US Department of Education (2016) [4] developed a series of principles for the use of technology in educating children. These

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principles are supplemented with recommendations regarding the use of technology as a tool for learning and child development, by highlighting the pros and cons.

The literature also specifies several ways in which technology contributes to the educational process, such as [23]: collaborative educational experiences (essays, media products, etc.); project-based learning or collaborative media research allow for real-time feedback from anyone on the network; the information presented in class can be expanded, with access to museums, libraries, etc.; there is access to a multitude of other courses that are not in the educational programs but are of interest to the pupil/student (learning a foreign language, etc.); obtaining online professional certificates by participating in courses offered by various providers, etc.

The examples of the use of technology in education are actually multiple:

-teaching classes by using films accessible online (for example in geography) or 3D museums;

-the use of virtual laboratories in different disciplines to deepen certain notions through experimentation;

-the use of games and simulations to deepen knowledge and stimulate cooperation;

-3D interactive representation programs (virtual medical laboratories);

-using artificial intelligence for complex teaching etc.

In fact, these tools offer more flexibility than traditional teaching materials. Whether we are talking about phones, laptops or cloud systems, it is certain that the learning experience can be customized so that any digital material (website, e-book, game, etc.) can be accessed by people with different levels of education. There are many studies that do not support the optimistic views regarding the positive impact of educational technologies on learning [8]. However, taking into account the educational remodeling due to the epidemic of COVID-19, as a result of which countries tried to transform their educational systems in such a way as to offer online education, it is possible that in the future the inclination towards digitalization will continue [6].

We must thus emphasize that it is not yet known which theories will dominate future educational systems. It is certain that the pandemic has led to education models based on a forced digitization of education at the level of course content and lectures. Erdogan Coşkun specified as early as 2021 the fact that digitization actually led to a standardization of knowledge at the pupil/student level. He thus draws attention to the fact that "Digitalization does not offer diversification as it is claimed; rather, it provides uniformity" [5].

What exactly are we sure to encounter in the future? Having the experience of the last years at our disposal, we can confidently state the following:

- education will no longer be limited in space and time - e-learning opportunities are increasing; schools have started to use resources outside the school, etc. – this creates a learning-oriented environment outside the school;
- personalized learning adapted to the student's needs will be promoted, based on different IT tools;
- free choice in learning will be promoted - through which individuals have control over what, when, where, with whom and with what learning takes place - thanks to the multitude of online course offers;
- the translation of the curriculum into digital format will allow the integration in education of other modern innovative teaching models such as learning through projects, learning through experimentation, critical thinking; it is expected that together with this way of learning, the assessment methods etc. will also change.

CONCLUSIONS

Research needs to be continued so we can understand the connection between digitization and education. However, we may conclude that the future educational reforms must focus on the following ideas:

- pupils/students must acquire basic values such as critical thinking because the labor market is constantly changing (the ability to know how to think and solve problems) - the promotion of a learning model based on processes that increase planning skills and capacity and elimination of those oriented to the subject or product;
- lifelong education must be promoted – information technology literacy must be promoted from primary and secondary education to the workplace;
- promoting creativity to ensure sustainable learning;
- the implementation of methods that lead to the acquisition of the motivation to learn, i.e. to learn to learn;
- ensuring the availability of educational resources anywhere and anytime.

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PERFORMANCE OF CATFISH (*PANGASIUS SP.*) CULTIVATION WITH POND MEDIA: CASE STUDY IN BANJAR REGENCY, SOUTH KALIMANTAN PROVINCE, INDONESIA

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Abstract

Catfish is a fish that is increasingly in need in Indonesia and is one of the mainstays in increasing aquaculture productivity. This study aims to analyze the production performance and financial feasibility of catfish culture using pond media and analyze the marketing performance of catfish. This study uses a survey method. The research location was determined purposively in Banjar Regency; the research respondents were catfish cultivators in ponds, collectors, retailers, and catfish consumers. The data collected were analyzed descriptively; financial analysis, marketing margin analysis, and farmer share analysis were also used. The results showed that catfish cultivators had implemented good and correct technical cultivation activities, farming in ponds was financially feasible, and the catfish marketing system was running efficiently.

Key words**:** *performance, catfish, cultivation, Banjar Regency*

INTRODUCTION

Increased fish production can be achieved through the aquaculture process because increased production through capture can disrupt the preservation of fishery resources [2]. An aquaculture is an option for fisheries-producing countries to increase their production in business activities. Aquaculture is also one of the fastest-growing food producers globally and can meet the needs of fish for human consumption of more than fifty percent [34], [17], [10]. This is because the quality of fishery products produced using cultivation is considered better, and because of its availability that will always be there will not run out, so aquaculture business is considered more productive [12].

Fish farming also plays an important role in maintaining food security, increasing income and economic community development [3]. Fish farming activities can also be a source of income for fish farmers who run small-scale businesses [1, 9].

Catfish is a fish that is increasingly in demand in Indonesia and is one of the mainstays in increasing cultivation productivity. This can be proven by the increase in catfish production in 2015 by 339,069 tons and increased to 437.11 tons in 2016; catfish production is still increasing where the national catfish production target in 2019 is to be 1,149,400 tons [21].

One of the leading fisheries businesses in Indonesia is catfish [28]. Catfish is an important fish in aquaculture. Fisheries and Aquaculture Department of Food and Agriculture Organization (FAO) placed catfish fourth after goldfish (*Cyprinus carpio*). Catfish is a freshwater consumption fish with a long body and silver-white color with a bluish back. Catfish is also a commodity of high economic value because it has a high selling price and is needed by the community continuously [25]. Catfish cultivation business has a milder risk than the cultivation of other freshwater fish. In addition, the catfish cultivation business also does not require high technology so that everyone can cultivate it.

To support the success of fish farming activities, farmers must understand it. Things that need to be understood are selecting cultivation locations, preparation of cultivation facilities and infrastructure, preparation and distribution of seeds, preparation and feeding, maintenance, pest and disease control, harvest and post-harvest [26].

Catfish farming activities play an important role in increasing people's incomes, creating jobs, food security and supporting development policies. Therefore, it is very important to understand catfish farming activities' product performance and economic performance for business continuity. The purpose of this study is to analyze production performance and financial feasibility in catfish farming with pond media and catfish marketing performance.

MATERIALS AND METHODS

Research Location

The study location was set purposively in Banjar Regency; the study respondents were catfish farmers in ponds, collecting merchants, retailers and consumers of catfish.

Data Collection Techniques and Data Types

This study used survey methods, limited to information collected from samples representing the entire population by using questionnaires as instruments in data collection, while sample selection was carried out *in purposive random sampling*. Other data collection techniques use interview techniques related to the supply chain and catfish distribution system. The data collected consists of primary and secondary data related to the technical cultivation of catfish in ponds, fish production data, cost data, pond land area, number of cultivators, and marketing systems.

Data Analysis Methods

Data analysis aims to simplify data in a more understandable form [23]. Especially for qualitative data, the information that has been collected in this study is grouped, then compiled and analyzed descriptively qualitatively. Analysis of purpose one is carried out data collection about the production system and its various inputs and sources, and technical production of catfish cultivation is then described. Analysis of purpose two using financial analysis, which includes profit/loss, Net Present Value (NPV), Gross Benefit Cost Ratio (Gross B/C), Internal Rate of Return (IRR) and Payback Period (PP)

Profit/loss analysis aims to find out the company's true ability to make a profit [15]. This calculation is taken from the remaining results of the business over a certain period. Business is profitable when the Total Revenue value is greater than the Total Cost. The formula used as a calculation of net income is as follows:

$$\pi = \mathbf{TR - TC} \quad \text{...............................(1)}$$

where:

π = Profit; TR = Total Revenue; TC = Total Cost = Fixed cost + variable cost.

Net Present Value (NPV) is the present value of the entire cash flow until the end of the existing project. The project is said to be accepted if the NPV value > 0 or the largest NPV value [29]. The formula used as an NPV calculation is as follows:

$$\mathbf{NPV} = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^2} \text{...........................(2)}$$

where:

Bt = Benefit of the t-year; *Ct* = Cost of the t-year; *i* = the prevailing interest rate; *t* = length of time/age of investment.

Criteria:

NPV > 0, the effort is worth implementing

NPV < 0, the business is not worth implementing.

Gross Benefit-Cost Ratio (Gross B/C) illustrates the influence of additional costs on the benefits received. The formula used as a gross B /C calculation is as follows:

$$\mathbf{Gross\ B/C} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+i)t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)t}} \text{.........................(3)}$$

where:

Bt = Benefit of the t-year; *Ct*= Cost of the t-year; *i* = the prevailing interest rate; *t* = length of time/age of investment.

Criteria:
Gross B/C > 1, the effort is worth carrying out
Gross B/C < 1, the effort is not worth doing
Gross B/C = 1, attempt in breakeven state

Internal Rate of Return (IRR) is a method used to calculate the interest rate that equates the value of the current investment with the value of net cash recipients in the future [32]. The formula used as an IRR calculation is as follows:

$$\mathbf{IRR} = \boldsymbol{i_1} + \frac{\boldsymbol{NPV_1}}{\boldsymbol{NPV_1 - NPV_2}} + (\boldsymbol{i_2} - \boldsymbol{i_1}) \quad \text{..........(4)}$$

where:
NPV_1 = Net Present Value (+)
NPV_2 = Net Present Value (-)
i_1 = Discount Rate generating (+)
i_2 = Discount Rate generating (-)

Criteria:
IRR > the applicable discount rate, the business is worth implementing
IRR < the prevailing discount rate, the business is not worth implementing
IRR = the prevailing discount rate; the business is not worth implementing.

The Payback Period (PP) method assesses the period required for the return on investment from cash inflows [11]. The formula used as a PP calculation is as follows:

$$\boldsymbol{PP} = \frac{\boldsymbol{Total\ Investmen\ x\ 1year}}{\boldsymbol{Profit}} \quad \text{.........................(5)}$$

Criteria:
PP < 3 years, the rate of return on capital is said to be fast
PP 3 years < PP < 5 years, the rate of return on capital is said to be moderate
PP > 5 years, the rate of return on capital is said to be slow.

The analysis used to answer the third purpose is done with descriptive and quantitative analyses. The descriptive analysis describes the marketing channels that occur from the manufacturer to the end consumer's hands. At the same time, quantitative analysis is used to determine the efficiency level of marketing. The formula used as a calculation of the price part received by the manufacturer is as follows:

$$\boldsymbol{Farmers\ Share\ (FS)} = \frac{\boldsymbol{Pf}}{\boldsymbol{Pr}}\boldsymbol{x100}\% \quad \text{...................(6)}$$

where:
FS = Farmer share or share of the price received by the cultivator (%)
Pf = Purchase price at the cultivator level (Rp/kg)
Pt = Retail price at the consumer level (Rp/kg)

Criteria: Fs ≥ 40%, then marketing is said to be efficient [7].

RESULTS AND DISCUSSIONS

Catfish Cultivation Business Production Performance

The location of catfish farmers in Banjar Regency is very good because the determination of the location has been accompanied by the availability of public facilities that support the running of cultivation businesses in the location, such as irrigation water availability and business locations easily accessible to consumers and the many supporting facilities that are already available such as electricity, housing, labor and irrigation. The availability of existing infrastructure or public facilities can encourage the smooth operation of the catfish farming business.

The supporting facilities available are elements that support the operation of the business directly, such as the availability of electricity networks, telephones, local water company, housing for workers and small stalls available around fish farming business locations in Banjar Regency.

The need for supporting equipment for fish farming businesses such as water pumps feed, making machines, generator sets and so on has been taken into account by farmers as a unit in a system related to their business needs to be able to produce fish farming products by the capacity and quality that has been planned. Vehicles are also needed for operations during the construction period and operation of the existing fish farming business in Banjar Regency. The vehicles needed by fish farmers are very dependent on the amount of effort, location and production produced. Most of the vehicles used by fish farmers are pickup cars and motorcycles.

Buildings owned by fish farmers in the form of feed warehouses, guard houses and fences. The shape and type of building owned by fish farmers are different, depending on the cost owned by each fish farmer there, the needs in the production process, and the form of the fish farming business.

Overall, the type of pond owned by the respondents of catfish farmers in Banjar Regency is a type of soil pond. The ground pond is also called an extensive pond, where the entire pond is made of soil [5]. Traditional pond structures generally still use natural materials, such as usually using compacted soil, sewerage, and water intake have not been made permanently [31]. Traditional ponds fall into the category of quiet water ponds. A quiet water pond is a fish maintenance container where the water is stagnant. A calm water pond is a fish rearing container where the water is stagnant [30]. The water that enters this pond is only to replace the water lost due to evaporation or seepage so that the height of the pond water level is maintained. The water source used to meet the needs of cultivated water in Banjar Regency comes from the Martapura Irrigation water flow.

The pond size used is between 20 x 25 meters to 25 x 35 meters. Before starting production, it is necessary to clean the pond to avoid disease pests that can grow and interfere with fish growth. Caring for a fish pond is very necessary because this is one of the important factors determining fish farming success. The success of fish farming is very influential with the construction of ponds made according to the correct rules. Pond care is not just about protecting and repairing from damage, but at the same time restoring its function and usefulness as a decent place to raise fish [30]. Before the catfish seeds are stocked, the pond should be given fertilizer. Fertilizers for ponds can use manure or green manure. The amount of fertilizer given is as much as 50–700 grams per square meter. The provision of fertilizers aims to grow natural food for catfish [33].

The solid spread of catfish seeds is as much as 20-30 heads per meter^3. This stocking solid exceeds the ideal catfish seed spread solid of 10-20 heads per m^3 [20]. The size of catfish seeds used by farmers is a size of three inches for IDR 375, four inches catfish seed size for IDR 425 and two inches catfish seed size for IDR 250. The picking catfish seeds is in the Bincau and Cindai Alus areas. Catfish seeds are sourced from several areas on the island of Java, namely from Bogor, Bekasi and Yogyakarta, which are then raised in Bincau and Cindai Alus.

The feeding duration generally given by fish farmers respondents is two times a day, namely morning and evening or adjusting weather conditions. The feed given by the bodyweight of catfish is as much as 3% - 5% of the total body weight. This is in line with the requirements for ideal feeding on catfish cultivation [27]. The source of feed used by catfish farmers consists of two, namely using factory-made feed from spreading seeds to harvesting, and cultivator respondents who use factory-made feed when spreading seeds until the fish are 3-4 months old then continued with self-made feed until the time. The source of factory-made feed is from feed entrepreneurs around Banjar Regency. At the same time, the source of feed made independently by cultivator respondents is divided into several areas, namely salted fish from Aluh-Aluh District, bran from Marabahan and oil palm meal from Pelaihari area, Tanah Laut Regency. The ingredients to make this feed are usually also provided directly by feed entrepreneurs to facilitate the cultivator respondents.

The length of catfish cultivation production, in general, is for 8, 12 and 18 months with weight sizes of 0.8 Kg, 1 Kg and 1.5 Kg, respectively. There are also respondents of catfish cultivators who choose to harvest with a sorting process, namely with a production time of 8 and 12 months. The selling price of catfish ranges from IDR 18,000 - IDR 20,000/ kilograms.

How to harvest catfish is by draining half the pond water using a water pumping machine, then the fish in the pond is herded from the

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corner of the pond to the corner of the pond the other by using a net and then the fish is lifted using scoop which will be placed into a large basin and container that has been provided previously. Usually, cultivators pay a wage of IDR 300/kilogram to the workers/employees who carry out the harvest process. Then the way used by catfish farmers in marketing production results is to contact directly collecting traders who have become regular customers or install a notification plan in front of their respective cultivation sites that "sold farmed fish" for payment methods made by collecting merchants with producers, namely by paying cash or credit to the agreed price.

Financial Feasibility of Catfish Farming in Ponds

Cost is all the burden borne to provide goods and services [4]. In business activities, investment and operational costs are needed to carry out business activities. Investment costs are funds invested by business owners in capital objects [8]. The operational process consists of total fixed costs and total variable costs.

The fishery business that an entrepreneur will carry out must produce sustainable profits. Therefore, it is necessary to conduct a business analysis to determine a type of business [22]. The purpose of business analysis is to determine the level of profit, return on investment and break-even point of a business. Various anticipations to improve and increase company profits can also be done if the business analysis is carried out. Business analysis on fisheries business is needed given the considerable uncertainty of business [35]. Summary of Financing and feasibility of catfish farming business with pond media presented in the Table 1.

The number of investment costs invested by each fish farmer varies, depending on the fish farming business owned by each fish cultivator and the amount of capital each fish farmer owns. The average investment cost incurred by cultivators is IDR 346,986,000.

The investments issued are for a pond of 46.33%, warehouses of 32.75%, machines of 13.76%, scales of 3.44% of existing investment costs, net of 0.82%, basins of 0.25% and scoop for Rp. 60,000 or 0.20% of the total investment costs.

Fixed costs are costs whose amount is fixed for a short period and is independent of production volume [14, 16, 19]. This study is included in the fixed costs, namely the cost of renting the pond, maintaining the pond and the cost of depreciation of investment goods.

Table 1. Feasibility of Catfish Farming in Ponds, 2021

No	Description	Value
1.	Cost	
	• Investment (IDR)	346,986,000
	• Fixed cost (IDR)	63,251,479
	• Variable cost (IDR)	1,039,348,667
	• Operational Cost (IDR)	1,102,600,146
2.	Revenue	
	• Production (kilogram)	65,643
	• Price (IDR/kilogram)	19,000
	• Revenue (IDR)	1,247,209,933
3.	Profit	144,609,787
4.	Business feasibility	
	• NPV 7%	590,034,488
	• BCR 7%	1,079
	• IRR (%)	39,388
	• Payback Period (year)	2,399

Source: Primary data processed in 2021.

The average amount of fixed costs incurred by catfish farmers in Banjar Regency is IDR 63,251,479.

Variable costs are ever-changing costs – change in line with the natural changes of the production process or are the costs of production factors [14, 16, 19]. The amount of costs incurred by each fish farmer in Banjar Regency differs depending on the number and input of cultivators and changes in other productions each seeding season. The average variable cost annually incurred by fish farmers in Banjar regency amounted to IDR 1,039,348,667, with the largest type of cost incurred per year for the purchase of feed, which is 84.22% of the total average variable cost feed by 14.01%, labor of 1.73% and for the cost of purchasing drugs are amounting to 0.04% of the total variable costs.

Operational costs are all expenses incurred by a business to fund business operations to achieve the business's goals. The total operational costs in the fish farming business

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in Banjar Regency are obtained from adding up fixed costs and variable costs. The entire operating cost of the catfish farming business per year is IDR 1,102,600,146.

Production is an activity to create or produce or add good value to an item to meet the community's needs [4]. The production produced by catfish farmers in Banjar Regency is the number of fish in a year of production by units (kilogram). The average production produced per catfish cultivator per year is 65,643 kilograms. Total acceptance is the amount of fish production produced per year multiplied by the price that occurs in the market between fish farmers and buyers. The average total revenue per catfish farmer per year is IDR 1,247,209,933, with the average selling price of fish per kilogram being IDR 19,000.

The profit of the catfish farming business in Banjar Regency is obtained from the difference between receipts and total operational costs and the average profit per cultivator per year of IDR 144,609,787 or IDR 12,050,816 per cultivator per month. This business can be profitable because it is worth more than the Regional Minimum Wage of South Kalimantan Province in 2021 of IDR 2,877,177.

Furthermore, based on various analysis results using investment criteria/financial analysis, it is stated that the catfish farming business in Banjar Regency is feasible to run and develop.

In principle, investment criteria analysis is an analysis used to assess whether a business is worth developing or not [13]. Each criterion uses a present value that has been discounted from the flow of interest and costs over the life of a business. This analysis used an interest rate of 7% by the interest rate of the Bank – Government Bank, which is commonly applicable to businesses engaged in agriculture and fisheries. The period used in this analysis is for ten years. Determination of the analysis period for ten years based on the economic age of the business.

Net Present Value (NPV) of 7% of 590,034,488 > 0 means that fish farming business activities in Banjar Regency provide a positive value which means that the benefits received (total revenue) are greater than the total costs incurred. The IRR rate of 39.388% is greater than the applicable credit rate at the bank (7%); this states that the value of the fish farming business is profitable and feasible to continue to be implemented and needs to be developed again for more advanced businesses.

Benefit Cost Ratio (BCR) 7%, which is 1,079 > 1; thus, the catfish farming business in Banjar Regency provides benefits and deserves to be run because BCR > 1. The BCR value indicates the present value on all land costs or, first coupled with the return for the investment invested in the business, will be refundable. The greater the BCR value of a business, the more efficient the business, so that the prospects for business returns and investments in the future will be better. The calculation results are known payback period (PP) obtained a value of 2,399 which means the time of return on investment costs invested by farmers in the catfish farming business is for 2,399 years.

Based on the various analyzes used, the catfish farming business in ponds in Banjar Regency is profitable and feasible to develop, this is in line with the research results of Alawode *et al*. (2020) [1], which show that the catfish aquaculture business in southwest Nigeria is profitable, but several challenges can reduce these profits and can even consume the invested capital.

Catfish Marketing Performance

Marketing specs related to the demand and supply of catfish production of ready-to-consume and its development in the future. The marketing spec concerns the marketing strategies and programs that will be made in marketing the production of farmed fish. The development of demand for aquaculture fish production can be known from changes in consumer income, tastes and consumer behavior in buying farmed catfish production.

The study results found that cultivators marketed the production of catfish farming products to various regions from South Kalimantan, East Kalimantan, Central Kalimantan and Java island with

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intermediaries from collecting merchants and retailers from these areas. The results showed that market demand had exceeded the number of fish produced, so this is an opportunity for farmers to increase catfish production. Based on the results of research on catfish respondents/cultivators in Banjar Regency, data on the amount of production for one year is 15,022,400 kilograms or daily production is 41,157.26 kilograms, and demand data from merchants both collectors and retailers is 48,000 kilograms per day, so the opportunities that are still available for cultivators to meet the demand from collecting merchants and retailers is 6,842.74 kilograms.

Based on the information from the cultivator, usually every time the harvest cultivator will be directly exhausted, and even many are collecting merchants and retailers who come directly to harvest to buy catfish run out of harvest stock. This is in line with catfish production and demand data, which shows the difference between demand and supply (production) of 6,842.74 kilograms. This means that farmers still have the opportunity to produce and market their catfish by 6,842.74 kilograms per day or 2,497,600 kilograms of catfish every year, and of course, this is a considerable opportunity.

The catfish marketing channel in Banjar Regency has four types of distribution chains, namely:

Type 1. Cultivators – Retailers – End Consumers

Type 2. Cultivators – Collecting Merchants – Retailer Merchants – End Consumers

Type 3. Cultivators – Collecting Traders – Traders outside the Province

Type 4. Cultivators – Collecting Merchants – Traders outside the District

Marketing efficiency is a goal you want to achieve in a marketing activity. One approach that can measure marketing efficiency is operational efficiency as measured by marketing margins, farmer's share, and profit-to-cost ratio [18, 6].

Summary of the efficiency analysis results based on the type of catfish marketing chain in Banjar Regency is presented in Table 2.

The margin value of catfish marketing in Banjar Regency in the type 1 marketing chain is IDR 6,000.00; type 2 is IDR 7,000.00; type 3 is IDR 4,500.00 and type 4 for IDR 3,000.00 (Table 2). The value shows that the largest margin occurs in the type 2 supply chain because the selling price of catfish at retailers who get supplies from collecting merchants is higher than the selling price of catfish in retailers who get supplies from cultivators. Judging from the two patterns of marketing channels, it can be said that the increasing number of institutions involved in marketing activities will add value to each actor, the greater the marketing margin will affect the selling price at the consumer level so that the selling price will be higher. Marketing margins on type 3 and type 4 marketing chains were lower, as the study did not track selling prices from out-of-province and out-of-county merchants.

Table 2. Efficiency based on Patin Fish Marketing Chain Type in Banjar Regency

Businessmen	Type 1	Type 2	Type 3	Type 4
Cultivator				
- Selling price	19,000	19,000	19,000	19,000
Collector Merchant				
- Purchase price	-	19,000	19,000	19,000
- Selling price	-	21,500	23,500	22,000
Retailer				
- Purchase price	19,000	21,500	-	-
- Selling price	25,000	26,000	-	-
Traders outside the province				
- Purchase price	-	-	23,500	-
- Selling price	-	-	-	-
Traders outside the district				
- Purchase price	-	-	-	22,000
- Selling price	-	-	-	-
Final Consumer				
- Purchase price	25,000	26,000	-	-
Marketing margin	6,000	7,000	4,500	3,000
Share	76.0%	73.1%	80.9%	86.4%
Criteria	>40%	>40%	>40%	>40%
Category	Efficient	Efficient	Efficient	Efficient

Source: Primary data processed, 2021.

The farmer share value obtained in all types of catfish marketing chains in Banjar Regency shows a figure of more than 40%, meaning that the catfish supply chain activities in Banjar Regency are efficient. Marketing efficiency is one of the indicators to determine the success rate of a supply chain [24]. The value of marketing efficiency is a percentage of the division of the total cost by the total value of the product. An efficient supply chain system can optimize profits and provide a fair share of the overall price paid by consumers to each supply chain actor.

CONCLUSIONS

The conclusions drawn from this study are: catfish cultivation in ponds in Banjar Regency has implemented good cultivation techniques starting from the preparation stage for cultivation in the form of pond soil processing, fertilization, seed stocking, feeding to harvesting activities. The catfish marketing system implemented so far is efficient in terms of marketing margins and farmer share value. Financially, the catfish farming business is feasible to run and develop.

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STRUCTURAL CHANGES OF ROMANIAN LABOR MARKET AT REGIONAL LEVEL DURING 2005-2020 PERIOD

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Abstract

The paper aims to analyze the labour resources a NUTS 2 level, between 2005 and 2020, by using the national databases regarding the Romanian workforce. We analyzed the employed population by total, residence environments and main economical national activities. The research revealed the increase in human resources in North-West of the country and in the areas surrounding the capital Bucharest, but the regions from North-East and South retain the higher shares in the structure of employed population. By observing the development pattern for 2005-2020 period we identified many challenges: the decrease of population and employment rate in the majority of the regions; the shift of employment from agriculture to industry and especially services sector.

Key words**:** *labour resources, employment, unemployment, rural workforce*

INTRODUCTION

After the revolution of 1989, Romania entered a decade of transition to the market economy, dominated by decreases in the Gross Domestic Product and the collapse of the labor market, i.e. decreasing employment rates, increasing unemployment, reducing working time and decreasing real wages [7]. During this transition period, the first regulations of the labor market appeared, the activity of trade unions increased, fiscal measures appeared, etc. At the beginning of the 90s, Romania had an active population of over 13 million people (of which 84.6% were employed), an activity rate of 87.3% and about 73% of the employed population were employees [9]. Inflation, lack of investment and, above all, the mechanisms implemented to balance the labor market (reduction of working time, extension of vacations) had cumulative effects of demotivation, indiscipline, non-adaptation, etc.

Changes related to the labor market have been rather slow. In 1991, the first law on the protection of the unemployed and professional reintegration was drafted [6] and it was only in 1994 that household surveys were carried out that measured unemployment according to the criteria of the International Labor Office (ILO). The Employment Agencies were established only in 1999.

During the period 1990-2000, the labor market was reconfigured: labor resources began to decrease; the population employed in manufacturing, construction, tourism and transport has decreased considerably; the privatization processes created jobs in the private sector (trade and services in the first phase), etc. The decrease in the period 2000-2010 was less than in the period 1990-2000, while the restructuring of economic activities intensified and the private sector was encouraged to create jobs [11].

Since 2010, Romania was characterized by positive natural growth and migratory balance, but also by a major flow of temporary emigrants. Chivu et al. [1] mentioned a decrease in Romania's population of almost 14% in only 15 years, but also an increase in economic dependency ("per 100 people of working age there were 23 young people and 27.4 elderly people") and inactive people (only about 46% of the total population are active people). To these we also may mention that: many people are not found in the records regarding the labor market (they are unemployed after the unemployment period or are employed in subsistence agriculture); there is a lack of information on jobs; there are many people who live on social benefits; entrepreneurship is very low compared to other European countries, etc. However, currently, industry, constructions and commerce act as polarizing sectors for the labour force [10].

In this context, the purpose of the paper was to analyze the labour resources a NUTS 2 level, between 2005 and 2020, by using the national databases regarding the Romanian workforce.

MATERIALS AND METHODS

We assessed the main characteristics of labour resources at national and regional level using the annual statistics regarding the workforce in Romania made by National Institute of Statistics- NSI Romania.

We focused on the dynamics and structure of employed population, within the 2005-2020 periods, by residence environment and main economical national activities (agriculture, industry and services).

RESULTS AND DISCUSSIONS

In 2020 the Romanian employed population reached 8.5 million persons, from which 3.8 million persons in rural areas. The North-East region had about 17.1% and 24% of that employed in rural areas, this being followed by the South Region - Muntenia with 14.5% and, respectively, 19.5% (Fig.1). The Bucharest-Ilfov and North-West regions had approx. 1.15 million employed people each (13.8%). From a structural point of view it can be seen that these regions increased in the period 2005-2020 by approx. 1.2-2.7 percentage points in total and by approx. 1-1.5 percentage points in rural areas. Moreover, in the period 2005-2020, the employed population increased in the Bucharest-Ilfov Region (by 18.8%) and the North-West (by 4.1%), while in the other regions there were decreases of approx. 5-15%. In the rural environment, the dynamic was more accentuated in the Bucharest-Ilfov Region, of 67.8% demonstrating a development of the labor market at the level of Ilfov county in the last decade.

Fig. 1. The dynamics and structural changes of the employed population (15-64 years) in the period 2005-2020 at the regional level

Source: own calculation based on the data from AMIGO, NSI Romania [8].

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If we compare the regions from the point of view of the employment rate ("the ratio between the employed population aged 15 and over and the total population of the same age group"), we can see that the North-East Region ranks first, with a rate occupancy of over 60% and Bucharest Ilfov with approx. 58% (Fig. 2). In the West and Center regions, where only about 9-10% of the country's employed population can be found, the employment rate was only about 47% and only 42-44% in the rural areas.

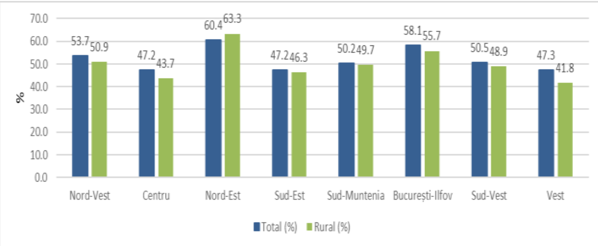

Fig. 2. Regional employment rates in 2020
Source: own calculation based on Romanian labour force: employment and unemployment AMIGO, NSI Romania [8].

The unemployment rate exceeds 7% at regional level and 9% in rural areas in the Center and South-East regions (Fig. 3). The Northeast region, which has the highest employment, has the lowest unemployment rate in 2020, of only about 3%.

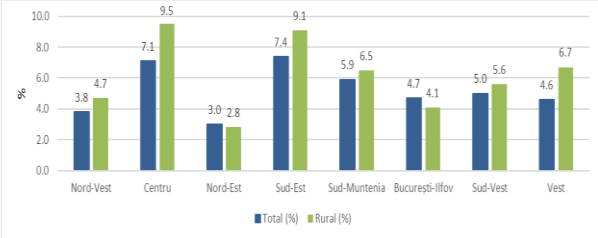

Fig. 3. Regional unemployment rates in 2020
Source: own calculation based on Romanian labour force: employment and unemployment AMIGO, NSI Romania [8].

The population employed in agriculture was decreasing in the period 2005-2020 with values of almost 70% in the West Region and only 20% in the North-East Region. Under these conditions, in 2020 the North-East Region managed to hold almost 40% of the resources used in agriculture, with approx. 11 percentage points more than in 2005. In the traditionally agricultural regions of Romania (South-East, South-Muntenia and South-West) there are still about 40% of the labor resources in agriculture.

The industrial sector, which includes the construction sector, had a positive dynamic in the west of Romania, but recorded increases in the rural environment in all regions (from approx. 13% in the South-Muntenia Region to over 60% in the North-West Region) (Fig. 4).

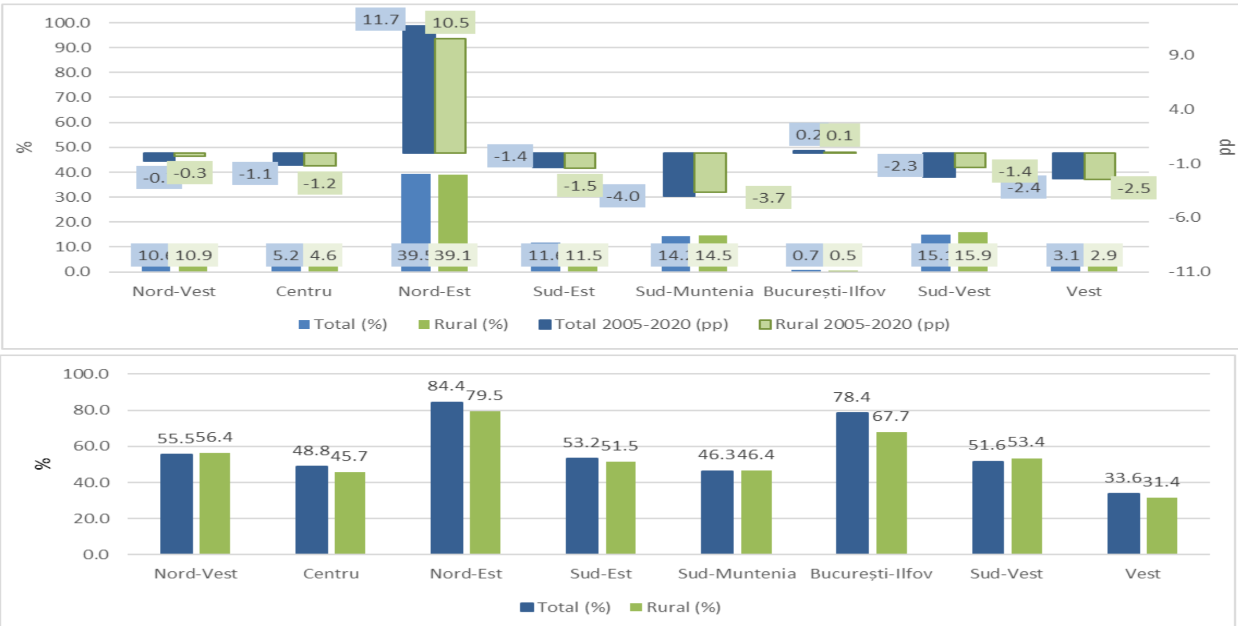

Fig. 4. The dynamics and structural changes of the employed population in agriculture, 2005-2020 at the regional level
Source: own calculation based on the data from AMIGO, NSI Romania [8].

However, the changes recorded in the period 2005-2020 at the level of all regions led to insignificant structural changes, namely a decrease of about 3-4 percentage points in the share of the Bucharest-Ilfov Region (urban environment) and the South-Muntenia Region (rural environment) and an increase of about 2-3 percentage points in the share of the North-West Region.

The dynamics of people employed in the service sector had a higher amplitude, especially in rural areas, from about 22% in the North-East Region, to 110.7% in the Bucharest-Ilfov Region (Fig. 5). In the regional structure, there is an increase in the share of people employed in the service sector in the Bucharest-Ilfov, South-Muntenia and South-East regions.

Similar remarks and results regarding the features of workforce and employment in the rural areas and at regional level were made by Cofas (2013)[2], Iorga (2017)[3], Iorga et al (2014) [4] and Iorga et al (2020)[5].

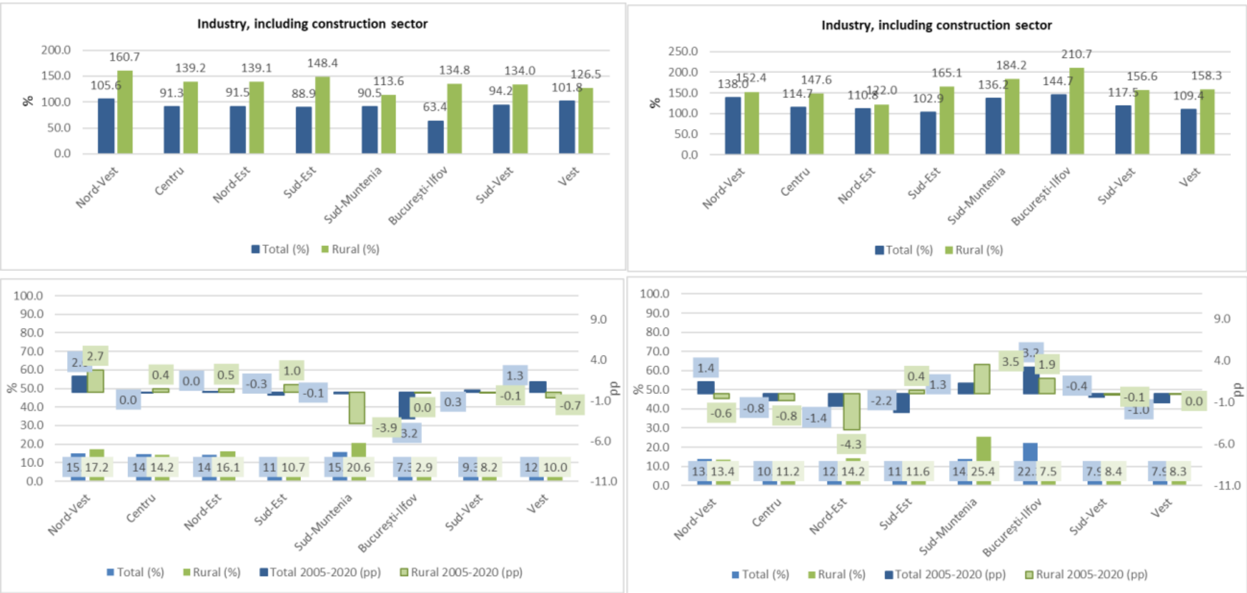

Fig. 5. The dynamics and structural changes of the employed population in industry and services in the period 2005-2020 at the regional level

Source: own calculation based on the data from (AMIGO), NSI Romania [8].

CONCLUSIONS

This sector lacked a coherent strategy in the last two decades, being characterized by the diminution of the capacity to face the competition market. At the same time, as a result of Romania joining the EU, its competitors from the EU both in the production and processing sector are testing.

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IMPORT AND EXPORT OF WHEAT, SUNFLOWER AND POTATO IN THE CONTEXT OF ENSURING FOOD SECURITY

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Abstract

Romania plays an important role in the whole of EU agriculture, being a major player in the cereals, oilseeds and vegetables market. In 2020, Romania ranked first in sunflower production, fifth in wheat production and seventh in potato production. The research aims to determine the distribution of import and export values for wheat, potato and sunflower crops, sales prices and the security of the position of the crops studied in Romania. By calculating the Gini coefficient, the degree of concentration for wheat import showed a high value, while for wheat export it showed a low value. For potato cultivation, the values of imports in 2020 were evenly distributed due to the lower concentration of the coefficient, while for exports, the degree of concentration was higher. For imports and exports, the Gini coefficient shows an even concentration range.

Key words: *Gini coefficient, food security, Romania*

INTRODUCTION

The European Union is a major producer and trader of cereals around the world. In 2016, 57 million hectares were cultivated and 301.3 million tonnes were harvested, 2.6% more than in 2000-2015, while the area decreased by 7.5% [12].

In Romania, agriculture and cereal production are important sectors that have ensured economic growth and population stability in recent years. With its biological function, it is a major source for economic activity and labour use. The Romanian authorities support cereal production, mainly after EU accession, by launching a series of instruments aimed at supporting local agricultural producers [15].

Cereal cultivation is very important for Romania, contributing by an estimated 5-6% to GDP. The competitiveness of the sector can be ensured by paying special attention to infrastructure, grain storage and processing centres and even attracting foreign and local investors to obtain higher quality products [14].

Romania is also an important player on the oilseed market at global and EU level, thanks to the country's position, climate and fertile soil, which favour plant growth. The European Union also supports the cultivation of oilseeds to help the bio-fuel industry and oilc onsumption [13].

The area cultivated with potatoes ranks Romania among the top EU countries, while the yield is among the lowest in the EU-27, the contribution at EU level in 2009 was 4.38%. This can be put down to the growing requirements of potatoes, which lead to high costs for farmers to maintain competitiveness and profitability [17].

The communist period favoured the development of cities, and after this period there was the retrocession of small and very large land, which led to the emergence of small and medium-sized farms and the emergence of subsistence farming. These farms showed and still show low productivity caused by lack of mechanization [6].

Food insecurity in the medium and long term is one of the world's main concerns, taking into account climate change, scarcity of land,

water and other agricultural resources, population growth, increasing fragility of markets and trade, and poverty in many areas, especially rural areas [1].
Food expenditure as a share of total consumer expenditure is a key indicator of a household's food security as it reflects access to food. This metric has been declining in Romania over the last two decades as the general standard of living increases [2], [3].
Romanian agricultural production is highly volatile and production levels are high and dependent on climate and other natural factors. This has negative effects in building food security through domestic production, where domestic farmers do not meet demand [9], [10].
To maintain food security in the long term, Romania should aim to increase agricultural potential through investments and favorabl epolicies. The instability of agricultural production is due to weather factors and improvement methods, and the main sources of household income are cash income and self-consumption [8].
The aim of the paper is to identify the dispersion of imports and exports in value for wheat, potato and sunflower crops, to identify the selling price and the position occupied by Romania at EU level for the crops studied in the context of ensuring food security.

MATERIALS AND METHODS

The Gini coefficient was created and used by the statistician Corrado Gini in 1912. The index measures the dispersion of statistical data, mainly used to describe the disproportionality of income or wealth distribution. It is represented as a percentage and is defined by the value ratio between 0 and 1, where 0 represents perfect equality and 1 represents perfect inequality.

$$G = \frac{\sum_i \sum_j |x_i - x_j|}{2 \sum_i \sum_j x_i}$$

The research analysed statistical data provided by Eurostat and TradeMap, on the basis of which the following statistical indicators were calculated:

- ***coefficient of variation*** v = $\frac{\sigma}{x}100$,
  where:
  - σ = mean deviation;
  - x = average level of a variable;
- ***growth rate*** $\bar{R} = (\bar{I}\ x\ 100) - 100$,
  where:
  - $\bar{I}$ = overallaveragegrowth rate.

RESULTS AND DISCUSSIONS

In 2020, Romania recorded an area of 4.27 thousand hectares, an increase by 53.6% compared to the area recorded in 2015 (2.78 thousand hectares).
The average production of durum wheat in 2015 was 20.31 tonnes/ha, reaching an average production of 20.37 tonnes/ha in 2021, an increase by 16.67%. Romania also showed an increase in total durum wheat production by more than 35% in 2020 (10.68 thousand tonnes) compared to the total production recorded in 2015 (7.91 thousand tonnes).
Romania cultivated potatoes in an area of 174 thousand hectares in 2020, showing a decrease by 10.75% compared to the area cultivated in 2015 (196 thousand acres).
In terms of yield, in 2020 its levl was 15.42 tons/hectare, an increase by 11.98% compared to 2015 (13.77 tons/ha).
Total potato production shows a decrease by 0.04% in 2020 (2,698.50 thousand tons) compared to 2015 (2,699.68 thousand tons).
Regrading sunflower, Romania cultivated in 2020 an area of 1,011.53 thousand hectares, reaching in 2020 an area of 1,194.32 thousand hectares, showing an increase by 18%.
The average sunflower yield decreased by 12.28% in 2020 (2.5 tons/ha), compared to the yield recorded in 2015 (2.85 tons/ha), while the total sunflower output increased by 23% in 2020 (2,198.67 thousand tons), compared to the level recorded in 2015 (1,785.77 tons) (Table 1).

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Table 1. Main technical indicators for the main durum wheat, sunflower and potato crops

Country	*Indicator*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2020/2015*
Durum wheat	Area (thousand ha)	2.78	7.02	4.78	5.63	5.73	4.27	53.60
	Average production (t/ha)	20,031	5,151	5,463	11,642	12,250	23,371	16.67
	Total production (thousand tonnes)	7.91	24.65	20.58	20.76	16.53	10.68	35.02
Potato	Area (thousand ha)	196.07	186.24	171.39	173.3	174.12	174.99	-10.75
	Average production (t/ha)	13.77	14.44	18.19	17.44	15.09	15.42	11.98
	Total production (thousand tonnes)	2,699.68	2,689.73	3,116.91	3,022.76	2,626.79	2,698.50	-0.04
Sunflowerseed	Area (thousand ha)	1,011.53	1,039.82	998.42	1,006.99	1,282.70	1,194.32	18.07
	Average production (t/ha)	2.85	3.51	4.3	3.69	2.89	2.5	-12.28
	Total production (thousand tonnes)	1,785.77	2,032.34	2,912.74	3,062.69	3,569.15	2,198.67	23.12

Source: Own processing based on EUROSTAT data [4].

At the E.U. level, Germany produced the largest quantity of potatoes (11,715.1 thousand tonnes of potatoes), followed by countries such as Poland (9,055.9 thousand tonnes), France (8,670.9 thousand tonnes), the Netherlands (7,020.1 thousand tonnes), with Romania ranking the 7th with a production of 2,683 thousand tonnes (Figure 1).

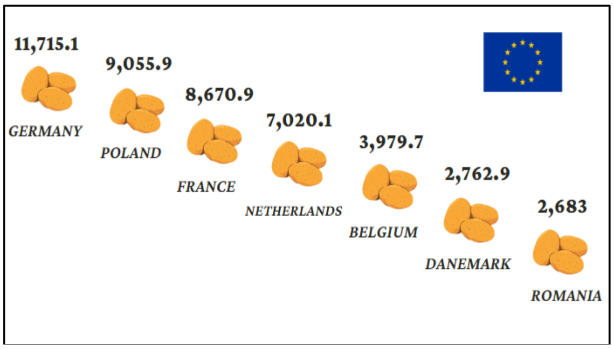

Fig. 1. Main potato producing countries in the European Union in 2020 (thousand tonnes)
Source: FAO data [5].

In terms of wheat production in 2020, Romania ranked the fifth with a production of 6,754 thousand tons, out distanced by countries such as France with a production of 30,144 thousand tons, Germany with 22,172 thousand tons, Poland with 12,433 thousand tons. Romania is an important wheat producer, producing enough to ensure thecountry's food security (Figure 2).

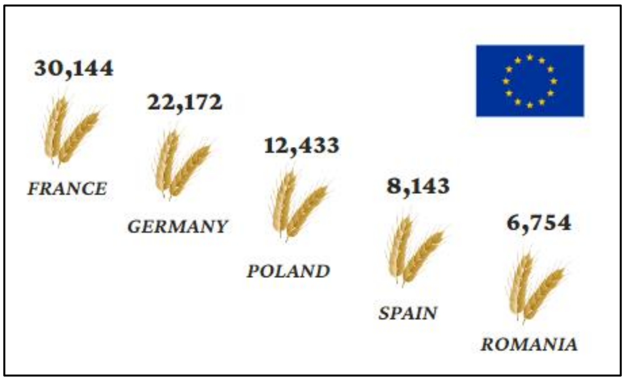

Fig. 2. Main EU wheat producing countries in 2020 (thousand tonnes)
Source: EUROSTAT data [4].

Romania ranks the first in sunflower production in 2020 with a production of 2,198.67 thousand tonnes, followed by Bulgaria with a production of 1,733.53 thousand tonnes, Hungary with 1,697.96 thousand tonnes (Fig. 3).

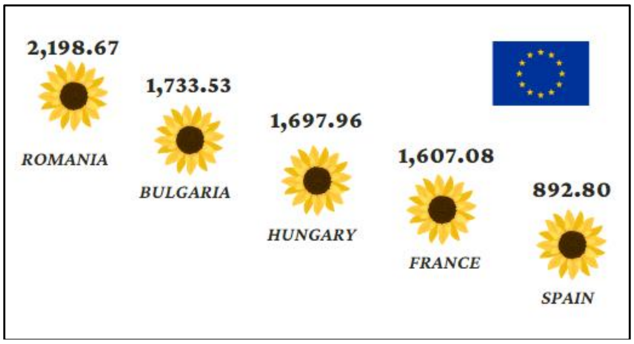

Fig. 3. Main EU sunflower producing countries in 2020 (thousand tonnes)
Source: EUROSTAT data [4].

In 2020, Romania imported €222.9 million worth of wheat at an average price of €181.9/tonne, by 5.3% more than in 2014. Of the total wheat imports, 63.1% came from Hungary (€140.6 million) at an average price of €180.9/tonne, Bulgaria (€69.8 million) 31.3% at an average price of €178.9/tonne and Slovakia (€4.1 million) 1.9% of the total wheat imports at an average price of €189.5/tonne. These price differences are mostly influenced by the distance to the importing country, the quality of the product, the quantity, and also the domestic production recorded (Table 2).

Table 2. Wheat imports and exports 2014-2020

Specification		2014	2015	2016	2017	2018	2019	2020	% from 2020	Growth rate %	CV %
Import value	**World**	115,726	115,195	331,919	202,846	115,302	158,219	222,917	100	8.9	44.4
	Hungary	24,579	50,011	179,786	107,692	30,686	82,950	140,658	63.1	24.7	71.4
	Bulgaria	79,729	48,166	109,229	74,279	70,965	65,845	69,773	31.3	-2.3	23.0
	Slovakia	970	2,007	23,254	1,593	80	459	4,177	1.9	27.6	193,5
Gini coefficient		0.70	0.57	0.60	0.61	0.64	0.64	0.68	**2020/2013**	**Growth rate %**	**CV %**
Selling price	**World**	172.5	176.6	154.0	162.3	165.8	179.7	181.9	0.6	0.09	5.9
	Hungary	179.3	183.0	157.0	162.5	173.3	189.3	180.9	-7.1	-1.05	7.2
	Bulgaria	166.5	164.8	148.9	157.3	158.1	163.2	178.9	4.8	0.67	5.6
	Slovakia	199.3	185.5	151.9	167.5	610.7	272.9	189.5	-4.9	-0.83	63.8
Value export	**World**	963,442	693,104	1,142,168	999,743	1,035,714	1,136,368	831,297	100	-2.3	15.5
	Jordan	109,323	80,588	146,076	116,720	132,523	115,372	130,724	15.7	8.5	22.2
	Egypt	361,873	224,561	202,501	171,818	188,821	266,830	116,198	14.0	-10.2	32.9
	Philippines	17,829	0	1,900	0	10,567	41,761	109,430	13.2	-	155.9
Gini coefficient		0.38	0.34	0.19	0.21	0.25	0.25	0.24	**2020/2013**	**Growth rate %**	**CV %**
Selling price	**Total**	194.0	195.0	163.3	171.0	175.9	183.6	191.4	-6.9	-1.0	7.6
	Jordan	194.7	191.1	175.6	167.9	175.3	182.6	186.5	-20.5	-3.2	10.9
	Egypt	199.9	193.7	156.1	170.3	177.0	192.2	196.4	0.5	0.1	8.4
	Philippines	172.4	-	172.7	-	163.2	175.7	178.2	3.3	-	-

Source: Own processing based on Trade Map data [16].

Regarding wheat exports, in the period 2014-2020, we note that Romania recorded a minimum value in 2015, when it was 693.1 million euros, and the maximum value was recorded in 2016, when it was 1.14 billion euros. The rate shows negative values, with a value of 2.3%, and the coefficient of variation shows a value of 15.5%, which indicates significant variations in wheat exports. largely influenced by domestic production.

In 2020, Romania exported wheat worth 831.3 million euro at an average price of 191.4 euro/tonne, by 1.4% less than in 2014. 15.7% of the total wheat export was purchased by Jordan (130. 7 million) at an average price of €186.5/tonne, Egypt (€116.2 million) 14%, at

an average price of €196.4/tonne and thePhilippines (€109.4 million) 13.2% of total wheat exports, at an average price of €178.2/tonne.

When comparing the Gini coefficients for wheat imports and exports, we observe significant differences in values, in the sense that for wheat imports the coefficients show a higher degree of concentration (0.68 in 2020), while for exports they show a lower degree of concentration, the values evenly distributed (0.24 in 2020) (Table 2).

Analyzing the value of sunflower imports in the period 2014-2020, we observe that Romania recorded a minimum value in 2014, when it was 99.5 million euros, and the maximum value was recorded in 2020, when it was 206.8 million euros. The rate shows positive values, with a value of 10.7%, and the coefficient of variation shows a value of 28.4%, which indicates significant variations in sunflower imports, influenced to a large extent by domestic production.

In 2020, Romania imported sunflowers worth 206.8 million euros at an average price of 824.9 euro/tonne, 1.4% lower than in 2014. 28.3% of total sunflower imports came from the Republic of Moldova (58.6 million euro) at an average price of 404.4 euro/tonne. Bulgaria (37.8 million euros) accounted for 18.32% at an average price of 1,164.2 euro/tonne and France (33.5 million euros) for

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16.2% of total sunflower imports at an average price of 7,452.9 euro/tonne.

Regarding the sunflower export, in the period 2014-2020, we note that Romania recorded a minimum value in 2014, when its price of 396.4 euro/tonne was by 17.8% more than in 2014. About 25.6% of the total sunflower export was purchased by Bulgaria (156.6 million euros) at an average price of 364.3 euros/tonne, the Netherlands (107.1 million euros) 17.5% at an average price of 383.4 euros/tonne, and France (71.3 million euros) 11.6% of the total sunflower export at an average price of 393.5 euros/tonne (Table 3).

Table 3. Sunflower imports and exports 2014-2020

Specification		2014	2015	2016	2017	2018	2019	2020	% from 2020	Growth rate %	CV %
Import value	**World**	99,499	127,759	137,635	159,946	193,239	200,800	206,846	100	10.7	28.4
	Republic of Moldova	12,330	44,745	48,573	62,860	60,177	51,050	58,640	28.3	27.9	47.7
	Bulgaria	30,144	24,367	22,433	30,513	40,103	40,787	37,815	18.3	3.7	21.8
	France	13,673	13,669	22,498	12,850	20,715	22,182	33,501	16.2	10.0	35.2
Gini coefficient		0.36	0.40	0.40	0.43	0.38	0.36	0.36	**2020/2013**	**Growth rate %**	**CV %**
Selling price		836.6	675.1	697.9	576.7	612.9	601.9	824.9	-24.1	-3.86	23.1
		303.4	353.3	342.6	316.0	304.3	323.7	404.4	37.7	4.67	11.0
		709.0	882.0	1,086.0	696.3	843.2	760.0	1,164.2	24.2	3.15	19.3
		7,720.5	8,607.7	6,136.9	6,589.7	7,435.4	6,968.9	7,452.9	-6.7	-0.99	10.7
Value export	**World**	444,755	452,212	487,205	529,867	638,122	754,920	612,190	100	1.5	18.9
	Bulgaria	17,529	29,017	30,370	50,505	77,165	121,066	156,611	25.6	30.1	80.5
	Netherlands	47,197	110,023	98,820	90,891	117,464	123,038	107,104	17.5	1.5	23.7
	France	67,340	78,130	105,825	89,292	95,596	123,966	71,316	11.6	0.8	23.2
Gini coefficient		0.20	0.30	0.27	0.26	0.28	0.29	0.31	**2020/2013**	**Growth rate %**	**CV %**
Selling price		336.4	411.3	411.6	396.8	369.5	358.7	396.4	1.8	0.2	6.9
		713.0	455.6	465.2	507.9	359.3	334.1	364.3	-84.2	-23.2	96.6
		323.9	407.0	379.3	346.2	320.7	345.2	383.4	-6.8	-1.0	9.7
		337.5	386.3	363.7	341.1	320.4	327.3	393.5	16.6	0.7	7.8

Source: Own processing based on Trade Map data [16].

Comparing the Gini coefficient for sunflower imports and exports, we see close values of the coefficient, which indicates a uniform degree of concentration of values.

In the case of sunflower seeds, we note that this product was imported in 2020 at an average price of 7,452.9 euro/tonne from France, totalling approximately 33.5 million euro, and sunflowerseeds were traded outside the country for 71.3 million euro at a price of 393.5 euro/tonne. This can be attributed to the fact that certified seed was imported, used for crop establishment, and Romania sold sunflowers for consumption and processing (Table 3).

Analyzing the value of potato imports in the period 2014-2020, we observe that Romania recorded a minimum value in 2015, when it was 15.1 million euros, and the maximum value was recorded in 2019, when it was 66 million euros, the rate shows positive values, with a value of 13.3%, and the coefficient of variation shows a value of 52.3%, which indicates significant variations in potato imports, influenced in a large extent by domestic production. In 2020, Romania imported potatoes worth 46.6 million euros, at an average price of 233.3 euros/tonne, by 39% higher than in 2014, 24% of total potato imports came from the Netherlands (11.2 million) at an average price of €293.3/tonne, France (€9.6 million) 20.7% at an average price of €196.5/tonne and Germany (€8.3 million) 17.7% of total potato imports at an average price of €210.2/tonne.

Regarding potato exports, in the period 2014-2020, we note that Romania recorded a minimum value in 2015, when it was 212 thousand euros, and the maximum value was recorded in 2020, when it was 3.5 million euros, the rate shows positive values, with a value of 3.8%, and the coefficient of variation shows a value of 64.2%, indicating significant variations in potato exports, largely influenced by domestic production (Table 4).

In 2020, Romania exported potatoes worth 3.5 million euro, at an average price of 149.5 euro/tonne, by 1.6% more than in 2014, 45%

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of the total potato export was procured by the Republic of Moldova (1.6 million) at an average price of 133.7 euro/tonne, Ukraine (824 thousand euro) 23%, at an average price of 111 euro/tonne and Poland (721 thousand euro) 20.1% of total potato exports, at an average price of 267.4 euro/tonne.

Table 4. Potato imports and exports 2014-2020

Specification		2014	2015	2016	2017	2018	2019	2020	% from 2020	Growth rate %	CV %
Import value	**World**	19,485	15,117	33,015	28,865	29,243	66,013	46,628	100	13.3	52,3
	Netherlands	4,453	2,154	4,441	2,980	4,501	12,647	11,196	24.0	26.4	72,9
	France	5,377	2,372	4,920	1,651	3,343	12,193	9,666	20.7	35.3	77,7
	Germany	2,807	2,693	5,739	3,479	4,203	9,445	8,274	17.7	9.2	48.9
Gini coefficient		0.35	0.27	0.33	0.33	0.33	0.33	0.35	**2020/2013**	**Growth rate %**	**CV %**
Selling price		167.8	140.0	200.4	212.4	198.2	317.8	233.3	64.4	7.36	28.5
		283.5	302.1	240.0	477.5	344.6	361.1	293.3	-6.2	-0.91	21.8
		108.0	72.0	213.6	168.7	119.7	268.8	196.5	60.6	7.00	41.0
		193.0	136.7	217.7	235.7	194.8	297.4	210.2	4.4	0.62	21.5
Value export	**World**	1,088	212	575	2,447	1,831	1,686	3,587	100	3.8	64.2
	Republic of Moldova	345	119	96	1818	756	503	1615	45.0	37.1	100.1
	Ukraine	0	0	0	3	0	0	824	23.0	-	281.7
	Poland	206	4	357	392	309	875	721	20.1	-6.7	76.4
Gini coefficient		0.37	0.59	0.62	0.74	0.42	0.57	0.50	**2020/2013**	**Growth rate %**	**CV %**
Selling price		147.1	129.7	245.1	120.0	154.7	307.4	149.5	-35.1	-6.0	36.2
		125.8	109.3	203.4	104.6	116.0	250.2	133.7	-13.0	-2.0	34.5
		-	-	-	136.4	-	-	111.0	-	-	-
		181.0	190.5	309.9	212.9	237.1	347.2	267.4	47.7	-1.5	23.5

Source: Own processing based on Trade Map data [16].

When comparing the Gini coefficients for potato imports an dexports, we observe significant differences in values, in the sense that the coefficients for potato exports show a higher degree of concentration (0.5 in 2020), while for imports they show a lower degree of concentration, the values evenly distributed (0.35 in 2020) (Table 4).

CONCLUSIONS

At EU level, Romania ranked the first for sunflower production in 2020, while for wheat production, it was ranked the 5th, ahead of countries such as France, Germany and Poland. In the case of potato production, Romania ranked the 7th with a production of 2,683 thousand tonnes, while Germany produced 11,715.1 thousand tonnes in the same year, topping the ranking. The problem with the decrease in potato production lies in the cost of delivery, which was found to be lower than the cost of production, with farmers having to reduce the area under potatoes.

Wheat imports in the years howed a positive annual pace of 8.9%, the main importing countries in 2020 were Hungary, Bulgaria,and Slovakia, the average purchase price was 181.9 €/tons in 2020, 5.3% lower than the price in 2014. Wheat exports also showed a positive pace of 1.5%, the main exporting countries were Jordan, Egypt and the Philippines, the average selling price of wheat in 2020 was 191.4 €/tonne. In the case of imports, according to the Gini coefficient, wheat imports had a higher degree of concentration (0.68% in 2020), while the degree of concentration of wheat exports was low.

The selling price per tonne of imported sunflower in 2020 was 824.9 euros, the main importing countries were the Republic of Moldova, Bulgaria and France. The main countries to which Romania exported sunflower were Bulgaria, the Netherlands and France, with an average selling price of 396.4 euro/tonne. For imports and exports, the Gini coefficient shows a uniform concentration fence.

For potato cultivation, imports showed a positive annual rhythm, 24% of total potato imports came from the Netherlands (11.2 million euro) at an average price of 293.3

euro/tonne, France (9.6 million euro) 20.7% at an average price of 196.5 euro/tonne and Germany (8.3 million euro) 17.7% of total potato imports at an average price of 210.2 euro/tonne. In 2020, Romania exported €3.5 million worth of potatoes at an average price of €149.5/tonne, up 1.6% on 2014, accounting for 45% of total potato exports, and was purchased bythe Republic of Moldova (€1.6 million) at an average price of €133.7/tonne, Ukraine (€824. 000) accounted for 23%, with an average price of €111/tonne, and Poland (€721,000) accounted for 20.1% of total potato exports, with an average price of €267.4/tonne.

The Gini coefficient shows that in the case of imports, the values are evenly divided due to the low degree of concentration, while in the case of exports, the degree of concentration is higher.

According to the data analysed, the wheat and sunflower areas and production show positive annual rates, which ensure Romania's food security.

In order to improve both production and agricultural areas, the size of farms needs to be optimised by encouraging associations between farmers, and the way subsidies are granted needs to be improved.

The main problem with the development of agriculture is the low level of infrastructure and logistics, which affects the production potential on the cereals market. Another major problem for Romania is the export of non-value-added products and value-added imports, both for wheat and sunflowerseeds.

With Romania's accession to the European Union, the degree of competitiveness of agri-food products has increased, and there is a permanent trade in the Black Seaports, as this region is one of the largest grain markets in Europe.

It is worth mentioning that Romania is a member of the European Union, and the prospects regarding the Green Deal pact force the member states to make the transition to org anic farming, but the real issue will be whether the agricultural sector will be able to cope with medical and political disruptions to ensure food security, as organic farming is more expensive and less productive than conventional farming [11].

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THE PROVISION OF SERVICES SPECIFIC TO THE AGRICULTURAL SECTOR IN ROMANIA

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Abstract

The paper studied the evolution of agricultural services sector in Romania. The data regarding agricultural services were retrieved from the Tempo online database and the analysis is also based on FADN data. The analyse had some limitations due to the insufficient statistic data in the field because, at national and regional level, the statistical value of agricultural services doesn't reflect the reality in the field. At farm level, due to the fact that he FADN sample design is achieved through a rotating panel technique the data from the analysed period (2010-2020) are not fully comparable. However, our research revealed a positive evolution in the last decades and a continuous development of rural business environment. In 2020, the services provided by third parties ("work carried out by contractors and to the hire of machinery") were much higher in horticulture and mixed farms (TF8), in specialist horticulture and mixed livestock farms (TF14) and in the farms from Bucharest-Ilfov Region. The analyse of the share of these costs in total intermediate consumption puts on the first places the mixed and mixed crops farms and the farms from North-East Region.

Key words**:** *agricultural services, contract work, share in total intermediate consumption*

INTRODUCTION

According to Commission Regulation (EC) 138/2004 [11], "agricultural and animal husbandry service activities, except veterinary activities" include "agricultural services in the form of contract work at the production stage (i.e. agricultural contract work)" and "other agricultural services (the operation of irrigation systems; the design, planting and maintenance of gardens, parks, and green areas for sports facilities and the like; tree pruning and hedge trimming, etc.)". The term to perform contract work it's clarified in the following way: "contract work (...) may be performed by: (a) specialist contractors for whom these are the principal activities (contractors in the true sense)".

Agricultural services can be found in production sector (vegetable and animal), as well as upstream and downstream of agriculture, including activities such as crop preparation, post-harvest handling, marketing of agricultural products, etc. Also, they can take a multitude of forms, respectively: research services; extension services; training services; financial services; input supply services (fertilizers, veterinary services, etc.); auxiliary services to agriculture (mechanization, herbicide application, etc.); conditioning or packaging services; distribution and transport services, etc [7].

Agricultural services have a direct impact on the efficiency of farms. In their paper Farid et al. (2021) [4] indicate that extension services provided to livestock farms regarding vaccination, artificial insemination, technology or farm management had a real impact on the production and economic level. Ssenyondo (2021) [12] recommends the promotion of credit services and marketing services to improve productivity. Zhao (2021) [14] analyses the need to create a model of functionality for agricultural service capable to enhance the added value of agriculture.

Regarding the agricultural services market, Tulkin and Qudrat (2022) [13] point out the existence of an entire agro service sector which develops continuously based on the innovation in agriculture. Olim et al. (2020) [9] proved that the farms under 40 ha and which have maximum 5 years since they started the activity are most likely in need of agricultural services (especially machinery services). However, “in the formation of markets for agricultural services in the agricultural sector should take into account the type of agricultural production (sowing), natural and climatic conditions, the size of arable land, the composition of agricultural crops, forms of ownership and management, and other similar factors” [10].

MATERIALS AND METHODS

According with the National Statistical Institute, the value of agricultural services in Romania represents around 2% from the agricultural output, but the collection of data is incomplete if we take in consideration that in our country about 35% of the costs per hectare represent agricultural services provided by third parties. So, the statistical studies regarding agricultural services are limited by data availability. To expand our analysis, we opted also for the database provided by FADN according with the method proposed by Kołodziejczak in 2020 [6]. The analysis covered all farms from Romania, classified on TF8, TF14 and regional types. We used the variable SE350, respectively “Contract Work’ which contains “costs linked to work carried out by contractors and the hire of machinery”[3]. For the selected indicators (agricultural services value in thou RON, contract work in euro/hectare) we used the time series from Tempo on line database and the data for 2010 and 2020 from FADN database. For all variables were performed a structural analysis and we analysed the evolution during 2010-2020 period.

RESULTS AND DISCUSSIONS

In the last decades, the services provided for agriculture have been constantly diversifying and their value has increased. According with Cilan and Nicoară (2021) [1] this increase “is largely due to the development of the number of new companies indicating a development of entrepreneurship”. In 2020, the agricultural services reached an amount of 1.8 million RON (2.26% from agricultural output), by 229.5% higher than in 2010. In fact, it is considered that the dynamics of agricultural services is much higher, but "it is missing from the official reports because the services provided are unregistered. The rental of agricultural machinery between small producers without a contract, the payment of these machinery without an invoice with money or with the agricultural production obtained" are very widespread practices.

Table 1. Agricultural services value (2010-2020), in Romania (thou RON, nominal)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2020/ 2010 (%)
Total	64,452.6	76,508.7	64,259.5	78,464.4	74,524.5	68,749.6	69,348.6	78,494.1	86,349.3	89,989.1	81,400.4	126.3
Agricultural services	557.3	544.8	535.1	744.1	984.5	859.7	899.8	945.5	1,229.6	1,792.9	1,836.4	329.5
Share (%)	0.86	0.71	0.83	0.95	1.32	1.25	1.30	1.20	1.42	1.99	2.26	1.4

Source: Own calculation on the basis of data from Tempo on line data base 2010-2020, NIS [8].

Actually, "farmers prefer to lend the tractor or exchange it for a combine harvester or pay for the borrowed equipment with the agricultural products obtained than to start their own business, cut invoices, pay VAT" [2].

Agricultural services provided by third parties are higher in horticulture, mixed, permanent crops and wine farms in both analysed years. In horticulture farms the contract work reached in 2020 around 134 euro/hectare (with almost 278% higher than country average) (Figure 1).

In 2020, the average economic size was double (18,000 euro SO face with 9,000 euro SO in 2010) and the total agricultural utilized area was with 72.8% higher than in 2010. The share of services in total intermediate consumption was lower in 2020 due to the structure of the FADN database because usually the farms with bigger sizes have the possibility to perform all the agricultural activities with their own assets and manpower. Also, in 2020, the activities were affected by COVID situation and many farmers didn’t had a viable market so they were reducing costs. So, the share of the contract work in total intermediate consumption was in 2020 at a level of 7-8% in mixed, permanent crops and field crop farms and at a level of 12-18% in 2010 in field crops, wine, permanent crops and mixed farms (Figure 2).

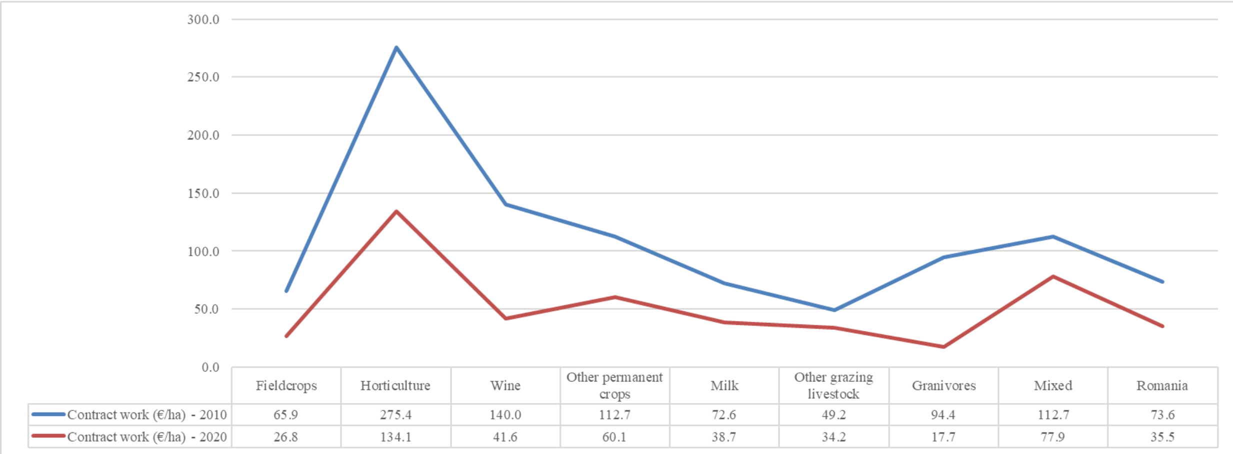

Fig. 1. Contract work (SE350) in Romania, 2010 and 2020, TF8 classification
Source: FADN data [5].
Note: Contract work = “Costs linked to work carried out by contractors and to the hire of machinery”, TF8

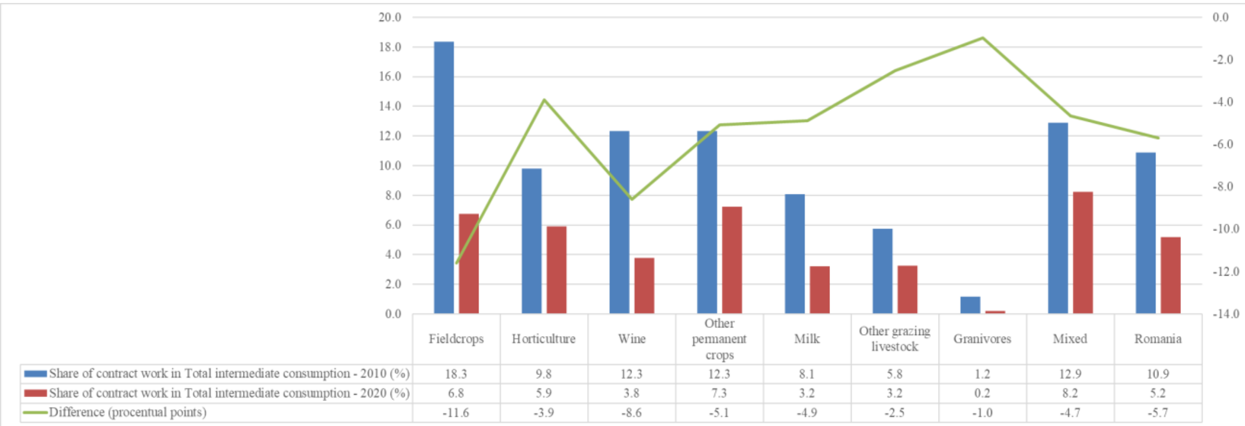

Fig. 2. Share of contract work in total intermediate consumption (SE350/SE275) in Romania, 2010 and 2020, TF8 classification
Source: FADN data [5].

If we perform the analyse based on the specialization of farms (TF14 classification) we observe that in 2020 the amount of the contract work reached 134.1 euro/hectare in specialist horticulture farms, 102.2 euro/hectare in mixed livestock, 97.7 euro/hectare in mixed crops farms and 74.4 euro/hectare in mixed crops and livestock farms (Figure 3). The situation was different in 2010 when the costs were higher also in specialist wine and orchards-fruits farms.

In mixed crop farms the share of contract work remained at around 14% from total intermediate consumption in both years (Figure 4). In 2020 we have around 8-10% in specialist other crops, mixed livestock, mixed crops and livestock farms. Due to the lower size, the farms from 2010 needed the services provided by third parties more, so the share in total consumptions were over 12% in almost all types of specialized farms and even at a level of 19% in specialist COP farms.

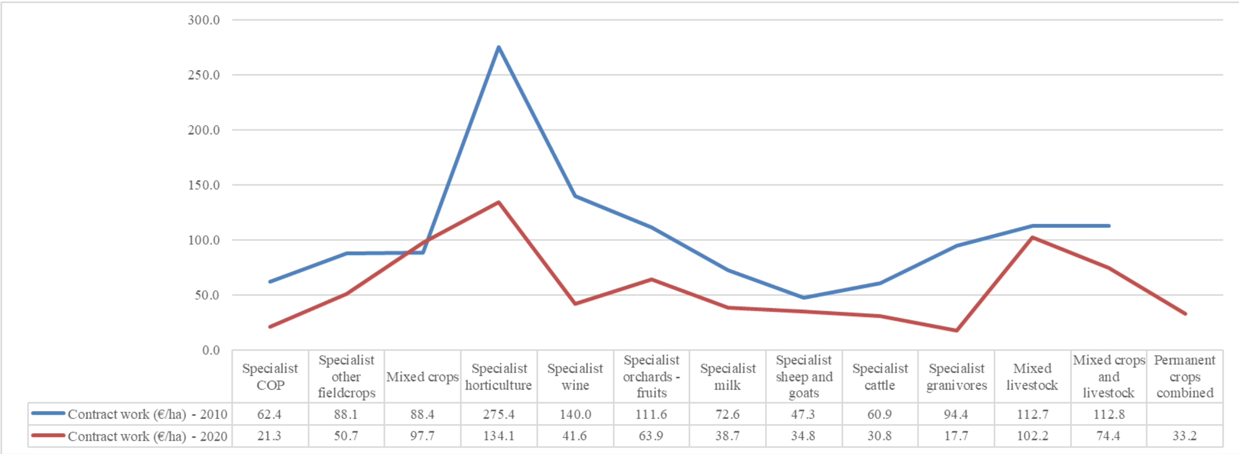

Fig. 3. Contract work (SE350) in Romania, 2010 and 2020, TF14 classification
Source: FADN data [5].
Note: Contract work = "Costs linked to work carried out by contractors and to the hire of machinery", TF14

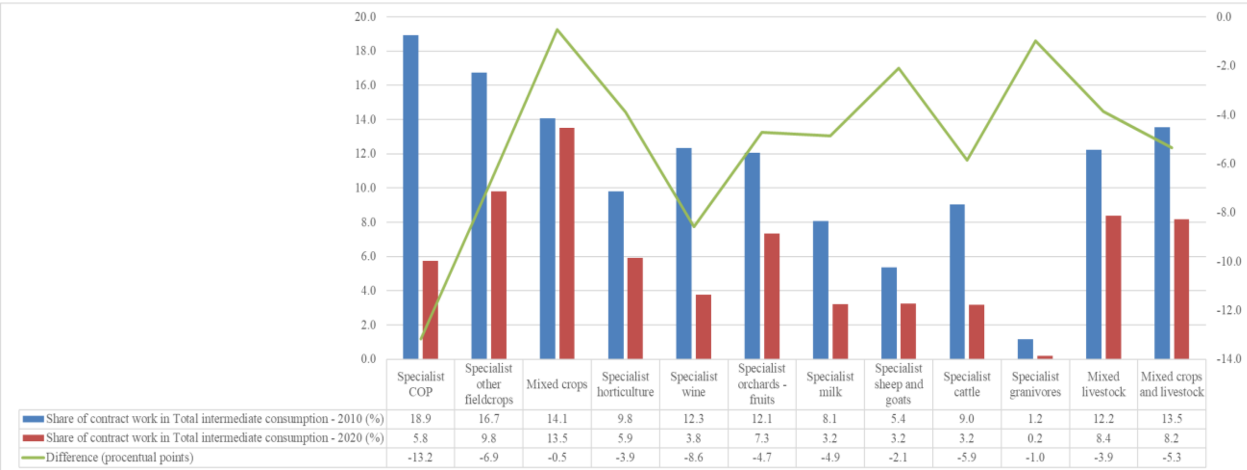

Fig. 4. Share of contract work in total intermediate consumption (SE350/SE275) in Romania, 2010 and 2020, TF14 classification
Source: FADN data [5].

In 2010, over 50% of the value of agricultural services were registered in South-East and South regions. In the period 2010-2020, the value of agricultural services increased in these regions with almost 100%, but the increase in Bucharest-Ilfov of almost 38 times placed this region on the first place in the structure of agricultural services from 2020 (with 43,4%) (Table 2).

Table 2. Agricultural services value on regions, 2010 and 2020 (thou RON, nominal)

Regions	2010	2020	2010	2020	2020/ 2010 (%)
Romania	557,251	1,836,430	100.0	100.0	329.6
North-West	42,248	40,804	7.6	2.2	96.6
Centre	48,695	56,916	8.7	3.1	116.9
North-East	48,374	108,701	8.7	5.9	224.7
South-East	194,974	381,663	35.0	20.8	195.8
South	107,696	210,066	19.3	11.4	195.1
Bucharest-Ilfov	20,272	796,464	3.6	43.4	3928.9
South-West	45,728	141,941	8.2	7.7	310.4
West	49,264	99,875	8.8	5.4	202.7

Source: Own calculation on the basis of data from Tempo on line data base, NIS [8].

In 2020, the contract work in many regions with developed agriculture reduced 2-3 times than the level of 2010. the situation is mainly due to the pandemic period when many farmers from horticulture or mixed farms couldn't sell their products so they cut their expenses especially from third parties. Also sample farms were different and average UAA was bigger. For this reasons in Bucharest-Ilfov region the contract work reduces from 154.7 euro/hectare to 3 euro/hectare. What we may observe however when we look on the numbers at regional level is that the costs with contract work is higher in North-East, South and South-East regions in both analysed years (Figure 5). Also in these regions the share of these expenses in total intermediate consumption are higher with a level of 6-9% (Figure 6).

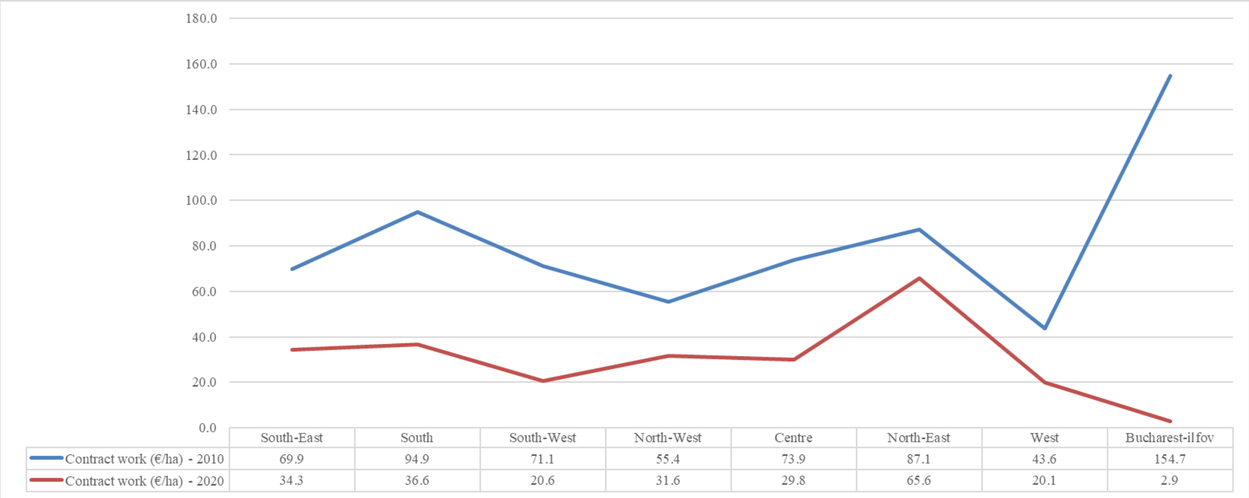

Fig. 5. Contract work (SE350) in Romania, 2010 and 2020, regional classification
Source: FADN data [5].
Note*: Contract work = "Costs linked to work carried out by contractors and to the hire of machinery"

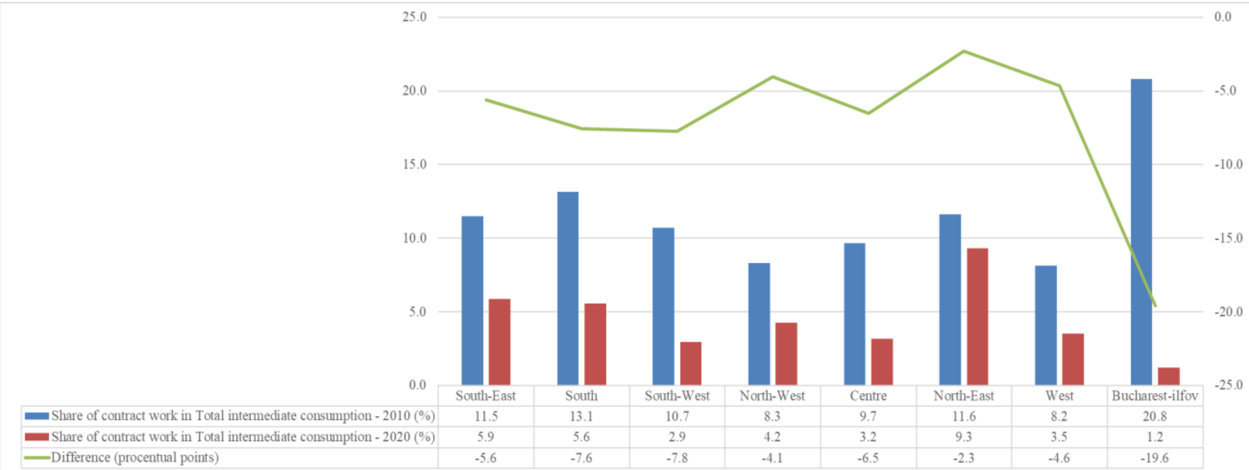

Fig. 6. Share of contract work in total intermediate consumption (SE350/SE275) in Romania, 2010 and 2020, regional classification
Source: FADN data [5].
Note*: Contract work = "Costs linked to work carried out by contractors and to the hire of machinery"

CONCLUSIONS

Agricultural services sector developed during the last decade but his real dimension is difficult to analyze due to the lack of data. There are many providers from transport, distribution etc which are not included in the statistics. Also, many services are delivered based on verbal agreements or exchanges, not contracts or invoices. All these challenges impose limitation in the research of this theme. However, our research revealed a positive evolution in the last decades and a continuous development of rural business environment.

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LAND RELATIONS IN BULGARIA - CHALLENGES AND TRENDS

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Abstract

Land relations are public relations arising on the basis of land use as an indispensable means of production in the agricultural sector. The purpose of this article is to analyze the challenges and trends in Bulgarian agriculture which is characterized by great intensity and dynamics. In the research of land relations, scientific approach is applied as well as the following methodological approaches: systematic, complex, structural, comparative and value-measuring. The methodical framework of this article provides a summary overview of the main changes in the agricultural policy and the structure of land relations in Bulgaria. For the purposes of the research different information sources have been used - scientific journals, publications by Bulgarian authors, as well as the author's own research.

Key words: *land relations, challenges, agriculture, Bulgaria*

INTRODUCTION

The processes in land relations, as public relations, are dominated by the changes in the institutional environment and socio-cultural traditions [13].

Given the current stage of development of land relations in Bulgaria, the relevance and significance of such a research are also inferred from the need to solve issues that have emerged as early as during the land reform, as well as issues that have arisen as a result of the implementation of the Community Agricultural Policy [10].

The comprehensive research of land relations is a constant condition for studying their impact on the socio-economic processes in Bulgaria. European subsidies represent an attractive instrument to a large number of farmers, but the money is not always reinvested in business activity.

The payment per unit of area gives rise to a number of imbalances in the sector and a small number of farms cultivate more and more land [13].

In this context, the purpose of the paper was to analyze the challenges and trends in Bulgarian agriculture which is characterized by great intensity and dynamics.

MATERIALS AND METHODS

The processes in land relations, as public relations, are dominated by the changes in the institutional environment and socio-cultural traditions. The methodical framework of this article provides a summary overview of the main changes in the agricultural policy and the structure of land relations in Bulgaria [10].

In the research of land relations, scientific approach is applied as well as the following methodological approaches: systematic, complex, structural, comparative and value-measuring. The diversity of approaches applied in different parts of the research will make it possible to identify and group the factors that determine the processes in land relations while implementing the Community policy. In order to achieve the intended purpose a number of contemporary scientific quantitative and qualitative methods will be used in this research, such as systematic, graphic and comparative one.

RESULTS AND DISCUSSIONS

A main factor for the dynamic changes in Bulgarian agriculture and land relations are the historical changes in the social model of society [8]. The subsequent changes in the implementation of Community policy and the accompanying mandatory provisions trigger new changes in the industry. One of the preconditions for many of the divergent processes in the sector is the socio-cultural specificities of Bulgaria. A huge variety of possibilities for synergistic effects in the implementation of Community policy in Bulgarian agriculture can arise when traditional attitude meets European policy [11].

The institutional environment in Bulgarian agriculture is a complex system of symbiotic relationships, dynamically changing under the influence of national and sectoral legislation [4].

The administration of land relations, land use in particular, often sets important boundary conditions for land markets. The institutional framework is a decisive factor [3].

The components of the institutional framework are:

• legal framework;
• transferability of properties, transaction costs;
• land taxation systems;
• financial markets; in particular, access to loans as options for mortgaging land and real property.
• Land register

These elements of the institutional framework constitute the system that ensures the functioning of the market, its impact on the maturity of land relations and the importance of economic results in the sector for creating a value chain in the national economy [2].

The new Agricultural Land Act seeks to clarify the use of agricultural land by fixing a maximum duration of contracts, which shall be long enough to allow farmers to plan their future activity in vegetable farms and to protect the producers who have invested in this activity. Thus, the Act will restrict big corporations (foreign legal entities) from purchasing land and will allow young farmers (up to 40 years) to participate in land-lease tenders of land from the State Land Fund. The Act allows for the consolidation of fragmented agricultural land under the so-called "contracts for use" /consolidation contracts [10].

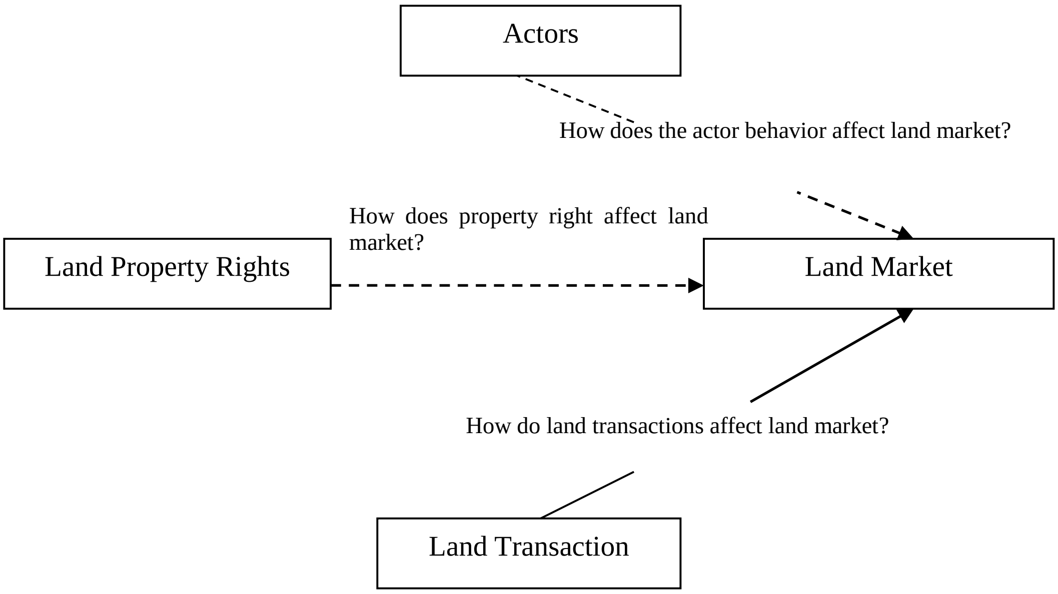

Fig. 1. The impact of land fragmentation on land market development
Source: Own research.

The main goal of the agricultural reform in Bulgaria was to establish the preconditions for a market economy, to restore the land in the country and to privatize the state and collective farms [9]. Restitution of ownership rights to the landowners, however, is one of the necessary conditions for land market development. The formal institutional changes did not guarantee a workable land market, but only provided good ground for its development in the future.

Bulgaria is divided according to planning regions. These regions are not administrative-territorial units in the sense of the Republic of Bulgaria's Administrative-Territorial Organization Act. Rather, their establishment corresponds to the European Union /EU/ requirements for implementation of regional policy. We were selected three administrative regions – Northeast, North Central and South Central (Figure 2). These three administrative regions have the largest share of farmland in Bulgaria. For instance, 24 percent of total farmland is located in Northeast region, 20.9 percent in South Central and 19.3 percent in the North Central region [1].

The Dobrich region is located in Northeast Bulgaria and covers the largest part of South Dobrudza. The region is well known for its massive grain production. The soil is fertile but not irrigated. Farmland is divided into large tracts. The largest size for these land track is around 150-200 hectares, while the smallest size is about 30-60 hectares. Also, there is a system of forest belts to protect cultivated crops and to separate land tracts. Land reform in the region began in 1991 and finished in 1997. The transformation process started with land restitution. Landowners claimed their property using different documents to prove ownership prior to collectivization. The land restitution process in the Dobrich region was completed more quickly in comparison to the other regions of Bulgaria [1].

The Plovdiv region is located in South Central Bulgaria. Total farmland there is about 1.4 million hectares. The land restitution process started in 1991 and was completed in 2000. The main problem during restitution was that many of the documents had landowner names and land size but no information about the precise location of the parcels. In such cases, witnesses provided information about the location of the claimed property [1].

In some municipalities of Plovdiv region where land of similar quality exists, the restitution process was carried out together with land consolidation. However, in this region, a large part of the land was heterogeneous, and the plots were restored according to old and new boundaries. Although the process of land restitution is over, landowners who were not able to obtain their property can still claim it through the court within a ten-year period after the official end of restitution [1].

The farm structure in the region includes many individual producers and a few large commercial farms and cooperatives. The individual producers cultivate almost half of the total farmland in the region, while the large commercial farms cultivate 21 percent and the cooperatives 37 percent.

Fig. 2. Regions in Bulgaria
Source: Statistical Reference Book.

In 2021, Bulgaria had 110,996.84 square km land area, of which agricultural land 60,598.78 square km meaning 54.6%, while forests represented 33.13% (Table 1).

Table 1. Land use in Bulgaria in 2021

Land use type	**Sq. km**	**Ha**	**%**
TOTAL	**110,996.84**	**11,099,684.00**	100.00
Agricultural area	60,598.78	6,059,877.73	54.60
Forests area	36,773.08	3,677,308.38	33.13
Urbanized areas	5,133.16	513.315.86	4.62
Transport areas	2,975.79	297,578.86	2.68
Areas occupied by water and water bodies	2 074.57	207,457.29	1.87
Protected areas	1,545.98	154,597.75	1.39
Disturbed areas	470.56	47,055.5	0.42
Not classified	1,424.93	142,492.62	1.28

Source: National Statistical Institute, https://nsi.bg/en/content/19674/land-use-distribution-republic-bulgaria, Accessed on Sept.2, 2022 [5].

Land transaction have become more frequent from a year to another and the average price of land transactions has substantially increased as shown in Table 2 regarding the price level in the year 2021 compared to its level in the year 2010.

The average price for total transactions reached 1,106 Levs/dca in 2021 being 3.86 times higher than in the year 2010.

The average price of land transactions differs from a region to another depending on many aspects like: the geographical position of the land, soil quality and its destination.

In 2021, the highest average land price per transaction accounted for 2,067 Levs/dca in Dobrich and the lowest level for 120 Levs.dcs in Pernik.

Agricultural rents also increased in 2021 compared to their level in the year 2010. The rent level also varied from a region to another. In the year 2021, the highest rent level was registered in Dobrich accounting for 108 Levs.dcs, followed by Silistra with 85 Levs/dcs.

Table 2. Average prices of land transactions, Bulgaria, 2021 versus 2010 (Levs.dca)

	2010	**2021**	**2021/ 2010 %**
TOTAL	279	1,106	386.4
Severna I Yugoiztochna Bulgaria	285	1,256	
Severozapaden	249	1,282	440.70
Vidin	210	1,014	482.85
Vratza	222	1,254	564.86
Lovech	195	694	355.89
Montana	312	1,532	491.02
Pleven	259	1,395	538.61
Severntsentralen	295	1,273	431.50
Veliko Tarnovo	280	1,158	413.57
Garbovo	439	498	113.43
Razgrad	211	1,255	594.78
Ruse	395	1,295	327.84
Silistra	277	1,526	550.90
Severoiztochen	365	1,541	422.19
Varna	237	1,250	527.42
Dobrich	531	2,067	389.26
Targovishte	272	898	330.14
Shumen	186	998	536.55
Yugoiztochen	230	928	403.47
Burgas	236	869	368.22
Silven	233	1,059	454.50
Stara Zagora	231	897	388.31
Yambol	220	954	433.63
Yugozapadna I Yuzhna Tsentralna Bulgaria	250	665	266.00
Yugozapaden	302	652	215.89
Blagoevgrad	523	-	-
Kyustendil	361	525	145.42
Pernik	-	120	-
Sofia	140	683	487.85
Sofia(Stolitsa)	-	1,209	-
Yuzhen Tsentralen	230	674	293.04
Kardzhali	354	-	-
Pazardzhik	257	706	274.70
Plovdiv	212	810	382.07
Smolyan	476	-	-
Haskovo	204	491	204.58

Source: NSI, 2022, Agriculturel Land Market, https://nsi.bg/en/content/11264/agricultural-land-market, Accessed on Sept.2, 2022 [6].

The lowest rent was in Garbovo, 22 Levs/dcs, followed by Kyustendil, which recorded a little more, 25 Levs/dca (Tabel 3).

Table 3. Agricultural rents in Bulgaria in 2021 versus 2010 (Levs.dca)

	2010	**2021**	**2021/ 2010 %**
TOTAL	23	54	234.7
Severna I Yugoiztochna Bulgaria	25	60	240.0
Severozapaden	19	55	289.5
Vidin	14	55	392.8
Vratza	20	56	280.0
Lovech	15	33	220.0
Montana	18	57	316.6
Pleven	22	60	292.7
Severntsentralen	25	64	256.0
Veliko Tarnovo	23	54	234.7
Garbovo	9	22	244.4
Razgrad	22	67	304.5
Ruse	23	63	273.9
Silistra	36	85	236.1
Severoiztochen	40	81	202.5
Varna	25	66	264.0
Dobrich	61	108	177.0
Targovishte	21	46	219.0
Shumen	21	57	271.4
Yugoiztochen	15	40	266.6
Burgas	15	36	240.0
Silven	16	42	262.5
Stara Zagora	15	40	266.6
Yambol	15	43	286.6
Yugozapadna I Yuzhna Tsentralna Bulgaria	13	32	246.1
Yugozapaden	13	28	215.4
Blagoevgrad	16	-	-
Kyustendil	8	25	312.5
Pernik	11	27	245.4
Sofia	11	27	245.4
Sofia(Stolitsa)	15	38	253.3
Yuzhen Tsentralen	13	34	261.5
Kardzhali	14	29	207.1
Pazardzhik	11	36	327.1
Plovdiv	13	35	269.2
Smolyan	4	-	-
Haskovo	16	31	193.7

Source; NSI, 2022, Rent and lease of agricultural land, https://nsi.bg/en/content/11265/rent-lease-agricultural-land, Accessed on Sept.2, 2022 [7].

CONCLUSIONS

The issue of land relations is an extremely complex social phenomenon. The economic, social and environmental influences involved in it have a two-way impact and interact with agriculture.

Land reform has eliminated the so called TKZS (Cooperative Farms) before restoring the land ownership. No liability has been claimed for the criminal transactions. The chaotic structural changes that followed have led to the elimination of what have been achieved in the past without the intervention of the state. The loss of old markets and severely limited access to European markets is the other important reason for the current state of the agriculture. The lack of the state’s regulatory role has led to the decline and destruction of intensive industries such as fruit and vegetable production, etc. [12].

Possible solutions for the improvement of land relations, land management and land use have emerged in the course of the research and analysis: land rent and land market with a view to overcoming some of the negative processes and trends that have emerged in Bulgarian agriculture during the implementation of CAP 2007-2014, as well as some subsequent adverse trends in the current programming period. This will contribute to a general improvement of the situation in the industry, as well as to a more efficient disbursement of financial assistance for the period 2020+, taking into account the national priorities and achievement of results [10].

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TRENDS IN ORGANIC FARMING IN ROMANIA

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Abstract

The aim of the paper is to present the evolution and future trend of organic farming, the forecast made for the next period, until 2025. The data provided by the international database Eurostat have been used to set up the forecast for the next period until 2025 regarding the areas occupied with oilseeds plants, using SPSS software, Forecasting working method. Organic farming is the production system that is based on certain strict principles of obtaining products, in accordance with guidelines and standards. national and international standards, which are designed to reduce the human impact on the environment while maintaining the normal functioning of the agricultural system. Comparing Romania to the EU member countries in terms of total area converted to organic farming, it ranks 8th with a total area of 291,629 ha, and first among European countries with 90,124 ha in terms of area grown with oilseeds in an ecological system. As a result of the application of measures to support and stimulate organic production, it is claimed that the area under organic farming at national level will increase by about 67% in 2022 compared to 2012. The results showed that in 2025 it is expected as Romania to cultivate up to 21,884 hectares of rapeseed, 71,274 hectares of sunflower and 26,963 hectares of soybeans in an ecological system.

Key words**:** *consumption, organic products, Romania*

INTRODUCTION

Organic production is the global system of agricultural management and food production that combines best environmental and climate action practices, a high level of biodiversity, the conservation of natural resources and the application of high animal welfare standards and high production standards. which meet the requirements of more and more consumers, who want products obtained with the help of natural substances and processes [7].

Organic agriculture is a dynamic sector in Romania that has recently seen an upward trend for all branches. The organization of product marketing is an important element in the organic farming sector [13].

In the paper "Prospects for organic farming in Romania", the authors mention that organic farming is in fact that production system that contributes to supporting the well-being of the entire ecosystem. Organic farming is based on a multitude of ecological systems, biodiversity systems but also cycles that are adapted to certain living conditions, without using prohibited substances (chemicals) with harmful effects on the environment [5], [12].

Also, in the work "Organic farming: from definitions and concepts to agricultural business and even politics", the authors Indira Deniz ALIM and Aurel LUP address the problems of organic farming from all perspectives, starting from its origin to the definition of organic farming, principles and specific characteristics. In this paper, it is mentioned that the philosopher R. Seiner, is considered the "forerunner" of organic farming, because in 1924 he laid the foundations of the concept of biodynamics, because he proposed the development of agriculture easily adapted to all living organisms by integrating four components namely man, animals, plants and soil [1]. In the same paper it is mentioned that in 1975, Fukuoka suggested the development of a less mechanical agricultural system, in which no phytopharmaceutical fertilizers and products should be used [1]. The role of organic farming refers to the production of healthier and safer foods, more suitable for the human body in close connection with the conservation of the environment [14], [2].

Romania is a country that has a competitive advantage, compared to other countries, in terms of natural resources, environment and climate conducive to the development of organic farming. Pest control and the use of environmentally friendly substances to control diseases as well as the use of natural fertilizers such as manure or compost are elements that contribute to maintaining the natural balance of the environment [3], [4].

MATERIALS AND METHODS

The paper is based on statistical data provided by the Eurostat international database on organically cultivated area with the main oilseeds, rapeseed, sunflower and soybeans, for the period 2006-2020.

The research method used consisted of a quantitative and qualitative analysis of statistical data to highlight the ecological area in Romania. Also, through the SPSS software, the cultivated area with oilseeds, rapeseed, sunflower and soybeans was forecast for the next period, until 2025, using the Forecasting method.

The optimistic variant is actually the upper limit of control, and the pessimistic variant is the lower limit of control. The control diagram, the graphical sector that actually displays the image of what happens in the production process in relation to time, thus, the two variants indicate whether the variations of the analyzed process are caused by certain specific events, abnormal events, or events that may affect process quality. These values are calculated on the basis of a confidence interval, being considered as the absence of any deviation from the evolution trend [11].

RESULTS AND DISCUSSIONS

The practice of organic farming in Romania is supported and encouraged, although at present there is no internal market for this category of organic products.

The conversion from conventional to organic farming is gradual, so that economic structures do not feel the effects of declining productivity, and producers gain confidence in organic systems.

Figure 1 shows the total area converted to organic farming in 2006 and the total area converted to organic farming in 2020.

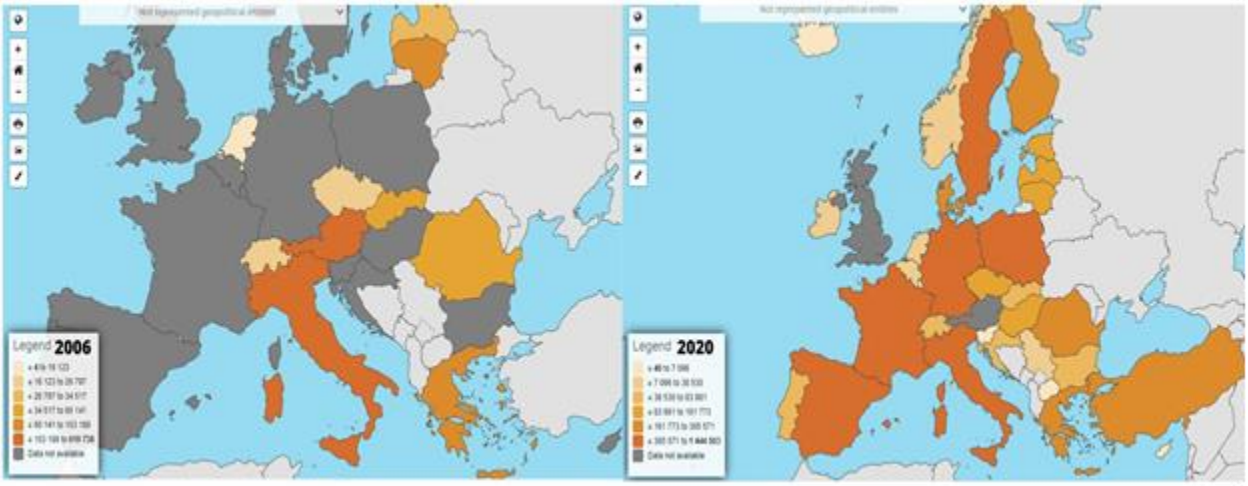

Fig. 1. Total area converted to organic farming in 2006 compared to 2020 in Europe
Source: EUROSTAT, Organic crop area by agricultural production methods and crops (from 2012 onwards), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=org_cropar, Accessed on 23.06.2022 [8].

According to Figure 1, in 2020, the largest organic agricultural area was in France (1,444,503 ha), followed by being from Italy with a total area of 1,016,289 ha. Romania

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ranks 8th out of a total of 34 countries, with a total area of 291,629 ha. Compared to 2006, the area increased considerably, as Romania in 2006 had only 45,605 ha of total arable land converted to organic farming.

Figure 2 shows the total area converted to organic farming occupied by oilseeds. According to the representation, in 2020, Romania ranks first among European countries with 90,124 ha, followed by Italy and Germany with areas occupied by oil plants of 34,788 ha and 14,802 ha, respectively. Compared to 2006 surface. In 2006, Romania owned only 16,058 ha, which is a 5-fold increase in 2020 compared to 2006. At the heart of the European Ecological Pact initiative set is agriculture, which has a key role to play in the transition to a sustainable and sustainable system. Organic farming has the role of producing food without the use of chemicals, which means that it encourages the use of natural resources in the most responsible way possible.

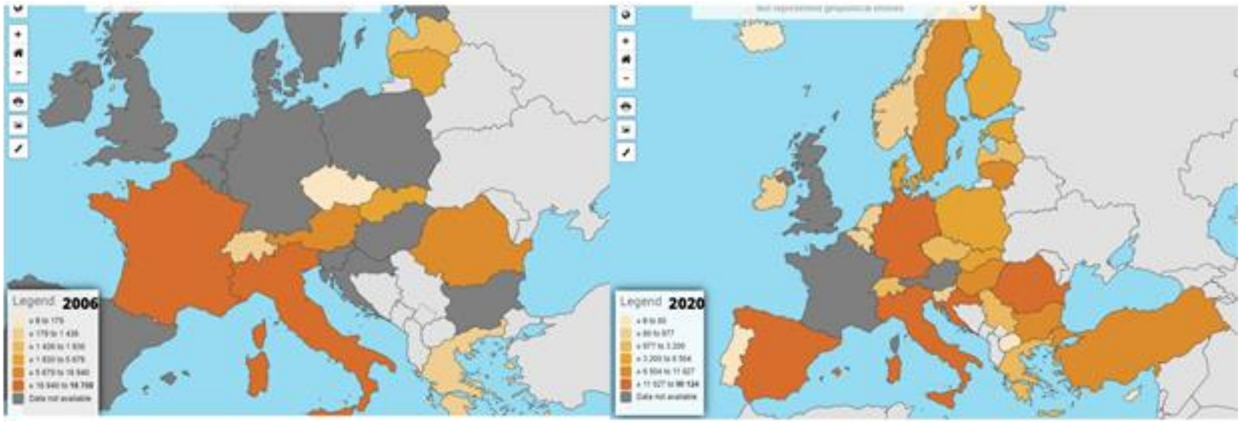

Fig. 2. Total area converted to organic farming in oilseeds in 2006 compared to 2020 in Europe
Source: EUROSTAT, Organic crop area by agricultural production methods and crops (from 2012 onwards); Crops: oilseeds,https://ec.europa.eu/eurostat/databrowser/view/ORG_CROPAR__custom_3031586/default/map?lang=en Accessed on 23.06.2022 [9].

In Romania, organic farming is on an upward trend, growing by around 67% in 2022 compared to 2012, as a result of the implementation of structures to stimulate the production of organic products. Most Member States have already defined the objectives for stimulating organically cultivated areas as a share of the utilized agricultural area. In addition, organic farming is also supported through the CAP, proving to be fundamental in stimulating farmers.

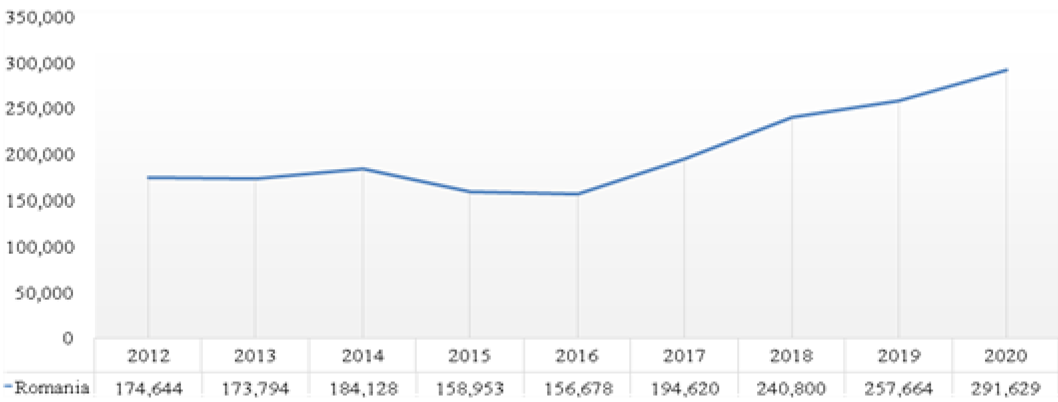

Fig. 3. The total area converted to organic farming in Romania
Source: EUROSTAT, Organic crop area by agricultural production methods and crops (from 2012 onwards), country: Romania, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=org_cropar&lang=en, Accessed on 23.06.2022 [10].

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Observing the upward trend of organically grown area and the presence of factors that have a positive impact on the stimulation of organic areas, such as CAP measures, implementation of the set of decisions on the European Ecological Pact, etc., a forecast was made of areas cultivated with oilseeds. until 2025. The forecast was made using the SPSS application, based on data provided by Eurostat.

According to the model made (Fig.4, Table 1), by 2025 in Romania could be cultivated approximately 21 884 hectares in ecological system, which would represent an increase 6 times higher compared to 2006. The area cultivated with organic rapeseed in Romania, in the period 2006-2020 had an upward trend, thus, in 2020 the area cultivated with organic rapeseed reached the value of 13,583 hectares, 4 times more compared to 2006. the action plan for the development of organic production, starting with 2023, will assess the circumstances and needs of each state regarding the increase of organically cultivated areas, as well as the implementation of support measures for the organic agricultural sector (Fig. 4, Table 1).

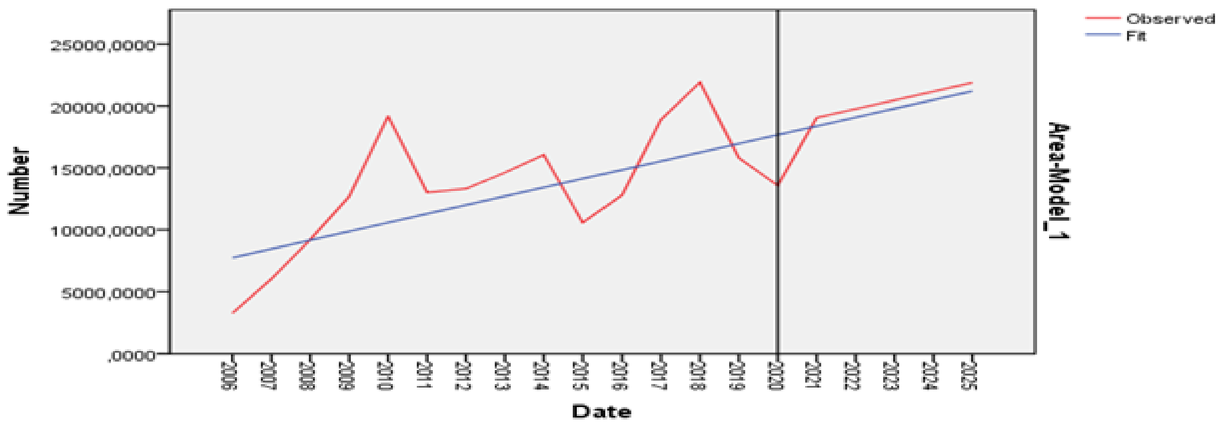

Fig. 4. Forecast of the area under rapeseed, horizon 2025 (ha)
Source: Own representation in SPSS.

Following the application of the model, two possibilities were obtained. The optimistic variant indicates that, until 2025, in Romania maximum of 28.2 thousand hectares could be cultivated with rapeseed in an ecological system (Table 1). The pessimistic variant, in which it is presented that Romania could cultivate rapeseed in the ecological system maximum 14.1 thousand hectares (Table 1).

Regarding the forecast of the area cultivated with sunflower, if the upward trend representative of the period 2006-2020 were maintained, by 2025 in Romania it could be cultivated up to 71 274 hectares, which would mean an increase of 4.5 times compared to the first year analyzed. And in this case, there are two possibilities, resulting from the application of the SPSS model. From an optimistic point of view, by 2025 a maximum of 110,726 hectares could be cultivated with ecological sunflower.

Table 1. Forecast of rapeseed area, horizon 2025 (ha) - forecast value, optimistic value, pessimistic value

Year	Predicted	Pesimist	Optimist
2006	3,273*	-	14,829
2007	6,030*	-	15,531
2008	9,218*	2,102	16,236
2009	12,699*	2,809	16,942
2010	19,179*	3,519	17,652
2011	13,020*	4,234	18,368
2012	13,321*	4,943	19,076
2013	14,621*	5,651	19,784
2014	16,065*	6,360	20,493
2015	10,589*	7,069	21,203
2016	12,811*	7,772	21,906
2017	18,909*	8,477	22,610
2018	21,917*	9,187	23,321
2019	15,799*	9,900	24,033
2020	13,583*	10,605	24,739
2021	19,056	11,308	25,441
2022	19,763	12,015	26,149
2023	20,470	12,723	26,856
2024	21,177	13,430	27,564
2025	21,884	14,138	28,271

Source:* Data provided by Eurostat; Own representation in SPSS.

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Also, from a pessimistic point of view, only 31,821 hectares could be produced in an ecological system (Fig. 5, Table 2).

Table 2. Forecast of the area cultivated with sunflower, horizon 2025 (ha) - predicted value, optimistic value, pessimistic value

Year	Predicted	Pesimist	Optimist
2006	-	-	-
2007	15,799*	-1,845	33,443
2008	13,786*	-3,858	31,430
2009	13,782*	-3,862	31,426
2010	14,796*	-2,848	32,440
2011	21,244*	3,600	38,888
2012	28,573*	10,929	46,217
2013	47,005*	29,361	64,649
2014	33,336*	15,692	50,980
2015	25,998*	8,354	43,642
2016	25,992*	8,348	43,636
2017	25,454*	7,810	43,098
2018	36,794*	19,150	54,438
2019	39,952*	22,308	57,596
2020	49,543*	31,899	67,187
2021	58,946	41,302	76,590
2022	62,028	37,076	86,980
2023	65,110	34,550	95,669
2024	68,192	32,905	103,479
2025	71,274	31,821	110,726

Source:* Data provided by Eurostat; Own representation in SPSS.

From 2022 onwards, the exchange of good practices will be promoted by offering educational programs, both nationally and internationally, on organic farming, which aim to present innovative solutions for the organic sector (European Commission, 2021, An action plan for the development of organic production, Brussels) [6].

Regarding, the forecast of the cultivated area with soybeans, by maintaining the upward trend representative for the period 2006-2020, until 2025 in Romania could be cultivated up to 26,963 hectares, which would mean an increase of 3.7 times compared with the first year analyzed. And in this case, there are two possibilities, resulting from the application of the SPSS model. From an optimistic point of view, by 2025 a maximum of 40,018 hectares of soybeans could be cultivated in an ecological system. Also, from a pessimistic point of view, only 13,097 hectares could be produced in an ecological system (Fig. 6, Table 3).

A general reason why organic farming is becoming more and more practiced is that although it does not have the same yield as conventional agriculture, organically obtained products do not have the same aesthetic appearance, it reaps its own rewards.

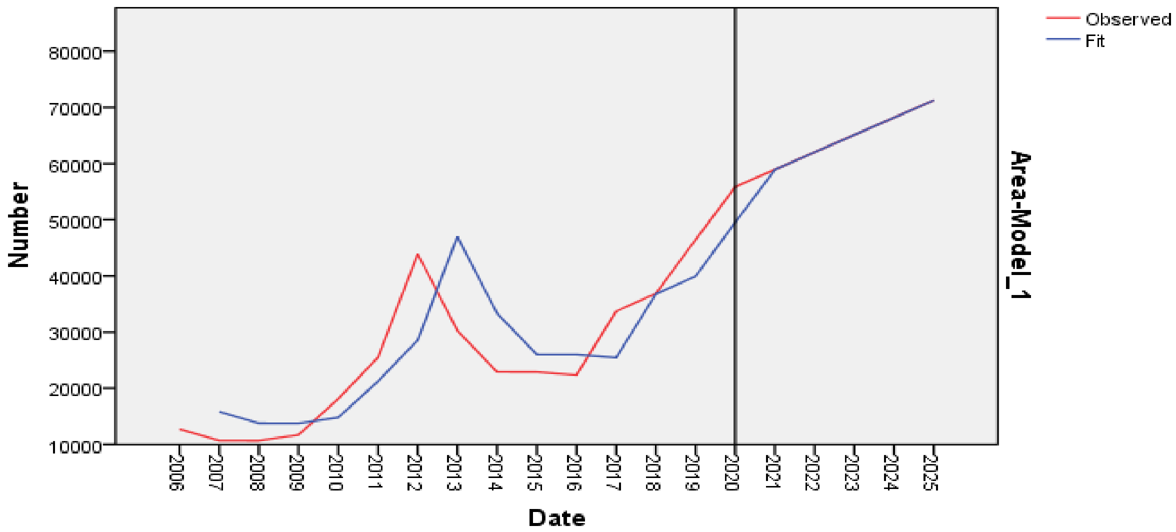

Fig. 5. Forecast of the area cultivated with sunflower, horizon 2025 (ha)
Source: Own representation in SPSS.

Although organic farming focuses mainly on sustainability, it also looks at how the actions people take today affect the future. The use of organic substances and fertilizers, as well as

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compliance with ecological guidelines, contributes to increasing production and at the same time contributes to the restoration of nutrients in the soil.

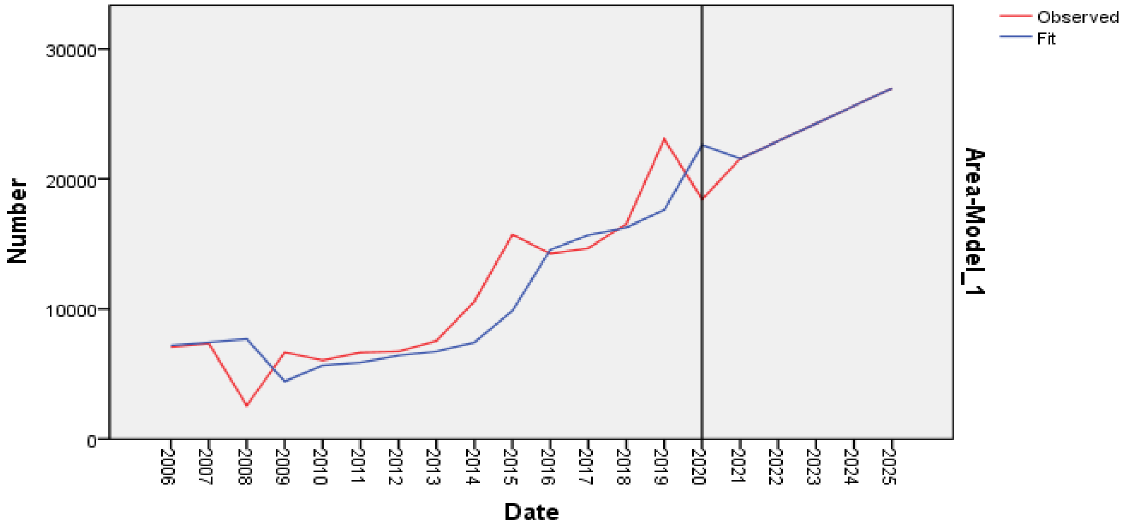

Fig. 6. Forecast of soybean area, horizon 2025 (ha)
Source: Own representation in SPSS.

Table 3. Forecast of soybean area, horizon 2025 (ha) - forecast value, optimistic value, pessimistic value

Year	Predicted	Pesimist	Optimist
2006	7,159*	745	13,573
2007	7,405*	991	13,819
2008	7,662*	1,248	14,077
2009	4,409*	-2,005	10,823
2010	5,644*	-770	12,058
2011	5,868*	-546	12,283
2012	6,400*	-14	12,814
2013	6,715*	301	13,130
2014	7,418*	1,003	13,832
2015	9,837*	3,423	16,252
2016	14,525*	8,111	20,940
2017	15,645*	9,231	22,060
2018	16,251*	9,836	22,665
2019	17,607*	11,193	24,021
2020	22,592*	16,178	29,007
2021	21,551	15,136	27,965
2022	22,904	15,093	30,715
2023	24,257	14,855	33,658
2024	25,610	14,453	36,766
2025	26,963	13,907	40,018

Source:* Data provided by Eurostat; Own representation in SPSS.

CONCLUSIONS

At the moment, Romania is at a time when it must adopt a strategic position in the face of new opportunities and challenges. Thus, our country must make the most of them and take advantage of the opportunities offered by the Common Agricultural Policy and by participating in the EU and third country markets.

The development of sustainable agriculture presents a framework in which, once each person has mastered it will contribute to creating a more equitable environment, defined by balance and solidarity, thus being able to cope with the changes of current global, regional and national issues.

In Romania, organic farming is a dynamic system, registering an overall upward trend. In 2020, the total arable area of the ecological system was 291,629 ha, ranking 8th among EU member states. At the same time in terms of the area occupied by organically grown oil plants, Romania ranked first among European countries with 90,124 ha, followed by Italy and Germany with areas occupied by oil plants of 34,788 ha respectively 14,802 ha.

The discovery of new technologies, research and the use of environmentally friendly nutrients and treatments can change the way agricultural products are obtained today, for the transition to an ecological and sustainable agriculture. Observing the upward trend of all crops analyzed, in the ecological system, and observing the forecast made through the SPSS program, it can be argued that further efforts must be made, maintained and sustained to promote sustainable agriculture that focuses on environmental protection, ensuring alternative incomes and a high level of farmers as well as maintaining an active agricultural sector involved in organic activities and analyzing the quality of agricultural products obtained.

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RESEARCH ON THE SUSTAINABLE USE OF PESTICIDES AT MACRO-REGIONAL LEVEL AND IN THE DEVELOPMENT REGIONS OF ROMANIA

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Abstract

The paper highlights the quantities of pesticides used in Romania and the evolution of the surfaces on which pesticides were applied, in the period 2015-2017 compared to 2011-2013, a comparison necessary to present the progress that Romania has made in reducing the use of these plant protection products. This period overlaps over the period in which the harmonized risk index was determined at EU level. In the European Union, it is envisaged that in the future, pesticides should be used in a sustainable manner, the impact that this measure will have representing the reduction of risks and negative effects on the environment and human health. The countries of the European Union take into account the proposed objectives, and by including in the National Strategic Plans the quantitative targets related to pesticides, they will constantly monitor the effects established by the implementation of the EU policy. The conclusions highlight that in Romania the quantities of insecticides and herbicides decreased, and those of fungicides increased in the period 2015-2017 compared to the period 2011-2013, and the surfaces on which insecticides and fungicides were applied increased while the ones with herbicides decreased, thus the average quantity of insecticides and herbicides per hectare decreased and the average quantity of fungicides per hectare increased.

Key words: *harmony risk, pesticides, Romania, UE*

INTRODUCTION

Nowadays, it is well known that agriculture is facing a number of challenges, of which the most relevant are: providing agricultural products, on the one hand, for food to the growing population, and on the other hand, for animal feed; reducing production costs in order to maintain the viability of production farms; reducing pollution due to the use of inputs necessary to obtain agricultural production etc. In order to achieve a self-sufficient agricultural production, it is recommended to use chemical fertilizers as well as the widespread use of pesticides [16]. The specialists in the field have identified over the decades of research, both the benefits and the risks of using fertilizers and pesticides [1]. At the level of the European Union there are regulations that stipulate optimal consumption in the categories specified above. European Union legislation on chemicals and pesticides aims both to protect the health of the population and environment and to prevent difficulties in their marketing [6]. Pesticides are those substances that are used in modern agriculture, because they contribute directly to the control of weeds, pests and diseases that can endanger both agricultural production and farmers' incomes [16]. Currently, there are many factors underlying the use of pesticides by farmers [8]. However, it is necessary to specify that we should not neglect the socio-economic variables that may tip the balance in favor of or against the use of pesticides [2]. In the specialized literature there was a clear delimitation of pesticides, taking into account the organism that must be combated, as follows: bactericides; fungicides; herbicides;

insecticides; acaricides; nematocides; moloscocides; raticides and mixed action [13]. In time, it was found that the practice of a conventional agriculture, which implies that sometimes the excessive use of pesticides, contributes directly to the degradation of the environment, to the depletion of resources and the loss of biodiversity [9, 10]. But at the level of the European Union it is clearly desired a sustainable use of pesticides, by reducing with 50% their use [3]. Thus, in order to measure progress regarding the reduction of risks of pesticide use, as well as its effects on the environment and human health, two specific risk indicators have been introduced at EU level, indicators that objectively contribute to the monitoring of the situation in each state. But risk assessment is not a facile method [11]. The risks associated with the use of plant protection products are not homogeneous, they are correlated with the unequal influence of specific factors, such as the active substance existing in their componence, the amount used per hectare, the frequency of application and the time, place and manner in which farmers use them in their own activity. Currently, two harmonized risk indicators, calculated differently, have been introduced at European level: Harmony Risk 1 is established based on sales of active substance and the Harmony Risk 2, based on the number of emergency authorizations granted. In the EU, the introduction of harmonized risk indicators was a necessity, as this determination highlights the use of pesticides in the Member States, while evaluating EU policies in this area. By calculating the risk indicators, the Member States identify the needs for the use of active substances in plant protection products, with an emphasis on those with a high degree of toxicity, in the sense of elimination from agricultural practice. The integrated control of diseases and pests, remains a priority of EU policies, by reducing the dependence on the use of pesticides [5, 7]. At the level of the European Union, Harmony Risk 1 determined for the period 2011-2019, recorded an oscillating evolution, its highest value being recorded in 2011, respectively 111, and the lowest value was 79 (2019). In the countries of the European Union there is also the oscillation of values during the analysis period. For Romania, Harmony Risk 1, recorded values below the European Union average, except for 2012, when the value recorded was 110, and at the European Union level was 97 [4]. But the progress registered by Romania is noticeable from the following year (2013), when this indicator decreased, and in 2014 the decrease in half of the value compared to the previous year was considered a progress. The oscillations recorded in the following years were small, the year 2019 being highlighted with the lowest value for this indicator, namely 38, by 65.46% lower than the maximum value recorded, namely 110, in 2012. It is necessary to remember that Romania is a country where agriculture is an important sector of the economy and where agricultural production is directed both to the internal and external market. The realization of agricultural production is determined by a number of factors: soil type; precipitation level; applied production technologies; quantity of pesticides used etc. [14]. Romania must take into account the directives of the European Union regarding the quantity of pesticides recommended to be used, as well as the types of pesticides allowed for use [15].

MATERIALS AND METHODS

The paper highlights the consumption of pesticides in Romania during 2015-2017, compared to 2011-2013. In order to better capture the pesticide consumption, it was necessary to analyze several specific indicators such as: the quantitative consumption of insecticides for the periods considered in the study; the land areas where insecticides were applied; the average amount of insecticides used on the land area where insecticides were utilized; the quantitative consumption of herbicides; the total land areas on which herbicides were applied; the average amount of herbicides used on the land area where herbicides were applied; the quantitative consumption of fungicides; the total land areas on which fungicides were applied; the average amount of fungicides

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used on the land area on which fungicides were utilized. The results were presented in tables and graphs. The statistical data underlying the paperwork were taken from the website of the National Institute of Statistics.

RESULTS AND DISCUSSIONS

In Romania, according to NIS data, the total quantitative consumption of insecticides (kg. s, a) recorded an oscillating trend in the period 2011-2013 and upwards in the period 2015-2017 (Fig. 1).

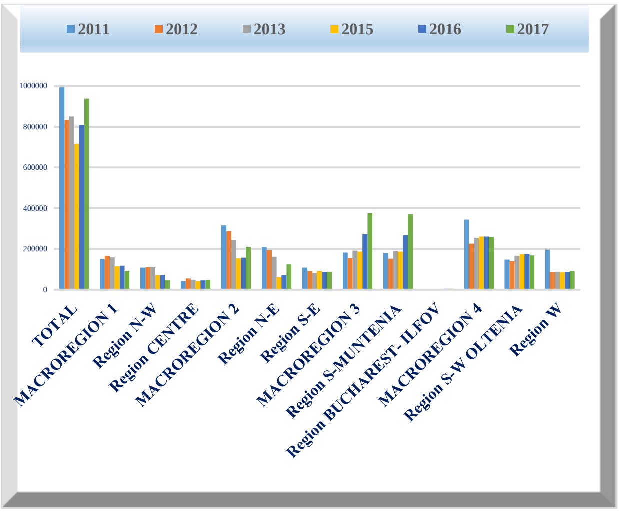

Fig. 1. Amount of insecticides (kg. s.a.) utilised in Romania
Source: [12].

There is a 7.97% decrease in the consumption of insecticides in the period 2015-2017 compared to 2011-2013.

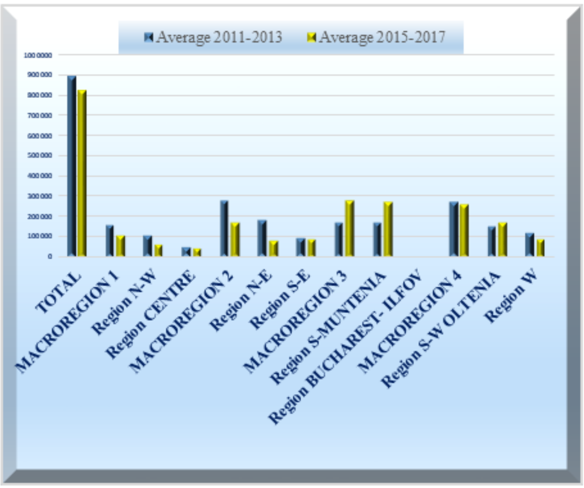

Fig. 2. Average quantity of insecticides (kg. s.a.) used in Romania in the periods 2011-2013 and 2015-2017
Source: [12].

This decrease is due to the situation within the second macro-region, with the North-East regions registering a decrease of insecticide consumption by 54.66% compared to the period 2011-2013 and the South-East Region with a decrease of insecticide consumption by 5.67%. Macroregion One also contributed to this decrease, with North-West Region (42.01% decrease in consumption) and Central Region with a 8.17% reduction. In the Macro-Region Four, South-West Oltenia Region recorded an increase of 13.50% compared to the previous period and the West Region a decrease of 29.01% (Fig. 3).

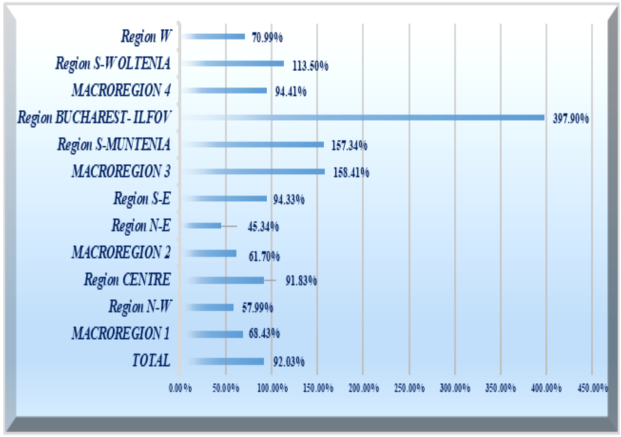

Fig. 3. Dynamics of the average quantity of insecticides (kg. s.a.) used in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

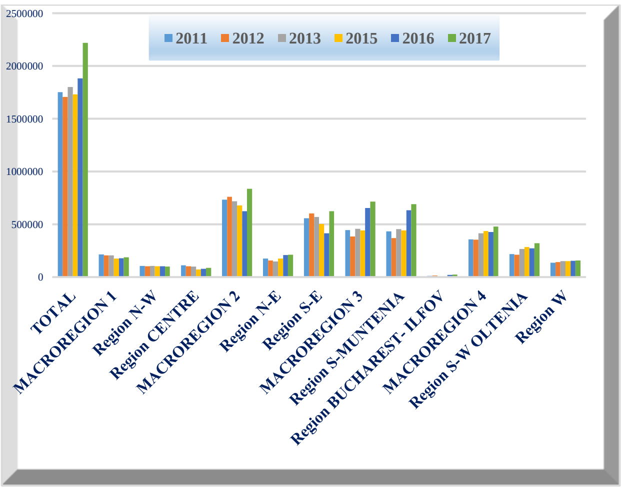

Fig. 4. Surface (ha) on which insecticides have been applied
Source: Own processing [12].

At the opposite pole is the South-Muntenia Region where there were increases in the consumption of insecticides by 57.34% compared to the previous period, and in the

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Bucharest-Ilfov Region, the increase was substantial by 297.90% more in the period 2015-2017 compared to the period 2011-2013. On the other hand, the total land area (ha) on which insecticides were applied recorded an oscillating trend in the period 2011-2013 and an upward trend in the period 2015-2017.

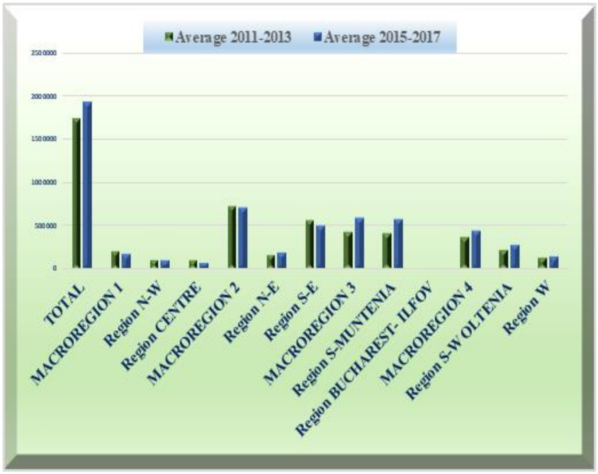

Fig. 5. Average land area (ha) on which insecticides were applied in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

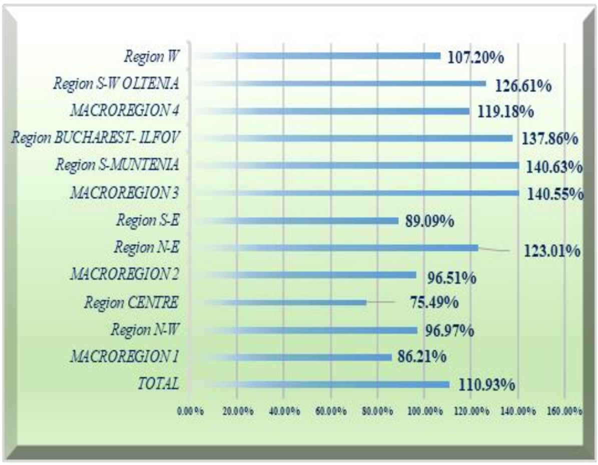

Fig. 6. Dynamics of the average surface on which insecticides (ha) were applied in Romania in the periods 2011-2013 and 2015-2017
Source: Own processing [12].

We notice the increase of the surfaces on which insecticides were applied by 10.93% in the period 2015-2017 compared to the period 2011-2013. This increase is due to the situation within Macroregion Three, which includes the South-Muntenia Region with an increase of the areas on which insecticides were applied by 40.63% as well as the situation in the Bucharest-Ilfov Region, with an increase of 37.86%.

Also, in the Macroregion Four there were increases in the areas on which insecticides were applied and these increases were due to the situation in the South-West Oltenia Region where on another 26.61% of land were applied insecticides compared to the period 2011-2013, but also in the West Region there was an increase of 7.20%.

At the opposite pole lies Macroregion One, with the North-West Regions (13.79% decrease of the surfaces where insecticides were applied) and the Center Region (3.03% decrease). In Macroregion Two, we noticed the following situation: North-East Region, increase of the areas on which insecticides were applied by 23.01% and South-East Region, decrease of these areas by 10.91%.

Analyzing the average amount of insecticides used on the land surface on which insecticides were applied during the period 2015-2017, it is noted that, in Romania, this decreased was of 0.09 kg a.s./ha, respectively 17.12% compared to the period 2011-2013.

Table 1. The average amount of insecticides used onthe area of land on which insecticides were applied (kg s.a./ha)

No. Crt.	Macroregions and development regions	Average		Dynamics Average 2015/2017 at Average 2011/2013	
		2011-2013	2015-2017		
		Kg. s.a.			
1.	TOTAL	0.51	0.42	-0.09	82.88%
2.	MACROREGION 1	0.76	0.60	-0.15	79.56%
3.	Region N-W	1.05	0.63	-0.42	59.64%
4.	Region CENTRE	0.47	0.57	+0.10	121.52%
5.	MACROREGION 2	0.38	0.24	-0.14	63.86%
6.	Region N-E	1.16	0.43	-0.74	36.52%
7.	Region S-E	0.16	0.18	+0.01	108.49%
8.	MACROREGION 3	0.41	0.45	+0.05	111.32%
9.	Region S-MUNTENIA	0.42	0.46	+0.04	110.32%
10.	Region BUCHAREST-ILFOV	0.10	0.28	+0.18	276.11%
11.	MACROREGION 4	0.74	0.58	-0.16	78.73%
12.	Region S-W OLTENIA	0.66	0.59	-0.07	89.94%
13.	Region W	0.87	0.57	-0.30	65.25%

Source: Own processing [12].

There are regions where this average amount of insecticides used on the surface on which insecticides were applied has grown and there are highlighted Macro-Region Three, with the South-Muntenia Region and the Bucharest-Ilfov Region, as well as the Center and South-

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East Regions. In the other development regions of Romania, there is a decrease in the quantities of insecticides used in the period 2015-2017 compared to the period 2011-2013. The total quantitative consumption of herbicides (kg. s.a) in Romania recorded an upward trend between 2011-2013 and 2015-2017, with a slight decrease highlighted in 2017. There is a 2.74% decrease in herbicide consumption in the period 2015-2017 compared to 2011-2013, taking into account the average consumption of these periods. This decrease is due to the situation within Macroregion One, with the North-West Regions, which recorded a decrease in consumption by 37.09% and the Centre Region with a decrease of 29.91%, as well as the West Region within Macroregion Four, with a decrease in the quantities of herbicides used of 7.82%.

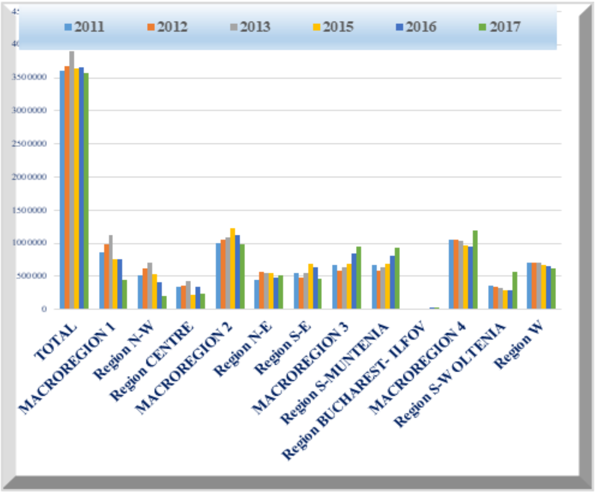

Fig. 7. Quantity of herbicides (kg s.a.) used in Romania
Source: Own processing [12].

At the opposite pole is Macroregion Two, with an increase in the quantities of herbicides used by 5.82%.

This was due to the increase within the South-East Region (12.24%) as well as Macroregion Three, with a total increase of 30.20% in which the South-Muntenia Region contributed with an increase in the quantities of herbicides used of 27.69% and the Bucharest-Ilfov Region stands out with a substantial increase of 783.18 compared to the previous period considered in the study.

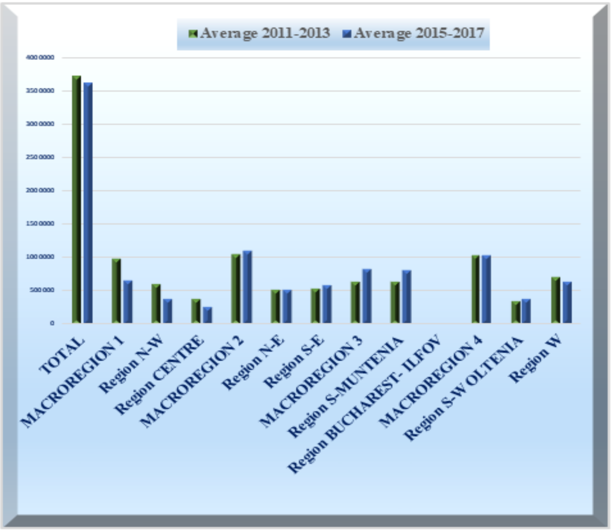

Fig. 8. Average quantity of herbicides (kg s.a.) used in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

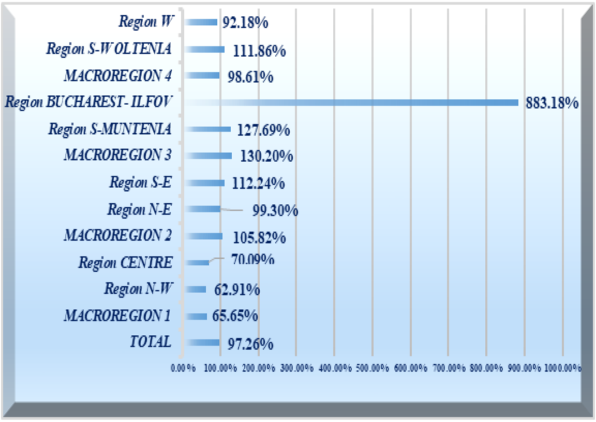

Fig. 9. Dynamics of the average amount of herbicides (kg. s.a.) used in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

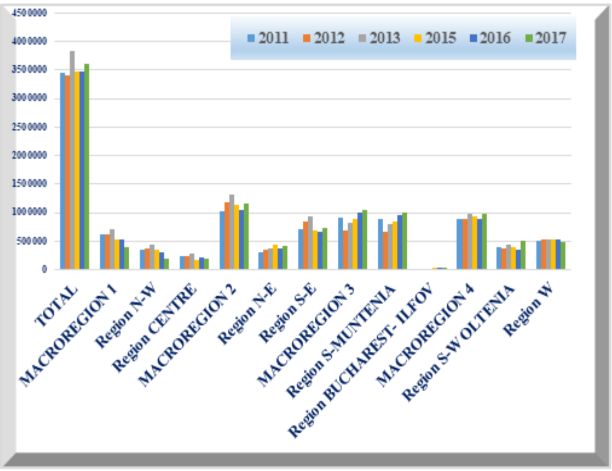

Fig. 10. Surface (ha) on which herbicides were applied
Source: Own processing [12].

On the other hand, the total area of land (ha) on which herbicides were applied recorded an oscillating trend in the period 2011-2013 as well as in the period 2015-2017.
It is noted the decrease of the areas on which herbicides were applied by 1.12% in the period 2015-2017 compared to the period 2011-2013.

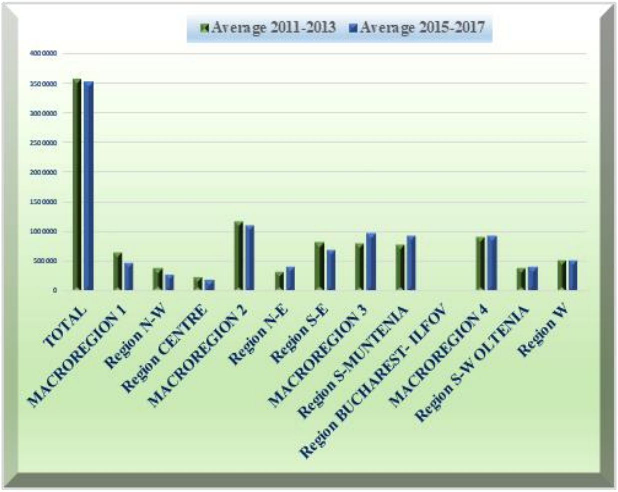

Fig. 11. Average area on which herbicides (ha) were applied in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

This decrease is due to the situation within Macroregion One, where the North-West Region has decreased in the areas on which herbicides were applied by 25.91%, and the Center Region which has decreased by 20.93% in the areas on which herbicides were applied and also Macroregion Two, with the South-East Region where these areas decreased by 16.23%.

Fig. 12. Dynamics of the average area on which herbicides (ha) were applied in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

A At the opposite pole are the areas on which herbicides were applied in the South Muntenia Region with an increase of 18.94% compared to the previous period and the Bucharest-Ilfov Region, with an increase of 58.76%. And in Macroregion Four, there was a slight 1.05% increase in the areas on which herbicides were applied.
nalysing the average amount of herbicides used on the land area on which they were applied during 2015-2017, it is noted that, at the level of Romania, there was a decrease of 0.02 kg s.a./ha, respectively 2% compared to the period 2011-2013.

Table. 2. The average quantity of herbicides used on the area of land on which herbicides were applied

	Macroregions and development regions	Average		Dynamics Average 2015/2017 at Average 2011/2013	
		2011 - 2013	2015-2017		
		Kg. s.a.			
1.	TOTAL	1.05	1.03	-0.02	0.98%
2.	MACROREGION 1	1.53	1.32	-0.21	0.86%
3.	Region N-W	1.57	1.33	-0.24	0.85%
4.	Region CENTRE	1.48	1.31	-0.17	0.89%
5.	MACROREGION 2	0.90	1.00	+0.10	1.11%
6.	Region N-E	1.53	1.24	-0.29	0.81%
7.	Region S-E	0.64	0.85	+0.21	1.34%
8.	MACROREGION 3	0.78	0.85	+0.07	1.08%
9.	Region S-MUNTENIA	0.80	0.86	+0.06	1.07%
10.	Region BUCHAREST-ILFOV	0.09	0.52	+0.43	5.56%
11.	MACROREGION 4	1.13	1.10	-0.03	0.98%
12.	Region S-W OLTENIA	0.85	0.93	+0.08	1.10%
13.	Region W	1.35	1.24	-0.11	0.92%

Source: Own processing [12].

There are regions where this average amount of herbicides used on the surface on which herbicides were applied has increased and Macroregions Two, Three and Four are highlighted, the most significant increase being in the Bucharest-Ilfov Region 0.43kg s.a//ha.
The total quantitative consumption of fungicides (kg.s.a.) in Romania recorded an oscillating trend both in the period 2011-2013 and in the period 2015-2017. It is noted the 7.37% increase in the consumption of

fungicides in the period 2015-2017 compared to the period 2011-2013, taking into account the average amount used during these periods.

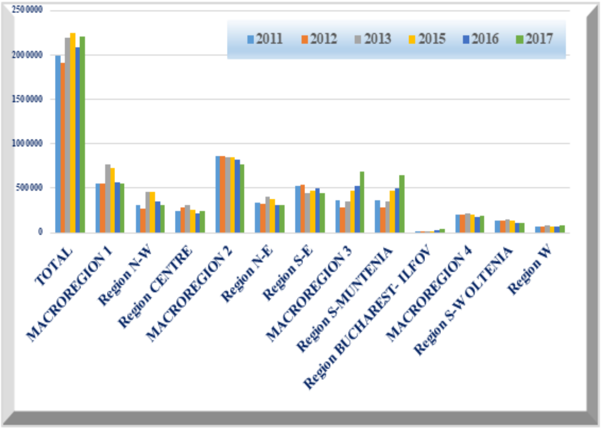

Fig. 13. Amount of fungicides (kg.s.a.) used in Romania
Source: Own processing [12].

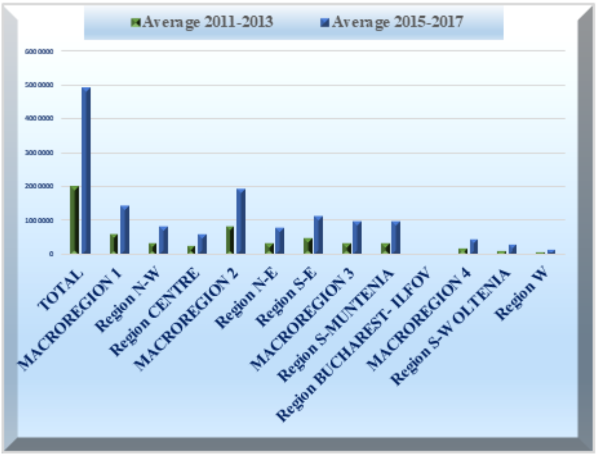

Fig. 14. Average amount of fungicides (kg s.a.) used in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

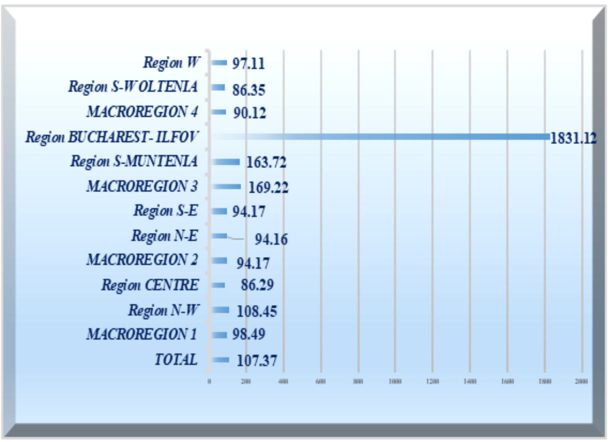

Fig.15. Dynamics of the average amount of fungicides (kg s.a.) used in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

This increase is due to the situation within Macroregion Three, in which the South Muntenia Region which recorded an increase in the consumption of fungicides by 63.72% compared to the period 2011-2013 and the Bucharest-Ilfov Region with an obvious increase of 1,831.12% compared to the previous period. And in the North-West Region of Macroregion One, the increase in fungicides consumption was highlighted with 8.45% compared to 2011-2013. At the opposite pole is Macroregion One, with a decrease of 1.51% due to the decrease in the use of fungicides quantities recorded in the Center Region (13.71%) and Macroregion Two, with a 5.83% decrease in the use of fungicides compared to the previous analysis period.

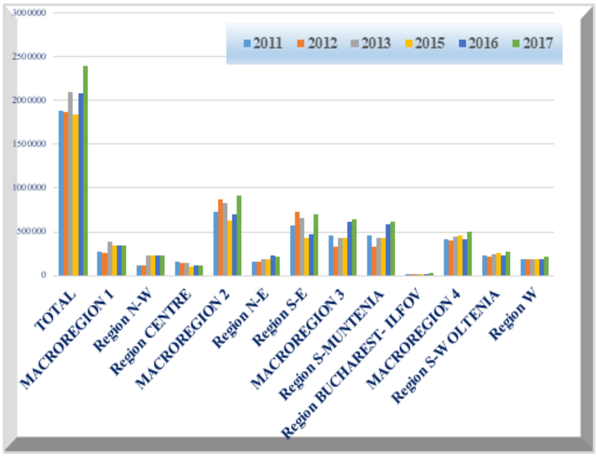

Fig. 16. Surface (ha) on which fungicides were applied
Source: Own processing [12].

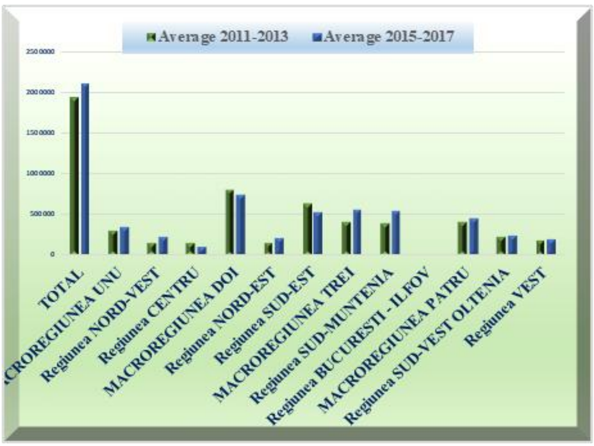

Fig.17. Average area on which fungicides (ha) were applied in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

The land areas on which fungicides were applied increased by 8.23% in the period 2015-2017 compared to the period 2011-2013. This increase is due to the situation within all Romanian Macroregions, with the exception of the Center Region and the South-East Region (the decrease of the areas on which fungicides were applied being of 24.81% and 17.63%, respectively).

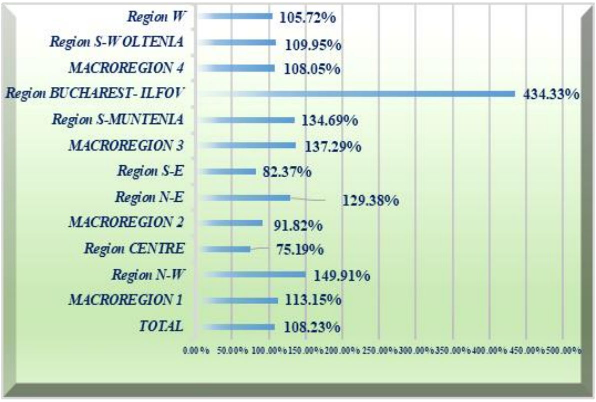

Fig. 18. Dynamics of the average area on which fungicides (ha) were applied in Romania during 2011-2013 and 2015-2017
Source: Own processing [12].

Analyzing the average amount of fungicides used on the land area on which fungicides were applied during 2015-2017, it is noted that, in Romania, it increased by 1.28 kg s.a./ha, respectively 2.22% compared to the period 2011-2013.

Table. 3. The average amount of fungicides used on the land area on which fungicides were applied

No. Crt.	Macroregions and development regions	Average		Dynamics Average 2015/2017 at Average 2011/2013	
		2011-2013	2015-2017		
		Kg. s.a.			
1.	TOTAL	1.04	2.32	+1.28	2.22
2.	MACROREGION 1	2.05	4.19	+2.14	2.05
3.	Region N-W	2.22	3.58	+1.36	1.61
4.	Region CENTRE	1.87	5.46	+3.59	2.92
5.	MACROREGION 2	1.06	2.62	+1.56	2.48
6.	Region N-E	2.18	3.83	+1.65	1.76
7.	Region S-E	0.78	2.14	+1.36	2.76
8.	MACROREGION 3	0.81	1.79	+0.98	2.20
9.	Region S-MUNTENIA	0.82	1.80	+0.98	2.21
10.	Region BUCHAREST-ILFOV	0.31	1.40	+1.09	4.52
11.	MACROREGION 4	0.51	1.05	+0.54	2.07
12.	Region S-W OLTENIA	0.31	1.40	+1.09	4.52
13.	Region W	0.51	1.05	+0.54	2.07

Source: Own processing [12].

There are no regions where this average amount of fungicides used on the surface on which fungicides were applied has registered a decrease, the smallest increase was recorded in Macroregion Four, West Region and the most significant increase was registered in the Bucharest-Ilfov Region, respectively 4.52 kg s.a./ha.

ACKNOWLEDGEMENTS

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CONCLUSIONS

Analyzing the quantitative consumption of pesticides on its components, insecticides, herbicides, fungicides as well as the land areas on which they were applied, in Romania, in the period 2015-2017 compared to the period 2011-2013, we note the following:

Quantitative consumption of insecticides decreased in 2015-2017 by 7.97% compared to the period 2011-2013, a decrease mainly due to the limitation of the use of these products in Macroregion One by 31.57%, Macroregion Two by 38.3% and Macroregion Four by 5.59%. In Macroregion Three the consumption of insecticides increased significantly, by 58.41%, noting the Bucharest-Ilfov Region with an increase of 97.90%.

The areas of land on which insecticides were applied increased in the period 2015-2017 compared to the period 2011-2013 by 10.63% but the quantitative consumption of insecticides in the same period decreased by 7.97%. The increase in the areas on which insecticides were applied is particularly evidenced by the increase in Macroregions

Three by 40.55% and Macroregion Four by 19.18%. In Macroregion One, the areas of land on which insecticides were applied decreased by 13.79% also in Macroregion two, by 24.51%.

- *The average amount of insecticides used on the land area on which insecticides* were applied in the period 2015-2017 decreased by 0.09 kg s,a,/ha, respectively 17.12% compared to the period 2011-2013.
- *Quantitative consumption of herbicides* decreased in the period 2015-2017 by 2.74% compared to the period 2011-2013, a decrease due in particular to the limitation of the use of these products in Macroregion One by 34.35% and Macroregion Four by 1.39%, in Macroregion Three the consumption of herbicides increased significantly, by 30.20%, noting the Bucharest-Ilfov Region with an increase of 783.18% compared to the reference period, 2011-2013, but also to the situation in Macroregion Two, with an increase of 5.82% due to the 12.24% increase in the South-East Region.
- *The land areas on which herbicides were applied* decreased by 1.12% in the period 2015-2017 compared to the period 2011-2013, a decrease due to the situation within Macroregion One, with the North-West Regions (-25.91%) and the Center Region (-21.93%) and in Macroregion Two, with the South-East Region (-16.23%). The South-Muntenia Region registered an increase (+18.94%) as well as the Bucharest-Ilfov Region (+58.76%). A slight increase of these areas can be also noticed in Macroregion Four (+1.05%).
- *The average amount of herbicides used on the area of land on which herbicides were applied* decreased by 0.02 kg s.a./ha, respectively 2% compared to the period 2011-2013, but there are areas (Macroregions Two, Three and Four) where there were recorded increases, the most significant increase being registered in the Bucharest-Ilfov Region (+0.43 kg s.a//ha).
- *The average amount of fungicides* increased by 7.37% in the period 2015-2017 compared to the period 2011-2013, an increase due to the situation within Macroregion Three, South-Muntenia Region (+63.72%), Bucharest-Ilfov Region (significant increase 1831.12%), as well as the North-West Region within Macroregion One (+8.45%). In Macroregion One, the average amount of fungicides decreased (-1.51%) due to the decrease recorded in the Center Region (-13.71%) but also in Macroregion Two (-5.83%) compared to the previous period of analysis.
- *The land areas on which fungicides were applied* increased (+8.23%) in the period 2015-2017 compared to the period 2011-2013, an increase due to the situation within all Romanian Macroregions, except for the Center Region and the South-East Region (-24.81%, respectively -17.63%),
- *The average amount of fungicides used on the land area on which fungicides were applied* increased by 1.28 kg s.a./ha, respectively 2.22% compared to the period 2011-2013, the smallest increase was recorded in Macroregion Four, West Region (+0.54 kg s.a./ha) and the most significant increase was recorded in the Bucharest-Ilfov Region (+4.52 kg s.a./ha).

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THEORETICAL APPROACH WITH REGARD TO THE MAIN BENEFITS OF SHORT SUPPLY CHAINS. FOCUS ON SMALL PRODUCERS AND LOCAL COMMUNITIES

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Abstract

Due to their characteristics, short food supply chains have an increasingly important role to play in local supply networks as a viable and sustainable alternative to conventional agri-food sector supply chains. They are considered innovative while providing many economic, social, environmental, health, and cultural benefits to small producers and, consequently, local communities. Basing on the specific scientific literature, these benefits are briefly presented in this paper. The contribution of short food supply chains to the improvement of food systems has become relevant in the context of sanitary crisis generated by COVID-19. More precisely, even if the global chains managed to overcome this unforeseen shock, the vulnerabilities appeared and were evident. Accordingly, in our opinion, the development philosophy of local agri-economy needs to change: the conventional agriculture has to coexist nearby the alternative agriculture, while not provoking damages each other. The chains interconnecting final producers and consumers have to be integrated into a socio-economic ecosystem with durable and sustainable basis, while the agri-food market needs to adapt to these new requirements.

Key words**:** *short food supply chains, local producers, agri-food sector, benefits*

INTRODUCTION

In recent years, the fact that the sustainability of conventional food chains has become increasingly questionable is highly debated across the literature. In the same time, considering the increased attractiveness of consumers for the short supply chains, as a component part of alternative systems, this type of chains could represent a viable and complementary alternative to the conventional ones. Their popularity tends to simultaneously increase in the case of consumers, producers, and political decision making factors [7]. Having a specificity of innovation, the issue of short supply chains has not been sufficiently explored from socio-economic, environmental protection, and juridical perspectives. Still, in the last years, in the research sphere, substantial efforts were made for integrating them in the local agri-food system, while a large list of projects such as FP7 (FOODLINKS, GLAMUR, SUPURBFOOD and FOODMETRES) and Horizon 2020 (SKIN, FOX, STRENGTH2FOOD, CITIES2030) significantly contributed in this regard.

Short supply chains are connected to circularity and environmental sustainability (transport, production method, greenhouse gases emissions), health, food quality, consumers behaviour, direct relationship between producer-consumer and local economy [21], but these factors could not be generalised for all types of such chains. The economic circularity and the peculiarities related to sustainability depend into a considerable level by the place, type and attitudes of consumers and small local producers that are part of the chain.

MATERIALS AND METHODS

In respect to the methodology, the indirect research method was used, a large variety of articles and studies from the field being investigated. The statistical data can be extracted especially from the individual case studies found in the specific literature, while the majority of their analyses used to contain qualitative data. In the last ten years, different reports and scientific articles appeared as a result of diverse projects implementation, that managed to collect and discuss important quantitative data in regard to functional short supply chains from different member states (or non-members) of European Union.

RESULTS AND DISCUSSIONS

According to the analysed literature, it seems that, till now, the concept of short supply chains does not have an unanimously accepted definition, fact that determines different uncertainties in understanding it. For some of the authors approaching this issue, the short supply chains refer to the different ways of marketing in the case of agri-food products, able to limit the number of links in agri-food circuits and/ or the physical, geographical distance between the actual place of production and the final consumers [23]. In this respect, it must be observed that the decreasing of the number of interagents specific to this type of supply chain is not synonymous with the concept of direct delivery, case in which there is no intermediate [32, 4, 42]. Through its exclusion from the commercial chain, its role and function have to be passed on the producer, that uses different management and marketing strategies (direct sales at the farm gate, along the roads, manufacturer's shop, agri-food market, own online store, specialized online platforms, participation and sale at trade fairs and festivals etc.) or on the final consumer (travel to the farm gate, to the producer's store/ agri-food market, order online).

Regulation no. 1305/2013, focusing on the plan of rural development policy in the period between 2014-2020, explicitly emphasises the implementation measures of organizing the food chain, with attention on the short supply one, defined as follows: a supply chain that implies a limited number of economic agents, being engaged in cooperation, local economic development and close geographical and social relationships between producers, processors and consumers [42].

Accordingly, following Michel-Villarreal et al., starting from the definition of Christopher, the short supply chains are seen as networks of actors that are connected and interdependent each other, that cooperate for controlling, managing and improving the flows of products, services, resources and information, from farm to fork, seeking a reduction in intermediaries and physical distance between producers and final consumers [9, 33]. In the same time, this concept is also used as an umbrella one [20, 29].

The attention on short supply chain increased in the European Commission legislation, considering its important role for achieving the environmental goals. This approach has a relevant effect on reinterpreting the market and the performance standards, taking into consideration the role of member states in defining the flexible rules for the local markets, but also the different interpretation of the principle of free movement of goods, in front of the size of local market [6].

The literature insists on the fact that short supply chains provide economic, social, environmental, cultural, and health benefits to local communities, such as: new opportunities of employment at the local level [35, 5, 7], encouragement of the transfer of know-how and information, agro-biodiversity conservation [12, 7], small farmers stimulation for adopting more eco-friendly production systems [38, 42], increase in the case of producers’ income [34], reduction of economic uncertainties [20], contribution to the support of local economy [16, 39, 7] – sustaining the local services and suppliers through the support given to the small producers' shops and peasant agri-food markets, supporting synergies with other sectors [20], combating the phenomenon of external migration [12] and ageing of population, preservation of cultural heritage, including the promotion of tourism [3] and local gastronomy, improving the population health through a high access to more healthy food [26, 1], improving the social interaction between the small producers and final consumers [17, 40] and cooperation between local producers [8].

Several articles and specialized studies have highlighted the multifunctional and cultural capacity of short supply chains to promote social inclusion, pro-environmental behaviours, health and well-being in urban and rural communities [36, 48, 49, 10, 41]. In the same time, urban agroecology, circular economy and urban metabolism concepts focus on rural-urban food networks, reduction of fuel consumption and carbon emissions [20], on the efficient waste and water management, and also on the establishment of different close links in producer-consumer relationship [14, 45, 47]. Local consumers are looking more and more for nutritious, fresh, tasty, and safe food [24]. The short supply chains could have a significant impact in the consumption of more healthy and sustainable food, in the decrease of food waste, but also some ethical aspects or high knowledge with regard to food and its source [41].

Considering the relationship between producers/ processors and final consumers, three ways of interaction specific to the short supply chain were identified [37, 29, 34]: direct contact („face to face") – direct acquisition from producers, spatial proximity – local production and distribution and spatially extended – consumers detain information with regard to place and process of production.

Referring to this type of relation and basing on the three proximity dimensions, a quite different approach with regard to the definition of the short supply chains concept was proposed by Malak-Rawlikowska et al. [28], as follows: „geographical proximity", expressing the physical logistical distance („food miles") of the product from the place of production to the place of concrete consumption; „social proximity", referring to the close relationship between producer/ processor and final consumer, leading to the direct transfer of information and bidirectional trustfulness and „organisational proximity", that is linked to the number of intermediaries implied in the food supply chain.

Moreover, the short supply chains detain an important role in guaranteeing the quality of the products directly bought from the manufacturer [22] or through the traceability guarantees. Still, the quality of the products is especially conditioned by the origin of a sustainable agriculture specific to the post-productivity [44]. These are perceived as being the most appropriate for the marketing of qualitative agri-food products, especially because their action of promoting sustainability and efficiency [2] and their influence with regard to food waste reducing, a healthier, sustainable and ethical food consumption. Moreover, it was shown that the short supply chains detain more data in respect to the bought products (source, certification, freshness, taste, etc.) [41].

However, more sceptical researchers with regard to the general optimism accompanying the short supply chains, especially from the perspective of environmental protection could be found. This category of researchers consider that these supply chains are more sustainable than the conventional ones, but this aspect is less quantifiable, more empirical research being necessary for exploring the impact of sustainability in the case of different types of short supply chains [15]. Moreover, more recent studies elaborated in the Strength2Food (Horizon 2020) project, using the Life Cycle Assessment (LCA) and evaluating the eco-efficiency indicators, demonstrated that, in average, the conventional (long) supply chains could generate less negative effects on environment than the short ones per kilo from a punctual product (with regard to energy consumption of fossil combustible, pollution, emission of greenhouse gases) [27]. The ample research was elaborated on a sample of 428 short and long food supply chains from six European countries. The results showed that the impact of the distribution process in the case of food on environment is not determined only by the geographical distance among producer and consumer, but also depends on diverse factors, including the infrastructure of supply chain.

The rural sustainable development from the emerging states (including Romania) represents an essential condition for a durable societal development in the context in which an important percentage of total population is still rural (comparatively to developed countries) and, most frequently, much more vulnerable and less resilient. Even though the agriculture from the emerging states seems to follow a favourable trend, unfortunately, this fact does not represent the pillar of improving individual wellbeing of rural population and the eradication of poverty among them. In the mentioned context, a variety of studies from the last period focused on finding different directions of sustainable development, both in the case of agriculture and of the rural space, with its entire complexity. Developing the sustainable agriculture in the case of rural economy implies, among other elements, also the transition from the scale economy to a sustainable local one. It is also reflected in the reconfiguration of food supply chains, determined by diverse socio-economic and environmental peculiarities [13, 18, 11, 30, 19, 43, 46]. The reconfiguration of conventional agricultural system supposes the development of new specific forms totally different to mass production, especially the following: local agri-food systems, short supply chains, rural networks interconnected to the urban ones [19, 31, 37] or, newer, integrated models such as CRFS - City Region Food System [42]. In the same time, the transition to alternative production and supply with local food represents a problem of high complexity (not still totally comprehended), as the conventional production system seems to be more democratic and more accessible for the consumers with different income [25].

Unfortunately, the development of short supply chains depends on some barriers specific to the countries of Eastern Europe (including Romania): low cooperation between producers/ processors, still extremely high percentage of farmers engaged in subsistence or semi subsistence agriculture, out of taxation system, poor specific infrastructure (low number of agri-food markets from both rural and metropolitan areas, specialty stores/ online platforms and food hubs, events and fairs with agri-food/ gastronomical profile), lower entrepreneurial spirit in the agri-food sector, poor digitalization and agri-marketing, unequal access to the small producers/ processors to the European funds ensuring food safety and security, the persistence of black market in the agri-food sector etc. (Fig. 1) [25].

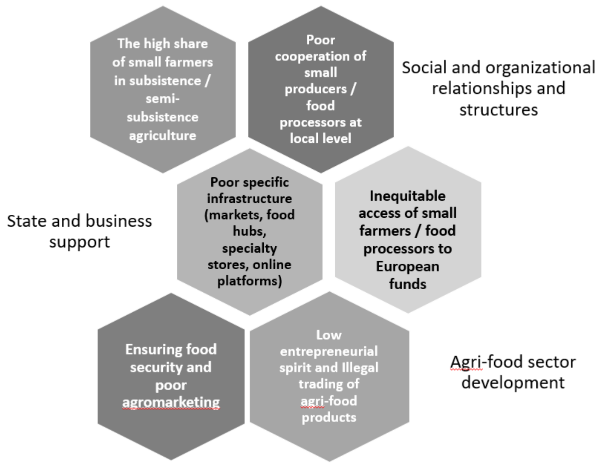

Fig. 1. Barriers in the development of short supply chains
Source: adaptation after [25].

From the perspective of small local producers/ processors, it could be observed that the benefits of short supply chains are mainly economic and social ones, but also environmental and with regard to the conservation of cultural heritage.

Economic benefits

1.Equitable access to local market for the small producers.

2.Access facilitation to a premium category of clients that are open to pay a good price (”dismantling the market”).

3.Market diversification for the local producers.

4.Local producers’ profit maximization – short food supply chains offer the possibility of higher profits through the avoidance of intermediaries, consequently contributing to larger financial gains. This net profit margin, in the classic food supply chain, tends to be divided among all the actors implied in the commercial chain, only a part from the profit being addressed to the producer, the one that remains after the payment of all necessary taxes.

5.Improving the negotiation capacity of farmers in relation to the final consumer.

6.Implying stable and long commercial relationships, based on reciprocal trust.

7.Reducing the geographical distance between the place of production and the one of consumption, the products arriving on the table of final consumer. Short supply chains offer the possibility of considerable reduction in terms of time costs – from the moment of harvest, assortment, temporal storage, delivery and concrete consumption. Most frequently, the short supply chains do not need additional investments in refrigeration equipment or storage spaces nearby the utilization of food additives or preservatives.

8.Often supposing fresh products selling – short supply chains reduce the time necessary to be used by the agri-food products from the moment of harvesting or production to the one of consumption (”from farm to fork”).

9.Significant contribution for diminishing of economic uncertainties in relation to the variations in terms of quantity produced and sold in the case of farmers. Basing on the direct feedback of consumers, local producers are more able to forecast their future crops.

10.Contribution to reduction or even avoidance of some costs in the case of producers. For example, considering the specificity of short supply chains in terms of single interagent, short food supply chains significantly diminish the cost for promotion, although by it the intermediary’s partners engaged in production also benefit.

11.Reducing the costs with packaging and storage of fresh products (fruits, vegetables) or with transport (especially when the intermediary or final consumer travels to the farm gate to pick up the products).

12.Given the higher profit possible to be gained through short supply chains, they could help farmers to become more resilient and to be able to resist in the difficult periods of economic crisis.

13.Using short supply chains, the farmers have access to innovative tools for agri-food marketing (direct delivery to the consumer’s door, food hub, food truck, mobile greengrocers, specialized stores, individual web pages and promotion platforms of local producers, social media, fairs and events with gastronomic profile – brunches, volante markets etc.).

14.Short supply chains utilise a series of extremely diversified marketing channels that address more types of consumers.

15.In the case in which the short supply chains include also an intermediary, the farmers/ processors do not invest time in the commercialization activity, focusing on the productivity one. The interagent, with the additional logistical infrastructure and experience, concentrates on the way of agri-food products from farm to fork for assuring it in the most proper conditions, guarantying the traceability of the products and as fast as possible.

16.Short supply chains implying an intermediary have the role of taking the production outcome from the small farmers/ processors. They do not focus on certain established quantities, but in function of the obtained ones, of the seasonality of crops and other external factors.

17.In some geographical areas, characterized by specific socio-economic peculiarities, the short supply chains could assure the access of producers on HoReCa.

18.Other real advantage for the economic environment is constituted by the fact that the financial personal economies are invested in the local economy, facilitating, in this way, the development of a favourable local entrepreneurial context. The short supply chains determine to a certain degree the retention of financial capital at the level of local communities, consequently, increasing the local public budget.

19.Through their activities, the local producers directly and indirectly contribute to the development of other economic operators’ activities from different distinct domains.

20.Improving the value distribution across the supply chain, the farmers benefit by a higher added value.

21.Offering the possibility of strategical reorientation of small farmers.

22.Short supply chains could contribute to the increase of the European Fund level of absorption in the case of local producers (individually or associated). These detain the premises for being able to be promoted and developed aided by the financial support offered through AM-PNDR 2021-2027 (National Strategical Plan), as also happened in PNDR 2014-2020 (16.4 and 16.4a Sub-measures).

Social benefits

23.Through the support offered to small local producers with regard to the marketing of their offer, the producers directly and indirectly benefit by the partial reinvestment of the income collected by the local authorities from the merchants from the local level in local infrastructure (road networks, public transport, educational institutions, sanitary units, green spaces etc.).

24.Through the support offered for productive and marketing activities, the local producers from short supply chains encourage the retention of human capital on the local level, the seasonal migration risk of the internal and external labour force being diminished.

25.Maintaining the social relation – social interaction between producers and consumers. The short supply chains functioning on the local level offers the producers and consumers the possibility to have a more direct communication and interaction, contributing to the final consumer' loyalty and trust consolidation.

26.Increasing the belonging feeling to a community in which the healthy food represents the focus, in which the producers could be able to share their experience from the local level through the know-how transfer and information (agricultural practices, production, marketing, recipes).

27.Different types of short supply chains (CSA – Community Supported Agriculture, GYO – Grow Your Own) facilitate and encourage the collaboration between producers and consumers, mutual aid or even risk or uncertainties sharing (solidarity, active participation).

28.Encouraging the transfer of know-how in the producer-consumer chain.

29.Contributing to the increase of local producers' self-esteem (observing that their work is appreciated), also considering their income increase.

30.Assuring to the small producers and to the finale consumers (categories usually perceived as being passive) an active role in the agri-food system.

31.Access to direct information from the final consumers – recommendations, positive/ negative feedback from the customers.

32.Favouring and creating an appropriate context for association and cooperation with other local producers and launching of umbrella brands.

Environmental benefits

33.Encouraging small farmers to adopt more sustainable and eco-friendly systems of production, specific to circular economy.

34.Contributing to the improvement of traditional agriculture practices and promotion of local agricultural systems with sustainable impact on the environment.

35.Reducing the producers' transport spending, especially in the case of goods marketing activity (positive impact on biodiversity).

36.Contributing to the local agri-biodiversity protection and conservation or even improvement of productive capacity (top rating notes) of agricultural land.

37.Encouraging the utilization of recycled or biodegradable packaging in distribution process.

Health related benefits

38.Short supply chains and local producers indirectly contribute to the improvement of consumers' state of health (local products, some of them ecologically certified, are included into the category of healthy food). This aspect offers a positive image to the producers.

Benefits of cultural heritage conservation

39.Conservation and promotion of local cultural heritage (local products, traditional/

local production practices, local habits and traditions, traditional gastronomy, local varieties).

CONCLUSIONS

On the global level, during the pandemic crisis of Covid-19, numerous initiatives for promoting the local production and development of short supply chains appeared, especially considering the higher and higher interest of consumers for them. Across the study, the necessity of initiation and improvement of local agri-food markets was emphasized, but also of promoting online shopping for improving the producer-consumer relation. In addition, the necessity of offering new storage facilities at the local level for easing the consumers' access to the food stock in case of urgency was underlined.

In the actual context, especially the conventional model of agricultural production does not contribute for attaining the sustainable goals. Consequently, there is a stringent need in the case of alternative agricultural systems to be created supposing, among other issues, the focus on local/ regional value chains development. The short supply chains seem to be better connected to: circularity and environmental sustainability (transport, method of production, emissions of greenhouse gases), the consumers' health and behaviour, the food quality, the direct relation between producer-consumer and local economy. Unfortunately, it is recommended the avoidance of establishing generalities on all types of short supply chains.

Therefore, although the revised literature tends to agree with the economic and social benefits of short supply chains, the impact on environment and sustainability usually implies more heterogeneous results, while health and nutrition benefits seem to be still underexploited.

The Covid-19 crisis made the 2020 year to be a special one with regard to the food sector, a trend of Romanian consumers in respect to the reconsideration of the manner in which food is purchased being remarked. This fact determined a reorientation towards a healthier diet based on food more frequently purchased from local sources through short supply chains. The pandemic boosted the development of this type of supply chain, while the small farmers adopting digital technology tended to be more privileged compared to the competitors. Including hypermarkets/ supermarkets, a need to adapt to the local market and to reconnect consumers with local producers appeared to be present, the share of locally sourced products on the shelves of large retailers being higher and higher.

The local producers' resilience, implying hardiness, adaptability, and transformability, depends into a high proportion on the development of short supply chains and on their permanent adaptability to the requirements of local consumers. Moreover, different types of such chains (for example, the direct deliveries from producers to final consumers) have appropriately adapted to the actual context generated by Covid-19, when much restriction was imposed with regard to persons' mobility, being perceived by some of final consumers as efficient solutions of supply during the state of emergency.

Thus, the contribution of short supply chains to the resilience of food systems has become relevant in the context of Covid-19 pandemic: even though the global chains passed over this unforeseen shock, the vulnerabilities were evident (for example, the high dependency of logistical infrastructure and seasonal labour force from agriculture, among others).

In our opinion, the philosophy of local agri-economy development needs to change: conventional agriculture and the alternative one have to coexist, without negatively affecting each other. The switches able to be done have to adapt to the local reality, to the needs of local producers and to the Covid-19 crisis that increased the level of poverty and emphasized the importance of local economy and of a local, diversified and resilient food system. The chains that interconnect the producers and final consumers have to be integrated in a socio-economic ecosystem, with sustainable and durable basis, while the local agri-food market is in need of adapting to new requirements.

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ORGANIZATION AND PERFORMANCE OF THE AGRICULTURAL LAND MARKET IN UKRAINE

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Abstract

This article outlines the main issues of the creation and functioning of an accessible land market nowadays. One has shown the background of pan-European land management experience. One has proved that comparing the experience of carrying out land reform is a useful and effective tool for the correct interpretation of Ukrainian ideas if one does not take into accounts the characteristics and features of different states. Considering the essence of land resources management, the concept of "land turnover" is of vital importance. The principal conditions for the formation and functioning of agricultural land turnover have been established. One has substantiated the necessity of complex management of land resources, which presupposes the complete determination of directed efforts, the correct choice of ownership of land plots, as well as the proper foundation of its use.

Key words: *land, land turnover, land resources, management, moratorium, market*

INTRODUCTION

During the period of world existence, the land has been, is and will be the main mean for its existence and production, a prime source of wealth and undoubtedly a major factor in territory investment attractiveness that ranks the highest position in world politics and in economic prosperity scheme of a country. The year of 1991 was the beginning of land relations the reform in Ukraine. There were radical changes of land ownership forms, as well as a fee was set for the use and production of land plots created to regulate the reliability of legal regulation of land relations due to the de-monopolization of territories. An environment of organization of a completely new fragment of market relations - the agricultural land market was created due to these conditions. However, one should note that our state is still at the stage of realizing the enormous importance and value of land and finding the necessary means of its rational use.

Nowadays the lifting of the moratorium and the establishment of a free agricultural land market has become the most debatable and at the same time a priority issue, as all farmers, politicians, economists and other specialists related to the agricultural sector are interested in this issue.

Without the introduction of official land turnover, one cannot speak of the completion of land transformations, which will be similar to the European experience.

Our modern active use of land resources has such dangerous consequence as the fact that degradation processes of agricultural land potential can lead to irreversible things [8]. Therefore, there is a need to introduce an appropriate legal regime for the use and protection of agricultural lands, increase their fertility and also limit the cases of such land withdrawal from further agricultural land turnover.

In this context, the purpose of the paper is to analyze the European experience in the regulation of land relations, as well as to determine the main tasks management the landed resources during the formation of the circulation of agricultural land in Ukraine.

MATERIALS AND METHODS

We have used a number of special and general theoretical methods of research to achieve our goal and to solve the set tasks in scientific research. Methods of induction and deduction, analysis and synthesis have been applied to show regularities, specifics of formation, functioning of agricultural land market; abstract and logical methods – to determine the further development of the object of study; system and diagnostic analysis – to study the current state of the promotion of the research phenomenon and to identify the main problems in the process; comparative analysis – to identify temporal and regional differences in the research object. One has used graphic, table and cartographic methods to visualize the results. The information base of the researches is the normative and legislative documents of Ukraine, data from official sites of the State Statistics Service of Ukraine, the State Service of Ukraine for Geodesy, Cartography and Cadastre, reports of the regional departments of the State Service of Ukraine for Geodesy, Cartography and Cadastre.

A. Martyn (2011), A. Tretiak (2006), H. Cherevko (2009), O. Litoshenko (2015), P. Sabluk (1999), M. Zos-Kior (2012a), and others [4, 11, 1, 3, 6, 13] studied the problem of rational use of land resources, taking into account the further improvement of existing relations. In addition, one should consider that today there is no clear legislative framework and regulated state policy for the establishment of free turnover of agricultural lands.

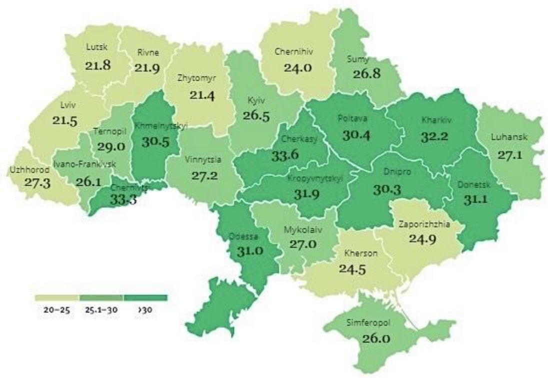
RESULTS AND DISCUSSIONS

Due to the present conditions, the land resources market is of great value in the agrarian sphere, because it is a space for commodity exchange, in which land plays the role of commodity [3]. We can control the redistribution of land and the transfer of ownership of land from one owner to the other thanks to the land market. According to A. Tretiak's arguments, the land market is an instrument and at the same time a guarantee of the fulfillment of the main constitutional rights of legal entities and citizens, which makes it possible to draw up all documents for land plots and ultimately have them privately owned [11]; the right to own, use and dispose of land plots freely (without causing damage to the natural environment and without at the same time disrupting other people's freedoms and legitimate interests); the main mean of land reform; the key component for reform in general [6].

Considering the logical completion of land reform one should get necessary and at the same time reliable information to understand its scope and to provoke threats that may arise in the course of obtaining the status of agricultural land. A. Tretiak extends the notion of land resources management in a market environment and draws attention the fact that they are processes of the registration and at the same time providing information on land ownership, land cost and use of the territories, and appropriate resources [10]. However, in the early stages of gathering and grouping information, there are obstacles caused by the lack of a single, comprehensive database on accounting for available land plots. A rational information system is missing and creates the conditions for conflict situations related to the purchase or sale of land or its lease, which in turn can be aggravated during the sale of agricultural land as a commodity. Taking into account the situation of completion of land reform, the beginning of which began in 1991, the main issue that attracts the most attention and is increasingly discussed is the formation of free circulation of land [4]. However, regulating the land market in Ukraine is impossible due to the lack of effective instruments, resulting in a moratorium (ban on alienation of agricultural land as a result of their sale), which continues on a regular basis, suspending the creation of free circulation of land [3].

Under the current conditions, it is necessary to distinguish the main factors that suspend the process of formation and operation of the land market due to carrying out of land reform. They are:
-shortage of funds for land purchase;
-fear of competition with large agricultural holdings;
-corruption in the sphere of land relations;
-lack of clear legislative rules and regulations;
-a complete distrust of public authorities;
-the threat of speculation over land territories;
-fear of changing the purpose of agricultural land and their rapid urbanization, which will lead to higher prices for agricultural products;
-shadow and illegal use of land territories;
-purchase of agricultural land by foreigners, etc.

Creating and putting into operation the free agricultural land turnover, as well as in the future its rational regulation by the state, it is possible to form the basis for solving a number of significant problems:
1.Implementation of the full right of private ownership of agricultural land by the subjects of land relations;
2.Determination of fair market value of agricultural lands as a result of their turnover;
3.Effective redistribution of agricultural land use;
4.Citizens' rapid access to the information and accounting database of agricultural lands;
5.Creating new jobs.



Map 1. Amount of regulatory monetary valuation per 1 hectare of land in the regions of Ukraine, thousand UAH/ha
Source: the authors' achievement according to [7].

Taking into account the data of the State Service of Ukraine for Geodesy, Cartography and Cadastre, the regulatory monetary value of one hectare of arable land in the regions of the country is on average 27.5 thousand UAH, which is about 840 Euros as of January 1, 2019 (Map 1).

The cheapest arable land is estimated in Zhytomyr region – 21.4 thousand UAH/ha, which is about 667 EUR, and the most expensive one is in Cherkasy region – 33.6 thousand UAH/ha (about 1,048 EUR).

Large tracts of agricultural lands are in long-term or short-term lease. Taking into consideration the information on certain EU countries, we can make conclusions that the cheapest lease of agricultural land is observed in Latvia – 46 Euros/ha, while the most expensive one is in the Netherlands – 791 Euros/ha. One should note that there is an even more critical situation since in certain regions the value of agricultural land lease reaches 41 Euros/ha (Fig. 1).

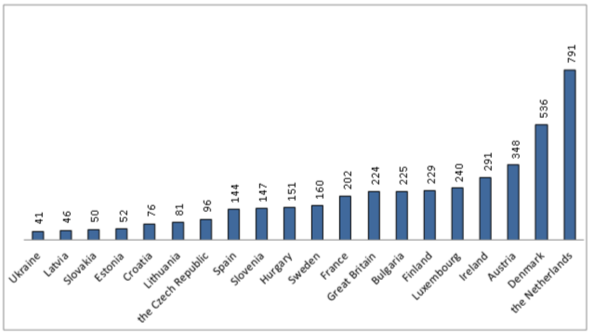


Fig. 1. An average lease payment for agricultural land in Ukraine and some EU countries for the year of 2017, Euro/ha
Source: Authors' achievement according to data [9].

Analyzing the average value of arable land in the European Union countries (Figure 2), we can conclude that one is ready to pay about 63 thousand Euros for one hectare of arable land in the Netherlands, which is considered to be the highest indicator and, moreover, not competitive one with other countries.

The lowest price indicators are set in Romania, where hectare of arable land is estimated at almost 2,000 Euros [9].

Over the last 5 years, the cost price of arable land increased in all EU member states except Greece. The value increased much more in the

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Czech Republic and Lithuania (in three times), Estonia (in 2.5 times), and Hungary (in two times) in the above period [9].

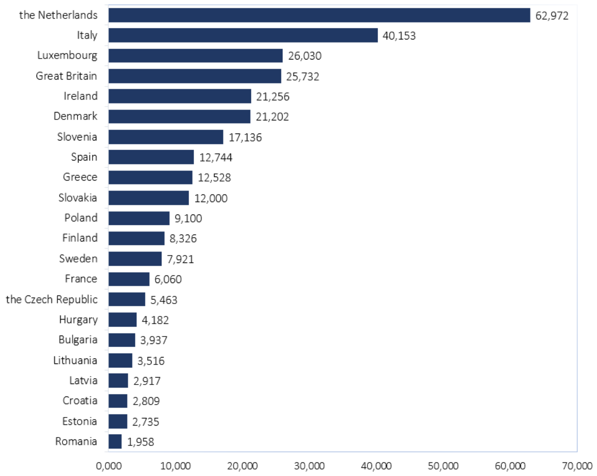

Fig. 2. The value of arable land in certain countries of the European Union for the year of 2017, Euro/ha
Source: the authors' achievement according to [9].

In addition, the most expensive tracts of arable land were found in the region of Italian Liguria – about 108 thousand Euros/ha, and the cheapest ones –in the south-western part of Bulgaria – almost 1.2 thousand Euros/ha (Table 1).

Table 1. The range of the value of arable land within the regions of certain EU countries, Euro/ha

EU countries	min	max
Italy	16,498	108,611
Spain	6,237	94,213
the Netherlands	49,250	77,834
Greece	5,744	55,515
Slovakia	14,700	49,550
Slovenia	14,220	32,982
Denmark	18,412	30,871
Great Britain	17,152	28,837
Luxembourg	26,030	26,030
Ireland	17,998	22,844
Sweden	1,637	15,958
France	2,600	12,680
Poland	5,324	12,396
Finland	4,980	11,065
Bulgaria	1,166	6,008
the Czech Republic	4,384	5,630
Hurgary	2,786	4,856
Croatia	2,739	4,651
Lithuania	3,516	3,516
Latvia	2,917	2,917
Estonia	2,735	2,735
Romania	1,863	2,059

Source: It is done according to data [9].

M. Zos-Kior assures that a rational and successful land resources management scheme based on foreign experience, is a guarantee and protection of land ownership, supports taxation, provides credit guarantees, expands land markets, promotes land reform, monitoring, land organization, and improves infrastructure growth [13]. The European experience in regulating land relations is based on the following basic principles:
a) the regulation of land resources should be carried out on a regulatory and legal basis with appropriate financial support;
b) the law must include land values, ownership, legally established forms of ownership and use of territories, major restrictions and encumbrances subject to mandatory registration;
c) the regulation of land relations should be transparent, free and accessible to all members of land relations;
d) the success, completeness and transparency of the land management system should be regularly controlled;
e) data should be aggregated in a single institution for their accuracy and timeliness in order to improve the basic information of land ownership, its value and use [14].
Considering modern conditions, the issue of the moratorium is urgent and is actively discussed both among scientists and in society. Prohibition of sale of agricultural land does not comply with Articles 14 and 22 of the Constitution of Ukraine, as it contradicts the essence of ownership of land, limiting the owner's right not only to legally dispose of their own territories but also to get economic profit [2].
The termination of the moratorium on the sale of agricultural land will give new prospects, first and foremost, for the poverty-stricken population, who will be able to sell their own shares or deliver decent rental value for them; improve their positions in the process of negotiations with large agricultural holdings, with regard to the leasing of their land; exchange of plots for better location, and reduction of parceling (splitting of land into small plots), which will facilitate the consolidation of such plots; obtain bank

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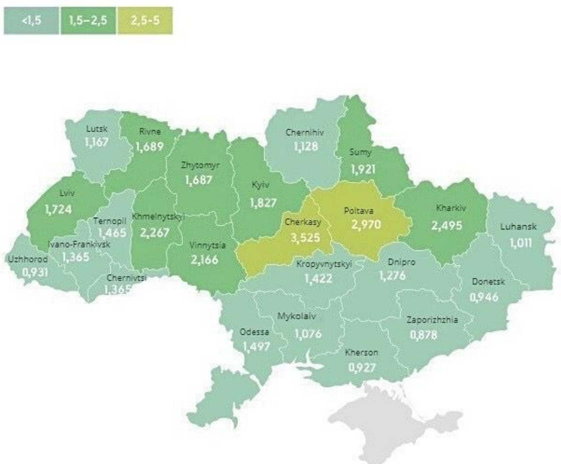
financial support for the development of farming and small business at the expense of pledge of land; attraction of investments; realization of legal rights regarding the disposal of property. A resource owner with a well-defined ownership strives to use the resources efficiently and rationally, because a decrease in efficiency means a loss of income [4].

Considering B. Paskhavel's opinion, the owner of agricultural lands can get a market result due to the use:

- during the land lease;
- in commodity agricultural production;
- at sale or pledge.

Due to these directions of obtaining the market effect, it encourages the development of three basic patterns of the land market [5]. However, this option does not satisfy farmers in the context of the restructuring of the food market. As the difference between the purchases value for an agricultural commodity and the cost of selling some types of products is increased ten times. To add more, one should take into account the poorly developed infrastructure of the agrarian market, and such an intermediate link as mediation. Therefore, you should never rely on the experience of foreign countries and give the state a leading role in regulating land turnover [2].



Map 2. Amount of the average rent charge for shares in regions of Ukraine for the year of 2018, UAH/ha
Source: It is done by the authors according to [7].

The average yearly rent charge was 1,613.4 UAH/ha according to the State Service of Ukraine for Geodesy, Cartography and Cadastre in all regions of Ukraine in 2018. At the same time, one has registered the highest rates of such payment in Cherkasy (3,525 UAH/ha), Poltava (2,970 UAH/ha) and Kharkiv (2,495 UAH/ha) regions. The least valuable use of land was in the Transcarpathian (931 UAH/ha), Zaporizhzhia (878 UAH/ha) and Kherson (927 UAH/ha) regions.

Today, market circulation must ensure the proper use of the land fund and the creation of efficient land use. In order to achieve this goal, one should involve the authorities to regulate land resources use not only at the legislative level but also as active landowners, who motivate the market relations and its corresponding participants [10]. Land transformations should be carried out in a qualified and informed way on the basis of a grounded scientific justification. The processes of lease, sale, pledge, a gift should be carried out on the basis of revised and improved appropriate institutional support (land legislation, data of the state land cadastre, information on registration of land ownership and land valuation); obtaining credit and unimpeded access to them; adjusting the structure of taxation created on the resource and natural potential [12]. The current reality of the establishment of the agricultural land market in our country depends not on the decision of the Supreme Court of Ukraine, but on the level of readiness of the country and the people for this act [1].

CONCLUSIONS

Considering the above-mentioned information, we can conclude that the existence of a large set of organizational, legal, financial and other problems are hindrances for the future formation and functioning of agricultural lands. The moratorium on land sales should be abolished only when the final formation of the legal and regulatory framework for the regulation of agricultural land turnover is completed. The prosperity of the shadow market of land territories with the existence of a legislative

framework, which in turn rejects the agricultural land market, creates dissatisfaction of the population with state political activity in the land sphere. Observing these events, the primary tasks in creating a land market are the following ones:
- the creation of a single database of land parcels (shares) that were in ownership as a result of the denationalization;
- transfer of information from paper to the electronic database of real property database, the ownership of which is registered until 2003;
- approving the right of free sale and sale of agricultural land, without first changing its intended purpose at the legislative level;
- improving the quality of providing and obtaining administrative services in land relations sphere;
- the creation of conditions for the formation of the market infrastructure of land, as well as the encouragement of owners and users of plots by obtaining credit preferences;
- the creation of equal conditions for access to resources for both powerful agricultural institutions and small and medium-sized farmers.

The establishment and functioning of agricultural land turnover require the creation of detailed and clear regulation and the existence of a successful, efficient and effective legal background.

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ANALYSIS OF PROFITABILITY IN THE RESEARCH OF ECONOMICAL ENTERPRISES PERFORMANCES

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Abstract

Investigations results about agricultural enterprises performances analysis within profitability rates in dynamic and factorial aspects are presented in this article. Quantitative influence on modification of consumed resources profitability rate of sold agricultural products structure, unit cost, average selling price was calculated. Results of factorial analysis show decisive influence of cost per unit of agricultural goods on the decreasing of return rate of consumed resources. This negative influence is explained by excessive growth of prices on fuel, fertilizers and pesticides.

Key words: *analysis, financial accountant decisions, performance, profitability ratios*

INTRODUCTION

The concept of economical financial performance has different senses, like growth, profitability, yield rate, efficiency rates in speciality textbooks.
The previous researches referred to the analysis of profit sensitivity based on effects measurement and also to the impact of cost structure on the profitability of agricultural products [9, 10].
This time, it is approached the performance of the enterprise based on profitability. Profitability is a synthetic form of expression of the economic and financial performance of an enterprise, taking into account the results of the use of factors of production, patrimony and available capital. The measurement and analysis of performance is carried out on the basis of the main rates of return: the rate of return of the resources consumed and used, the rate of commercial profitability, the rate of return on assets, the rate of return on equity. At the same time, these rates mirror multiple sides of the enterprise's activity on the basis of which the financial-accounting decisions are adopted, regarding the optimization of expenses, the formation of prices, the attraction of credits etc [1].
Given that profitability rates are among the most synthetic efficiency indicators, they allow the discovery of the strengths and weaknesses of the activity carried out and the adoption of measures to improve the company's performance in the future [2].

MATERIALS AND METHODS

The informational basis of the investigation is the following information sources on all agricultural enterprises in the Center Region of the Republic of Moldova:
-Annual financial ratios;
-Annual statistical research 21 - Sale "Sale of agricultural production".
The estimation of the economic and financial performances was performed using traditional methods of economic analysis such as: rate method, comparison, decomposition, recalculation method, chain substitutions.

RESULTS AND DISCUSSIONS

The study on the evolution of profitability rates in the agricultural enterprises from the Centre region has shown us an unstable character (Table 1). The calculations made in Table 1 demonstrates that the lowest level of rates of return was recorded in 2020. The low level of profitability rates is also attested in 2012 and 2019.

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These data reflect the unfavourable influence of climatic factors that determine the risk and uncertainty in obtaining the expected financial results by agricultural entities.

Table 1. Evolution of profitability rates in agricultural enterprises in the Central Region of the Republic of Moldova (%)

Rate designation	Year								
	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Rate of return of resources consumed and used	18.51	22.17	26.52	24.05	25.89	30.96	24.58	18.33	16.22
2. Rate of return on trade	15.62	18.15	20.96	19.39	20.56	23.64	18.18	15.21	13.33
3. Rate of return on assets	2.85	5.02	6.38	3.19	4.91	7.76	3.84	3.17	2.05
4. Rate of return on equity	2.89	8.97	11.37	5.31	13.4	21.81	12.38	7.46	5.17

Source: Author's calculations based on data of the National Bureau of Statistics of the Republic of Moldova.

At the same time, the calculations presented in Table 1 shows that in the favorable years after climatic conditions such as 2014, 2016 and 2017, the highest rates of return were obtained. For example, in 2017, for each leu of the resources consumed and used, a gross profit of 30.96 bani was obtained or 6.91 bani more than in 2015. In 2017 there is an increase in the profitability of assets and equity compared to 2015, respectively, by 6.57 and 19.5 percentage points.

In the average for 2015-2017, there was a tendency to increase all rates of return compared to the average of 2012-2014, which is due to the increase of gross profit by 1.2 times, profit up to taxation of 1.3 times and net profit of 1.7 times.

From 2018 to 2020 we see a significant decrease in all the rates of return. In our opinion, the decrease in profitability is a result of the unfavorable influence of climatic factors, the pandemic crisis and the increase in prices of diesel fuel, fertilizers and pesticides.

The results obtained (Table 1) demonstrate that there is a connection between the rates of return given that the increase or decrease in the rate of return of the resources consumed and used implies the same tendencies in the modification of the other rates. Thus, in the period of 2015-2017, the rate of return of the resources consumed and used constituted 27.01%, and in the average 2018-2020 this rate decreased to 19.71% or by 7.3 percentage points. It is also established the deminuation of the rate of return on assets by 3.05 percentage points and of the return on equity capital by 5.17 percentage points.

The existence of the nominated connection allowed us to highlight from the variety of profitability rates the most significant that reflects the efficiency of the operational activity of the agricultural enterprises, this being the rate of profitability of the resources consumed and used. The significance of this rate, in my opinion, can be explained by the informational capacity that ensures highlighting the efficiency of the investments made in the basic activity of the enterprise, because more than 95% of the effect obtained and the effort made come from the sale of agricultural products [3].

The validity of the rates as instruments for assessing the economic and financial performances is identified by comparing the effective level with the established norm.

In the specialized literature there are opinions according to which the normative value of the rate of return of the consumed and used resources must be ≥25.0% [4].

The results of the comparative analysis of this rate (Figure 1) show that from the last nine years to six (2012, 2013, 2015, 2018, 2019, 2020) the actual values were lower than the norm established on average by 4.4 percentage points.

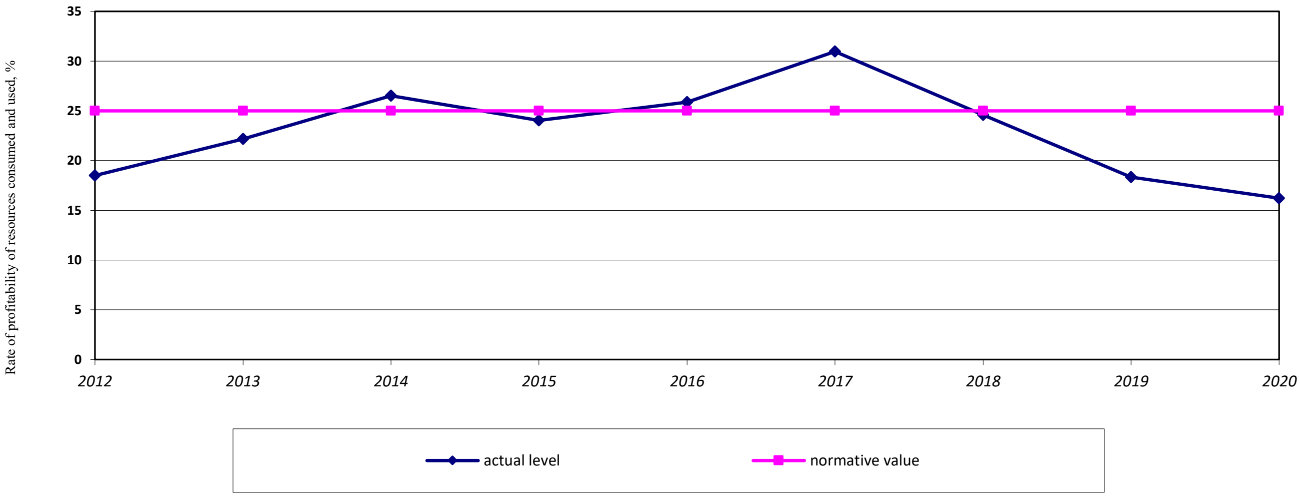

Fig. 1. Dynamics of the rate of profitability of the resources consumed and used in the agricultural enterprises of the Central Region of the Republic of Moldova
Source: Elaborated by the author on the basis of the information in Table 1.

At the same time, there is a considerable exceeding of the rate of return of the resources consumed and used compared to the norm in 2014 - by 1.52 percentage points, and in 2017 almost by 6.0 percentage points. The changes observed in the evolution of the rate of return of the resources consumed and used require the identification of influence factors. The factorial analysis model reflecting the correlation between the rate of return of the resources consumed with the evolution of costs, the increase in prices and the structure of sales can be presented:

$$\boldsymbol{R_{rc}} = \frac{\sum \boldsymbol{qiPi} - \sum \boldsymbol{qiCi}}{\sum \boldsymbol{qiCi}} \times \mathbf{100} \qquad (1)$$

According to this model (formula 1) the factors that influence the rate of return of the resources consumed and used (costs) are:
-change in the structure and assortment of agricultural products sold (Δq);
-change in unit costs for products sold (Δc)
-change in the selling prices of the products sold (Δp).
The methodology of factorial analysis consists in quantifying the influence of factors after the following calculation relationships:

1.1 $$\Delta R^{q}_{rc} = \left[\left(\frac{\sum qi_{(1)}Pi_{(0)} - \sum qi_{(1)}Ci_{(0)}}{\sum qi_{(1)}Ci_{(0)}}\right) - \left(\frac{\sum qi_{(0)}Pi_{(0)} - \sum qi_{(0)}Ci_{(0)}}{\sum qi_{(0)}Ci_{(0)}}\right)\right]$$

1.2 $$\Delta R^{c}_{rc} = \left[\left(\frac{\sum qi_{(1)}Pi_{(0)} - \sum qi_{(1)}Ci_{(1)}}{\sum qi_{(1)}Ci_{(1)}}\right) - \left(\frac{\sum qi_{(1)}Pi_{(0)} - \sum qi_{(1)}Ci_{(0)}}{\sum qi_{(1)}Ci_{(0)}}\right)\right]$$

1.3 $$\Delta R^{p}_{rc} = \left[\left(\frac{\sum qi_{(1)}Pi_{(1)} - \sum qi_{(1)}Ci_{(1)}}{\sum qi_{(1)}Ci_{(1)}}\right) - \left(\frac{\sum qi_{(1)}Pi_{(0)} - \sum qi_{(1)}Ci_{(1)}}{\sum qi_{(1)}Ci_{(1)}}\right)\right]$$

From the factorial model (formula 1) we can see that the costs of the products sold exert on the rate of profitability a double action, influencing differently the size of the numerator and the denominator of the formula. If the growth rate of unit costs is exceeded on that of selling prices, the denominator, i.e. the profit will be reduced and the denominator representing the cost of sales will increase, which will lead to the negative influence of this factor being decisive on the R_{rc}.

Table 2. Information base for carrying out the factorial analysis of the rate of return of the resources consumed and used in agricultural enterprises in the central region

Indicator	In average 2015-2017	In average 2018-2020		Absolute deviation, (±)
		Recalculated	Actually	
1. Sales revenue, mil. lei	3,362.4	3,330.6	4,172.7	+810.3
2. Cost of sales, mil. lei	2,647.3	2,808.8	3,485.6	+838.3
3. Gross profit (gross loss), mil. Lei	715.1	521.8	687.1	-28.0
4. Rate of return of resources consumed and used, %	27.01	18.58	19.71	-7.3

Source: Author's calculations based on data of the National Bureau of Statistics of the Republic of Moldova.

Using the data from Table 2 we will calculate the influence of these factors when changing the rate of return of the resources consumed and used in the average 2018-2020 compared to 2015-2017. The data presented in Table 2 demonstrate that in the period 2018-2020 the rate of profitability of the resources consumed and used recorded a decrease compared to the average of 2015-2017 by 7.3 p.p. This dynamic is a result of the decrease of the gross profit by MDL 28 million. lei against the background of the increase of the cost of sales by 838.3 mil. lei or with 31.7%.

Table 3 presents present the calculation of the influence of factors when changing the rate of profitability of the resources consumed and used according to the formulas 1.1., 1.2., and 1.3.

Table 3. Calculation of the influence of factors when changing the rate of return of resources consumed and used in agricultural enterprises in the Central region

Name of the factors	Calculation of the influence of factors	Result of influence ± percentage points
1. Change in the structure and assortment of agricultural products sold	$\left[\left(\frac{521.8}{2,808.8}\times 100\right)-\left(\frac{715.1}{2,647.3}\times 100\right)\right]$	-8.43
2. Change in unit costs for products sold	$\left[\left(\frac{-155.0}{3,485.6}\times 100\right)-\left(\frac{521.8}{2,808.8}\times 100\right)\right]$	-23.03
3. Change in selling prices of marketed products	$\left[\left(\frac{687.1}{3,485.6}\times 100\right)-\left(\frac{-155.0}{3,485.6}\times 100\right)\right]$	+24.16
Total	X	-7.3

Source: Author's calculations based on data of the Table 2.

From the calculations made in Table 3 it results that the reduction of the profitability of the resources consumed and used in the agricultural enterprises was determined by the unfavorable influence of the following factors:

(1)Changes in the sales structure caused the rate of return to decrease by 8.43 percentage points. Due to the reduction of the share of products with a higher profitability compared to the average of the period 2018-2020 such as: fruits, grapes, vegetables, sunflower. During this period, an unfavorable influence exerted a harsher competition for these products on the European Union market, as well as the pandemic crisis.

(2)The upward dynamics of unit costs (which increased in 2018-2020 by 31.7% compared to the previous period) negatively influenced the decrease of the profitability rate by 23.03 percentage points. This result is largely due to the increase in the prices of diesel fuel, fertilizers and pesticides. At the same time, the rise of prices may be the consequence of inflation. Thus, comparing the intensities of the influence of unit costs and the selling prices of agricultural products, we note that these factors have approximately the same values (only opposite directions), which determines that inflation is an important cause in the increase in unit costs.

The results of the factorial analysis show that in the reference period the increase of selling prices for agricultural products influenced the increase of the rate of profitability by 24.16 percentage points.

Thus, this factor completely exceeded the negative influence of unit costs (-23.03 p.p.), but it was not enough to exceed the decrease in the rate of profitability, which requires increasing the competitiveness of agricultural products to be promoted on new markets (for example, apples in the United Arab Emirates).

The analysis carried out leads decision-makers to measures regarding the causes with unfavourable impact on the dynamics of the rate of return on the resources consumed respectively to the influence of the increase in unit costs. It is known that it is not the reduction of costs that represents a lever to increase the rate of profitability, but the negotiation of prices for the purchased resources, their efficient management, the observance of production technologies and the motivation of employees [5].

As it was previously mentioned, the evolutionary nature of the rate of return on consumed and used resources can also modify the other rates, thus demonstrating that the efficiency of the basic activity of agricultural enterprises determines the size of the rates of return on assets and equity.

The rate of return on assets as a performance indicator expresses the managerial ability to obtain profit for one leu of available assets [8].

In the agricultural enterprises of the Central Region, the return on assets can be analyzed according to the Du Pont system and decomposed by the influencing factors according to the model:

$$R_a = \frac{Pimp}{TA} \times 100 = \frac{Pimp}{TA} \times \frac{VV}{VV} = \frac{VV}{TA} \times \frac{Pimp}{VV} \quad (2)$$

From the obtained model we observe that the factors that influence the change in the return on assets are:

-The number of asset rotations ($\Delta\frac{VV}{TA}$);

-Sales profitability ($\Delta\frac{Pimp}{VV}$).

In this context, we conclude that measures aimed at increasing the profitability of assets are necessary:

-Efficient management of the company's assets, so that for every lei of total assets, the entity must obtain 2 lei of sales revenue;

-Increasing the profitability of sales, which must be at least 10%.

At the same time, we would like to mention that there is an inverse correlation between these two factors of asset profitability. This is manifested by the fact that the increase in the number of asset rotations implies a reduction in sales profitability (by reducing sales prices), while an increase in sales profitability (by increasing sales prices) causes a decrease in the number of asset rotations (by reducing sales volume) [6].

The management option for improving performance through one of these two variables must take into account the nature of the company's activity and its activity sector. Thus, notable differences in the economic profitability of different companies can appear due to the acceleration of the turnover of assets or through the increase of the commercial margin [7].

In Figure 2 we present the possible variants of the profitability of the assets depending on the rotation of the patrimony ($\Delta\frac{VV}{TA}$) and sales profitability ($\Delta\frac{Pimp}{VV}$). From the graphic presentation, it follows that depending on the nature of the activity, significant differences may appear between companies regarding the rates of return on assets.

Thus, under the conditions of the lowest turnover of assets (0.25 - 1.0) against the background of the decrease in sales profitability from 15.0% to 10.5%, the return on assets registers an increase from 3.75% to 10.5%.

Accelerating asset turnover from 1.25 to 1.5 along with reducing sales profitability from 9.0% to 7.5% provides a maximum ROA of 11.25%.

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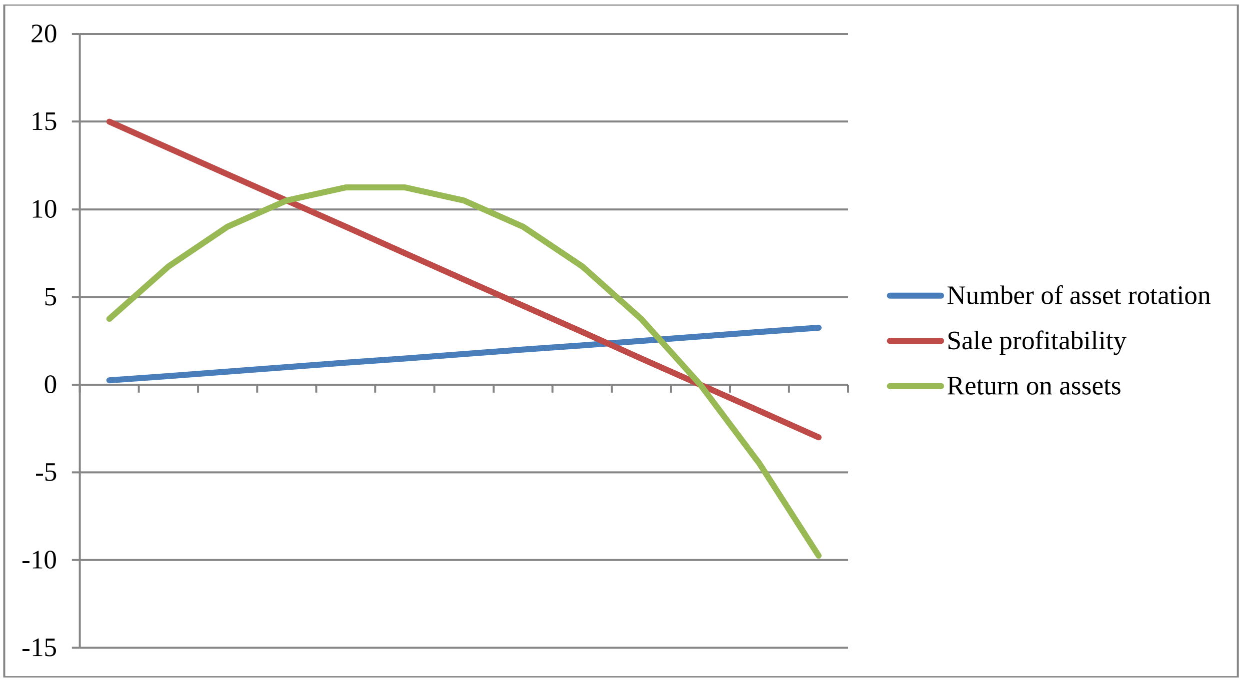

Fig. 2. Rate of return on assets depending on asset turnover and sales profitability.
Source: The author's calculations based on the data of the National Bureau of Statistics of the Republic of Moldova.

The increase in the number of rotations from 1.75 to 2.5 implies a decrease in the profitability of sales from 6.0% to 1.5% and influences the reduction of the return on assets from 10.5% to 3.75%. In the conditions when the number of rotations ≥ 3.0, negative values of sales profitability and the rate of return on assets are attested. The evolution of profitability rates is also reflected directly on the financial situation, summarizing various ways of evaluating the performance of the agricultural enterprise (Figure 3).

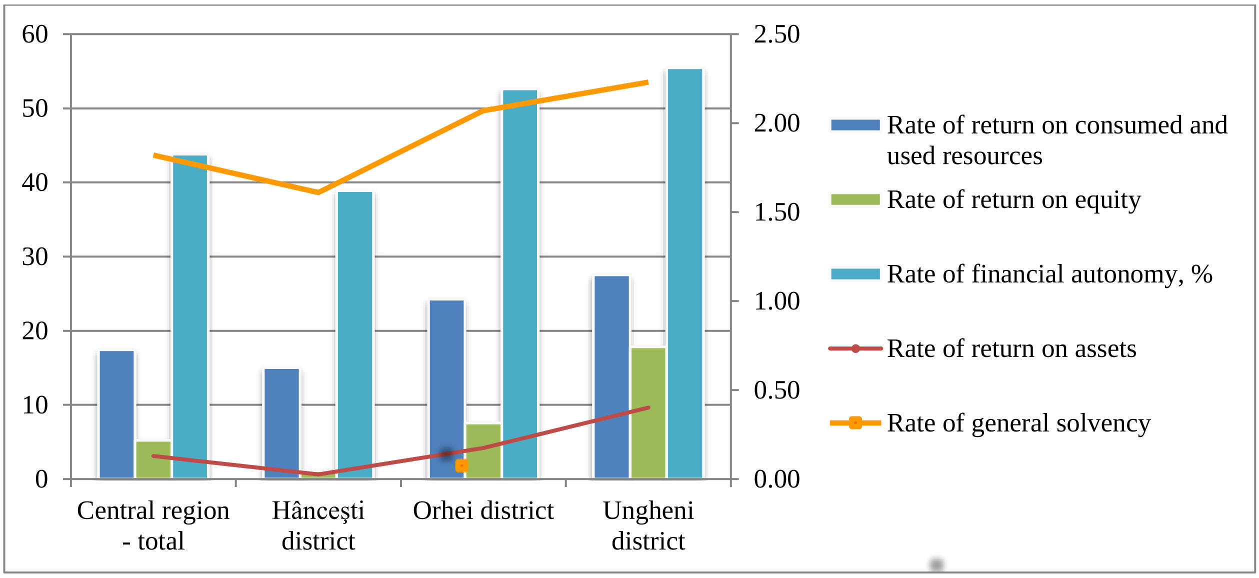

Fig. 3. Concordance of profitability rates with financial autonomy and general solvency rates
Source: The author's calculations based on the data of the National Bureau of Statistics of the Republic of Moldova.

From the graphic presentation (Figure 3) we notice that the higher the level of profitability, the higher the degree of financial autonomy and the ability of agricultural enterprises to pay their debts. For example, in Hânceşti district, where the lowest values of profitability rates were recorded, financial autonomy and general solvency do not reach the minimum acceptable value. The same situation is characteristic for the Central region as a whole. When the rate of return on consumed and used resources exceeds 20%, the rate of financial autonomy and the general solvency rate fall within the established limits of the regulations (Figure 3).

Thus, in the agricultural enterprises in the districts of Orhei and Ungheni, where the rate of return on consumed and used resources is 24.25% and 27.55% respectively, the rate of financial autonomy exceeds the established ceiling of 50%, the degree of indebtedness is much lower than the average for the region Center and Hâncesti district.

In the districts of Ungheni and Orhei, the sum of the total sources exceeded the total debts more than 2 times, a fact that confirms a good financial stability without any risk of insolvency.

CONCLUSIONS

The results of the investigations allow us to conclude that the financial stability of agricultural enterprises depends on the efficiency of the operational activity. Thus, the higher the rate of the return on the resources consumed and used, the higher the efficiency of the use of the total assets, of own capital, and the more stable the financial situation. Starting from this, we believe that in order to reach the minimum values of the financial stability rates, it is necessary to observe the payment discipline for the agricultural production delivered to the processing factories and other economic agents. In this context, we mention that at the end of 2019, 668.2 million lei or 53.93% of the total amount of commercial receivables from the agricultural enterprises of the Center region are overdue. Based on the situation created, we consider it necessary to apply a well-argued system of a state support that provides for the distribution of subsidies allocated from the state budget to the agricultural enterprises. In our opinion, the minimum amount of subsidies must cover the cost of mineral fertilizers and petroleum products consumed, i.e. the amount subtracted from working capital in connection with the disproportion of prices for agricultural products on the one hand and for fertilizers and petroleum products on the other hand [11].

At the same time, we must recognize that the high degree of indebtedness of agricultural enterprises, the insufficiency of subsidies, and the consequences of the recent drought do not allow a quick financial recovery in the branch. Due to the lack of financial resources and efficient equipment, many agricultural enterprises refuse to apply fertilizers, quality seeds and carry out technological soil tillage operations, which consequently lead to the decline and financial instability of agriculture.

We believe that for the recovery of financial stability in agriculture, we need:

- the implementation of a reasoned subsidy system by the state, which must cover the disproportion between the prices of fertilizers, chemicals and fuels, which will contribute to increasing the efficiency of the operational activity;
- in order to increase the degree of objectivity in assessing the solvency of agricultural enterprises, the optimal range of the current liquidity rate must be reduced from 2.0-2.5 to 1.0-1.5;
- in order to increase financial stability and the efficiency of operational activity in the agricultural enterprises, it is necessary to respect the production technologies, the rational use of land, material and human resources, as well as the timely reaction to changes in climatic factors and the competitive environment.

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THE VALUE DIMENSION OF UKRAINIAN EXPORTS OF GRAIN CROPS, FATS AND OILS TO EUROPEAN UNION COUNTRIES

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Abstract

Grain crops, fats and oils of animal or vegetable origin are the main products of the agricultural sector of Ukraine with the greatest export potential. Their total share in Ukraine's total exports in 2021 was 28.4 %. Within the framework of the article, a comprehensive analysis of the distribution of Ukrainian exports of grain crops, fats and oils between EU member states was conducted. The analysis was conducted on the basis of statistical data of the State Statistics Service of Ukraine for 2021. The study used ABC-method, which allows to divide the initial set of objects into three subsets depending on their share in the total value of a certain indicator: A – about 80 %; B – about 15 %; C – about 5 %. It is determined that the largest recipients of Ukrainian grain crops in the EU (worth more than USD 65 mln) are countries such as Spain, the Netherlands, Italy (group A), as well as Belgium, Portugal, Ireland (group B). Ukraine has not exported grain crops to two EU countries (Luxembourg and Slovenia). At the same time, most Ukrainian fats and oils in the EU (worth more than USD 25 mln) were purchased by countries such as the Netherlands, Spain, Poland (group A), as well as Italy, France, Lithuania, Portugal and Germany (group B). Ukraine did not export fats and oils to Luxembourg.

Key words: *export, grain crops, fats and oils, Ukraine, EU countries*

INTRODUCTION

In the commodity structure of Ukraine's exports in 2021 a significant share (over 10 %) was occupied by such goods as grain crops (USD 12,343.9 mln; 18.1 %), fats and oils of animal or vegetable origin (USD 7,037.3 mln; 10.3 %), ores, slag and ash (USD 7,119.6 mln; 10.5 %), ferrous metals (USD 13,951.3 mln; 20.5 %) [10]. As we can see, the total share of grain crops, fats and oils (28.4 %) indicates that in Ukraine the agro-industrial complex has the greatest export potential.

Since the President of Ukraine applied for membership in the European Union (hereinafter – the EU) on February 28, 2022, after the start of Russia's war against Ukraine, it is appropriate to analyze how Ukrainian exports of grain crops, fats and oils are distributed among EU member states.

Ukraine's foreign economic activity was studied in the following context: Fediv R. and Fediv I. (2020) – directions of development and realization of Ukrainian export potential [1]; Kastakova E. and Bebiakova D. (2016) – economic impact of the implementation of the DCFTA on the foreign trade of Slovakia and the Ukraine [2]; Koliadenko S. *et al.* (2020) – Ukrainian agricultural exports to EU countries [3]; Kryukova I. O. *et al.* (2018) – the export potential of the agrarian sector of Ukraine in a competitive environment [4]; Melnyk T. *et al.* (2021) – export potential of Ukrainian agro-industrial complex [5]; Moroz S. *et al.* (2017) – trade relations between Ukraine and the EU (Visegrad vector) [6]; Nagyova L. *et al.* (2018) – export trade between Ukraine and the Visegrad countries [7]; Parkhomenko N. *et al.* (2022) – export potential of the agricultural sector of Ukraine [8]; Polkovnichenko S. O. and Rosokhach O. V. (2016) – current trends in realization of the export potential of the agricultural sector of economy of Ukraine [9]; Totska O. L. (2021) – ABC-analysis of EU countries in terms of trade with Ukraine [12]. However, these studies did not provide a comprehensive analysis of the distribution of Ukrainian exports of grain crops, fats and oils of animal or vegetable origin between EU member states, which is the purpose of this work.

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MATERIALS AND METHODS

To achieve this goal we used ABC-analysis – a method of classifying certain objects (in our case – EU countries) by their relative importance, which divides the initial set into three subsets depending on their share in the total value of a given indicator: A – about 75–80 %; B – about 10–15 %; C – about 5–10 %.
In our study, EU countries will be divided into the following three groups:
A – countries with a large volume of purchases of Ukrainian grain crops / fats and oils of animal or vegetable origin (about 80 % of the total);
B – countries with an average level of procurement of basic agro-industrial goods of Ukraine (about 15 %);
C – countries with a small volume of purchases of Ukrainian grain crops / fats and oils (about 5 %).
Note that the statistics of the State Statistics Service of Ukraine [10] for 2021 are presented without taking into account the temporarily occupied territory of the Autonomous Republic of Crimea, Sevastopol and the temporarily occupied territories in Donetsk and Luhansk regions.

RESULTS AND DISCUSSIONS

Ukrainian grain crops exports to EU countries

In 2021, Ukraine exported grain crops to the EU countries in the amount of USD 1,934.8 mln, which was 15.67 % of total grain crops exports from Ukraine (USD 12,343.9 mln). The distribution of this commodity between the EU member states is given in more detail in Table 1. In it, the countries are in descending order of the value of grain crops imported from Ukraine.
According to Table 1, group A includes three EU countries (Spain, the Netherlands, Italy), to which Ukraine exported grain crops in 2021 in the amount of USD 237.6 mln to USD 644.9 mln. The accumulated share of countries in this group in total exports amounted to 74.15 %.

Table 1. Ukrainian grain crops exports to EU countries

Country	Cost, thousand dollars USA	Share in total exports, %	Accumulated share in total exports, %	ABC group
Spain	644,882.9	33.33	33.33	A
Netherlands	552,213.6	28.54	61.87	A
Italy	237,563.4	12.28	74.15	A
Belgium	157,148.0	8.12	82.27	B
Portugal	150,307.9	7.77	90.04	B
Ireland	66,559.0	3.44	93.48	B
Germany	46,394.9	2.40	95.88	C
Cyprus	20,570.8	1.06	96.94	C
Poland	16,892.0	0.87	97.81	C
Greece	13,180.0	0.68	98.50	C
Lithuania	10,166.2	0.53	99.02	C
Hungary	7,417.6	0.38	99.40	C
Czechia	2,292.5	0.12	99.52	C
Latvia	2,144.7	0.11	99.63	C
Romania	1,849.8	0.10	99.73	C
Austria	1,775.2	0.09	99.82	C
Bulgaria	1,598.9	0.08	99.90	C
Denmark	936.0	0.05	99.95	C
France	282.9	0.01	99.97	C
Croatia	202.9	0.01	99.98	C
Slovakia	153.1	0.01	99.99	C
Finland	129.2	0.01	99.99	C
Estonia	114.6	0.01	100.00	C
Sweden	42.8	0.00	100.00	C
Malta	0.9	0.00	100.00	C
Luxembourg	-	0.00	100.00	C
Slovenia	-	0.00	100.00	C
EU 27	1,934,819.9	100.00		

Source: Author's calculation based on data from the State Statistics Service of Ukraine [11].

Group B also brought together three EU countries (Belgium, Portugal, Ireland) with purchases of Ukrainian grain crops ranging from USD 66.6 mln to USD 157.1 mln. Their contribution to total exports amounted to 19.33 %. The difference between the lower export position in the previous group (USD 237.6 mln) and the upper in this group (USD 157.1 mln) was USD 80.5 mln.
Group C included 21 EU countries to which grain exports from Ukraine were either less than USD 50 mln or absent. The share of countries in this group in total exports amounted to 6.52 %. The difference between the lower export position in the previous group (USD 66.6 mln) and the upper in this group (USD 46.4 mln) was USD 20.2 mln.

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In general, the spread of export amounts ranged from USD 0.9 ths. up to USD 644.9 mln. Ukraine has not exported grain crops to two EU countries (Luxembourg and Slovenia). The results of the ABC-analysis of the EU countries on the value of Ukrainian grain crops exports in 2021 are shown in Fig. 1.

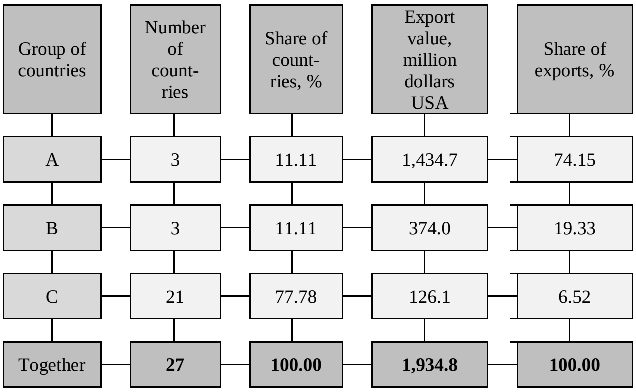

Fig. 1. Results of ABC-analysis of EU countries by value of Ukrainian grain crops exports
Source: Author's calculation based on data from Table 1.

As we can see, in 2021, 22.22 % of EU countries bought 93.48 % of Ukrainian grain crops exports to the EU.

Ukrainian exports of fats and oils of animal or vegetable origin to EU countries

In 2021, Ukraine exported to EU countries fats and oils of animal or vegetable origin in the amount of USD 2,362.5 mln, which is 33.57 % of total exports of fats and oils from Ukraine (USD 7,037.3 mln). The distribution of this commodity between the EU member states is given in more detail in Table 2. In it, the countries are listed in descending order of the value of fats and oils of animal or vegetable origin imported from Ukraine.

According to Table 2, group A includes three EU countries (Netherlands, Spain, Poland), to which Ukraine exported in 2021 fats and oils in the amount of USD 394.9 mln to USD 763 mln. The accumulated share of countries in this group in total exports amounted to 68.92 %. Group B brought together five EU countries (Italy, France, Lithuania, Portugal, Germany) with purchases of Ukrainian fats and oils ranging from USD 25 mln to USD 328.7 mln. Their contribution to total exports was 26 %. The difference between the lower export position in the previous group (USD 394.9 mln) and the upper in this group (USD 328.7 mln) was USD 66.2 mln.

Table 2. Ukrainian exports of fats and oils of animal or vegetable origin to EU countries

Country	Cost, thousand dollars USA	Share in total exports, %	Accumulated share in total exports, %	ABC group
Netherlands	762,964.6	32.29	32.29	A
Spain	470,396.8	19.91	52.21	A
Poland	394,875.2	16.71	68.92	A
Italy	328,674.5	13.91	82.83	B
France	198,087.7	8.38	91.22	B
Lithuania	32,232.5	1.36	92.58	B
Portugal	30,181.9	1.28	93.86	B
Germany	25,030.7	1.06	94.92	B
Slovakia	18,761.8	0.79	95.71	C
Romania	14,562.6	0.62	96.33	C
Bulgaria	14,130.1	0.60	96.93	C
Czechia	12,956.5	0.55	97.48	C
Greece	11,956.0	0.51	97.98	C
Austria	11,675.0	0.49	98.48	C
Estonia	8,907.1	0.38	98.85	C
Belgium	7,879.0	0.33	99.19	C
Cyprus	7,369.0	0.31	99.50	C
Latvia	5,159.4	0.22	99.72	C
Hungary	2,277.0	0.10	99.81	C
Sweden	2,023.2	0.09	99.90	C
Malta	1,810.2	0.08	99.97	C
Croatia	329.9	0.01	99.99	C
Slovenia	124.4	0.01	99.99	C
Denmark	92.9	0.00	100.00	C
Ireland	38.9	0.00	100.00	C
Finland	5.8	0.00	100.00	C
Luxembourg	-	0.00	100.00	C
EU 27	2,362,502.6	100.00		

Source: Author's calculation based on data from the State Statistics Service of Ukraine [11].

Group C included the other 19 EU countries, to which exports of fats and oils from Ukraine were either less than USD 20 mln or absent. The share of countries in this group in total exports amounted to 5.08 %. The difference between the lower export position in the previous group (USD 25 mln) and the upper in this group (USD 18.8 mln) was USD 6.2 mln. In general, the spread of export amounts ranged from USD USD 5.8 ths. up to USD 763 mln. Ukraine did not export fats and oils to Luxembourg. The results of the ABC-analysis of the EU countries on the value of

Ukrainian exports of fats and oils of animal or vegetable origin in 2021 are shown in Fig. 2.

Group of countries	Number of countries	Share of countries, %	Export value, million dollars USA	Share of exports, %
A	3	11.11	1,628.2	68.92
B	5	18.52	614.2	26.00
C	19	70.37	120.1	5.08
Together	**27**	**100.00**	**2,362.5**	**100.00**

Fig .2. Results of ABC-analysis of EU countries by value of Ukrainian exports of fats and oils of animal or vegetable origin
Source: Author's calculation based on data from Table 2.

As we can see, in 2021, 29.63 % of EU countries bought 94.92 % of Ukrainian grain exports to the EU.

CONCLUSIONS

Ukraine's export potential is formed by such goods of the agro-industrial sector as grain crops, fats and oils of animal or vegetable origin. In 2021, they were exported in the amount of USD 12,343.9 mln and USD 7,037.3 mln, respectively. The largest recipients of Ukrainian grain crops worth more than USD 65 mln in the EU are Spain, the Netherlands, Italy (group A), as well as Belgium, Portugal and Ireland (group B). At the same time, most Ukrainian fats and oils worth more than USD 25 mln in the EU were purchased by countries such as the Netherlands, Spain, Poland (group A), as well as Italy, France, Lithuania, Portugal and Germany (group B). In the analyzed period, Ukraine did not export grain crops to Luxembourg and Slovenia; fats and oils of animal or vegetable origin – to Luxembourg.
For the completeness of the study, it is advisable to conduct a mirror study of imports of agricultural products from EU countries to Ukraine, as well as an analysis of the share of Ukrainian grain crops, fats and oils in world imports of these goods to EU countries.

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UKRAINE AND ROMANIA: FINANCIAL ASPECTS OF TRADE IN AGRICULTURAL PRODUCTS

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Abstract

Ukraine and Romania are neighboring countries, which facilitates their foreign economic cooperation. The article provides a detailed analysis of the financial aspects of trade in agricultural products of Ukraine and Romania. The analysis was conducted on the basis of statistical data of the State Statistics Service of Ukraine for 2021. The study used ABC-method. It is determined that the following groups of goods of the agro-industrial complex of Ukraine are in the greatest demand in Romania: preparations of grains; cocoa and cocoa preparations; sugar and sugar confectionery; animal or plant fats and oils; meat and meat preparations; alcoholic and non-alcoholic beverages, vinegar (group A). They were exported in the amount of USD 9,594.8 ths. to USD 38,145.7 ths. At the same time, the largest shares of imports from Romania to Ukraine have such agricultural products as tobacco and industrial substitutes of tobacco; cereals; other mixed foodstuffs (also group A). They were imported in the amount of USD 5,438.5 ths. to USD 29,378.2 ths.

Key words: *export, import, agricultural products, Ukraine, Romania*

INTRODUCTION

Romania is one of Ukraine's neighbors. Such a close location facilitates foreign economic cooperation between the two countries, in particular trade in agricultural products. Especially since some of them have short shelf life. In 2021, the total value of exports of Ukrainian goods abroad amounted to USD 68,089,287.9 ths., including Romania – USD 1,543,654.7 ths. (2.3 % of total exports of goods). During the same period, foreign goods were imported to Ukraine from abroad in the amount of USD 72,816,818.0 ths, including from Romania – in the amount of USD 796,373.0 ths (1.1 % of total imports of goods) [11]. Thus, the total balance of foreign trade (the difference between the value of exports and imports) of Ukraine in 2021 amounted to USD -4,727,530.1 ths, with Romania – the amount of USD 747,281.7 ths.

Foreign trade of Ukraine and Romania, various aspects of their relationship are revealed in the works of the following scholars: Cassidy K. L. (2013) – cross-border small trading in the Ukrainian-Romanian borderlands [1]; Chiappini R. (2011) – the impact of trade specialization on exports in Central and Eastern European countries [2]; Chobal L. and Lalakulych M. (2019) – the legal basis for the development of Ukrainian-Romanian cross-border regions [3]; Degtyarev S. I. and Zavhorodnia V. N. (2019) – the nature and specifics of diplomatic and trade and economic relations between the Ukrainian state and Romania in the context of the territorial conflict after the Bessarabian question [4]; Ignjatijević S. *et al.* (2013) – comparative advantages and level of specialization in international trade in primary and industrial products of the Danube region [5]; Ignjatijević S. *et al.* (2015) – the level of competitiveness of the processed food sector in the countries of the Danube region [6]; Manrai L. A. *et al.* (2001) – classification of Central and Eastern European countries in terms of their overall attractiveness for international marketing [7]; Pidhirna V. N. (2011) – the level of openness of the economies of Ukraine and Romania for foreign trade and investment based on national priorities [9]; Stamule T. (2017) – Moldova's trade with the EU and the CIS, including Ukraine and Romania [10]; Wust A. and Zichner H. (2010) – trade activities of small traders and small entrepreneurs on the

Romanian-Ukrainian border [12]. Besides, we will note that Parkhomenko N. *et al.* (2022) investigated the export potential of the agricultural sector of Ukraine [8]. However, these papers did not provide a detailed analysis of the financial aspects of trade in agricultural products of Ukraine and Romania, which is the purpose of this article.

MATERIALS AND METHODS

The ABC method was used in the research process, which allows to divide all analyzed objects into three groups depending on their specific weight in the total size of the selected indicator: A (about 80 %), B (about 15 %), C (about 5 %).

Within the framework of this article, agricultural products will be divided into three groups:

A – goods with the highest value of exports/ imports (about 80 % of the total);

B – goods with an average level of export/ import value (about 15 %);

C – goods with the lowest value of exports/ imports (about 5 %).

RESULTS AND DISCUSSIONS

Financial aspects of exports of agricultural products from Ukraine to Romania

In 2021, Ukraine exported to Romania agricultural products worth USD 147,705.5 ths. This amounted to 9.6 % of total exports of goods to Romania [11]. The distribution of exports by individual types of goods is shown in Table 1. In it, agricultural products are arranged in descending order of the value of export transactions.

Table 1 shows that group A includes six types of goods with the greatest export potential from USD 9,594.8 ths. to USD 38,145.7 ths. (preparations of grains; cocoa and cocoa preparations; sugar and sugar confectionery; animal or plant fats and oils; meat and meat preparations; alcoholic and non-alcoholic beverages, vinegar). The accumulated share of these goods in the total amount of exports of agricultural products amounted to 73.9 %.

Table 1. Exports of agricultural products from Ukraine to Romania in 2021

Commodity code and title by Ukrainian Classification of Commodities in Foreign Trade	Export value, thousand dollars USA	Share in total exports of agricul-tural products, %	Accumulated share in total exports of agricultural products, %	ABC group
19 Preparations of grains	38,145.7	25.8	25.8	A
18 Cocoa and cocoa preparations	18,731.6	12.7	38.5	A
17 Sugar and sugar confectionery	17,117.8	11.6	50.1	A
15 Animal or plant fats and oils	14,562.6	9.9	60.0	A
02 Meat and meat preparations	10,962.0	7.4	67.4	A
22 Alcoholic and non-alcoholic beverages, vinegar	9,594.8	6.5	73.9	A
21 Other mixed foodstuffs	9,360.2	6.3	80.2	B
08 Eatable fruits and nuts	7,272.2	4.9	85.1	B
23 Remains and wastes of food industry	5,156.3	3.5	88.6	B
07 Vegetables	4 552.6	3.1	91.7	B
12 Oil seeds and fruits	4,426.6	3.0	94.7	B
04 Milk and milk products; eggs; honey	2,589.9	1.8	96.5	C
10 Cereals	1,849.8	1.3	97.7	C
20 Products of vegetables processing	1,792.1	1.2	98.9	C
16 Preparations from meat, fish	1,067.2	0.7	99.6	C
11 Flour-grinding products	203.4	0.1	99.8	C
03 Fish and crustacea	195.5	0.1	99.9	C
09 Coffee, tea	70.0	0.0	100.0	C
13 Shellac natural	35.2	0.0	100.0	C
05 Other animal products	14.0	0.0	100.0	C
24 Tobacco and industrial substitutes of tobacco	4.2	0.0	100.0	C
06 Seedings and other trees	1.9	0.0	100.0	C
Together agricultural products	147,705.5	100.0		

Source: Author's calculation based on data from the State Statistics Service of Ukraine [11].

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The next group B includes five types of goods with exports ranging from USD 4,426.6 ths. to USD 9,360.2 ths. Their contribution to the total amount of exports of agricultural products amounted to 20.8 %.

Group C includes 11 types of goods with exports ranging from USD 1.9 ths. to USD 2,589.9 ths. Their share in the total export of agricultural products amounted to 5.3 %.

The results of the ABC-analysis of exports of agricultural products from Ukraine to Romania are shown in Fig. 1.

Group of goods	Quan-tity of goods	Share of goods, %	Export value, thousand dollars USA	Share of exports, %
A	6	27.3	109,114.4	73.9
B	5	22.7	30,767.9	20.8
C	11	50.0	7,823.3	5.3
Together	**22**	**100.0**	**147,705.5**	**100.0**

Fig. 1. Results of the ABC-analysis of exports of agricultural products from Ukraine to Romania in 2021
Source: Author's calculation based on data from Table 1.

Thus, in the analyzed period, half of the goods (11 types) provided 94.7 % of exports of agricultural products from Ukraine to Romania.

Financial aspects of imports of agricultural products from Romania to Ukraine

In 2021, agricultural products were imported from Romania to Ukraine in the amount of USD 61,746.6 ths. This amounted to 7.8 % of total imports of goods from Romania [11]. The distribution of imports by individual types of goods is shown in Table 2. In it, agricultural products are arranged in descending order of the value of import operations. Table 2 shows that groups A and B included three types of goods with high (from USD 5,438.5 ths. to USD 29,378.2 ths.) and medium (from USD 2,574.2 ths. to USD 5,148.8 ths.) level of imports of goods: tobacco and industrial substitutes of tobacco; cereals; other mixed foodstuffs, as well as oil seeds and fruits; animal or plant fats and oils; preparations of grains.

Table 2. Imports of agricultural products from Romania to Ukraine in 2021

Commodity code and title by Ukrainian Classification of Commodities in Foreign Trade	Import value, thousand dollars USA	Share in total imports of agricul-tural products, %	Accumulated share in total imports of agricultural products, %	ABC group
24 Tobacco and industrial substitutes of tobacco	29,378.2	47.6	47.6	A
10 Cereals	11,168.4	18.1	65.7	A
21 Other mixed foodstuffs	5,438.5	8.8	74.5	A
12 Oil seeds and fruits	5,148.8	8.3	82.8	B
15 Animal or plant fats and oils	3,677.6	6.0	88.8	B
19 Preparations of grains	2,574.2	4.2	92.9	B
07 Vegetables	1,814.8	2.9	95.9	C
22 Alcoholic and non-alcoholic beverages, vinegar	576.0	0.9	96.8	C
18 Cocoa and cocoa preparations	389.2	0.6	97.4	C
04 Milk and milk products; eggs; honey	266.5	0.4	97.9	C
17 Sugar and sugar confectionery	249.7	0.4	98.3	C
05 Other animal products	225.5	0.4	98.6	C
02 Meat and meat preparations	221.5	0.4	99.0	C
06 Seedings and other trees	220.5	0.4	99.4	C
20 Products of vegetables processing	166.9	0.3	99.6	C
08 Eatable fruits and nuts	86.6	0.1	99.8	C
11 Flour-grindingproducts	66.0	0.1	99.9	C
23 Remains and wastes of food industry	47.5	0.1	100.0	C
13 Shellac natural	30.1	0.0	100.0	C
09 Coffee, tea	0.2	0.0	100.0	C
03 Fish and crustacea	-	-	100.0	C
16 Preparations from meat, fish	-	-	100.0	C
Together agricultural products	61,746.6	100.0		

Source: Author's calculation based on data from the State Statistics Service of Ukraine [11].

The accumulated share of group A goods in total imports amounted to 74.5 %, group B – 18.5 %. Group C includes 16 types of goods with imports of less than USD 2,000 ths. or absent. Their share in the total amount of imports of agricultural products amounted to 7.1 %.

The results of the ABC-analysis of imports of agricultural products from Romania to Ukraine are shown in Fig. 2.

Group of goods	Quan-tity of goods	Share of goods, %	Import value, thousand dollars USA	Share of imports, %
A	3	13.6	45,985.0	74.5
B	3	13.6	11,400.7	18.5
C	16	72.7	4,360.9	7.1
Together	**22**	**100.0**	**61,746.6**	**100.0**

Fig. 2. Results of ABC-analysis of imports of agricultural products from Romania to Ukraine in 2021
Source: Author's calculation based on data from Table 2.

As you can see, in 2021, 27.2 % of goods accounted for 93 % of imports of agricultural products from Romania to Ukraine.

CONCLUSIONS

Despite the fact that Romania is a neighbor of Ukraine, their foreign trade relations are not active enough, including trade in agricultural products. In 2021, Ukraine exported to Romania agricultural products worth USD 147,705.5 ths. (9.6 % of total exports of goods to Romania). At the same time, agricultural products were imported from Romania to Ukraine in the amount of USD 61,746.6 ths. (7.8 % of total imports of goods from Romania). The value of exports of certain types of goods ranged from USD 1.9 ths. to USD 38,145.7 ths., imports – from USD 0.2 to USD 29,378.2 ths. The following groups of goods of the agro-industrial complex of Ukraine are most in demand in Romania: preparations of grains; cocoa and cocoa preparations; sugar and sugar confectionery; animal or plant fats and oils; meat and meat preparations; alcoholic and non-alcoholic beverages, vinegar. At the same time, the largest shares of imports from Romania to Ukraine have such agricultural products as tobacco and industrial substitutes of tobacco; cereals; other mixed foodstuffs. To intensify trade between the two analyzed countries, it is advisable to hold joint international fairs, various marketing events, to organize meetings at the state level of agro-industrial producers with potential customers. The study can be deepened by analyzing trade in other groups of goods and services.

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FORECAST MODELING OF FOREIGN TRADE IN AGRICULTURAL COMPLEX PRODUCTS BETWEEN UKRAINE AND ROMANIA

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Abstract

The article presents forecast modeling of foreign trade between Ukraine and Romania by separate groups of agro-industrial goods. Indicators were forecast for three years (2022-2024) based on actual data for eleven years (2011-2021). Five trend models (exponential, linear, logarithmic, polynomial, and power) were constructed for each indicator and only one with the highest value of the reliability of the approximation R^2 was selected. The constructed trend models indicate a positive trend in 2022-2024 for preparations of grains, cocoa and cocoa preparations, sugar and sugar confectionery, animal or plant fats and oils; in 2023-2024 – for meat and meat preparations, alcoholic and non-alcoholic beverages, vinegar. At the same time, the forecast models indicate an increase in imports of tobacco and its industrial substitutes in 2023-2024, a decrease in imports of cereals over the same period, an increase in imports of other mixed foodstuffs in 2022-2024. Of the nine selected models, six are polynomial, one is power, one is logarithmic, and one is exponential. Two of them have a very high degree of reliability of the approximation R^2 (>0.9) and, accordingly, a high probability of forecast prediction.

Key words: *forecast modeling, foreign trade, products of the agro-industrial complex, Ukraine, Romania*

INTRODUCTION

Ukraine conducts foreign trade in goods and services with many countries around the world. One of Ukraine's trading partners is neighboring Romania. In 2021, Ukraine exported to Romania the products of the agro-industrial complex in the amount of 147,705.5 thn USD. The largest shares in its structure were occupied by groups of goods according to the following codes by Ukrainian Classification of Commodities in Foreign Trade: 19 Preparations of grains (38,145.7 thn USD; 25.8 %); 18 Cocoa and cocoa preparations (18,731.6 thn USD; 12.7 %); 17 Sugar and sugar confectionery (17,117.8 thn USD; 11.6 %); 15 Animal or plant fats and oils (14,562.6 thn USD; 9.9 %); 02 Meat and meat preparations (10,962.0 thn USD; 7.4 %); 22 Alcoholic and non-alcoholic beverages, vinegar (9,594.8 thn USD; 6.5 %) [9].

The amount of exports of these six groups of goods amounted to 109,114.5 thn USD or 73.9 % of the total exports of agricultural products of Ukraine to Romania.

At the same time, in 2021 Ukraine imported from Romania products of the agro-industrial complex in the amount of 61,746.6 thn USD. Thus, the balance of Ukraine's foreign trade with Romania in 2021 according to these indicators amounted to 85,958.9 thn USD. The largest shares in the structure of imports of agro-industrial products were occupied by the following groups of goods: 24 Tobacco and industrial substitutes of tobacco (29,378.2 thn USD; 47.6 %); 10 Cereals (11,168.4 thn USD; 18.1 %); 21 Other mixed foodstuffs (5,438.5 thn USD; 8.8 %) [9].

The amount of imports of these three groups of goods amounted to 45,985.1 thn USD or 74.5 % of the total imports of products of the Romanian agro-industrial complex to Ukraine.

Among the scientific works that analyzed the trade between Ukraine and Romania are: Cassidy K. L. (2013) – cross-border small trading in the Ukrainian-Romanian borderlands [1]; Chiappini R. (2011) – the dynamics of trade specialization and exportations in central and eastern European countries, including Ukraine and Romania [2]; Ignjatijević S. et al. (2013) – comparative

advantages and level of specialization in international trade in primary and industrial products of the Danube region [3]; Ignjatijević S. et al. (2015) – the level of competitiveness of the processed food sector in the countries of the Danube region [4]; Pidhirna V. N. (2011) – levels of openness of the economies of Ukraine and Romania for foreign trade and investment [7]; Stamule T. (2017) – Moldova's total exports and imports to the EU and the CIS, including Ukraine and Romania [8]; Wust A. and Zichner H. (2010) – small trade activities of small traders and entrepreneurs on the Romanian-Ukrainian border [12]. At the same time, there are scientific studies of exports of agro-industrial products of Ukraine: Koliadenko S. et al. (2020) – analysis and forecasting of Ukrainian agrarian exports to the EU countries [5]; Parkhomenko N. et al. (2022) – assessment of export opportunities and export potential of the agricultural sector of Ukraine [6]; Tkalenko S. et al. (2021) – empirical analysis of exports of organic agricultural food products of Ukraine [10]; Vasylieva N. (2020) – production and export components of Ukrainian cereals in global food security [11].
The purpose of this study is forecast modeling of trade between Ukraine and Romania by certain groups of goods, which had the largest shares in the structure of exports and imports of agro-industrial products in 2021.

MATERIALS AND METHODS

For the forecast modeling of indicators of export and import of goods of agro-industrial complex the method of extrapolation of trends which allows to extend past and present patterns for the future is used.
Forecasting of foreign trade indicators of Ukraine and Romania was carried out for three years (2022-2024) on the basis of actual data for eleven years (2011-2021). Five trend models were built for each indicator: exponential ($y = a_1 e^{a_0 x}$), linear ($y = a_1 x + a_0$), logarithmic ($y = a_1 \ln(x) + a_0$), polynomial ($y = a_2 x^2 + a_1 x + a_0$), degree ($y = a_1 x^{a_0}$), where a_0, a_1, a_2 – constants, x – time. However, for each group of goods selected only one with the highest value of the reliability of the approximation R².

RESULTS AND DISCUSSIONS

Forecast models of agro-industrial products exports from Ukraine to Romania
The analysis of Ukraine's export trade operations with Romania will be conducted on the basis of Table 1. It will provide actual and forecast data for the three groups of agro-industrial products that had the largest exports in 2021.

Table 1. Exports of agro-industrial complex products from Ukraine to Romania 1 (thn USD)

Year	19 Preparations of grains	18 Cocoa and cocoa preparations	17 Sugar and sugar confectionery
2011	1,015.0	75.3	120.1
2012	2,422.0	260.6	251.8
2013	2,983.5	552.0	404.6
2014	3,225.2	1,328.4	806.8
2015	7,850.7	2,944.7	9,639.0
2016	9,685.0	3,991.0	19,362.1
2017	12,281.6	6,029.1	7,841.4
2018	13,231.0	10,560.3	12,102.4
2019	21,793.6	12,074.7	13,995.6
2020	30,866.6	14,501.5	15,978.0
2021	38,145.7	18,731.6	17,117.8
Forecast data			
2022	45,473.6	22,746.2	29,974.6
2023	54,773.1	27,137.9	36,439.5
2024	64,971.4	31,916.7	43,661.9

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

As you can see, exports of preparations of grains ranged from 1,015.0 thn USD in 2011 to 38,145.7 thn USD in 2021. The dynamics of the indicators was positive annually. The average value of exports of preparations of grains for the analyzed period amounted to 13,045.4 thn USD.
In Fig. 1 for the indicators of exports of preparations of grains from Ukraine to Romania, a trend line is constructed, as well as its equation and the value of the reliability of the approximation R².
As can be seen from Fig. 1 and the forecast data in Table 1, the polynomial trend model assumes an increase in exports over the next three years. The value of R² is very high (>0.9), which indicates a high probability of prediction.

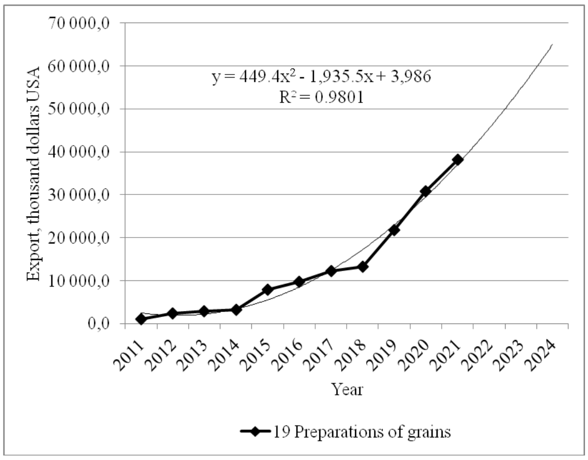

Fig. 1. Forecast model of exports of preparations of grains (thn USD)
Source: Author's calculation based on data from Table 1.

The third column of Table 1 shows that in the analyzed period, exports of cocoa and cocoa preparations ranged from 75.3 thn USD in 2011 to 18,731.6 thn USD in 2021. The dynamics of the indicators was also positive annually. The average value of exports of cocoa and cocoa preparations was 6,459.0 thn USD.

Figure 2 shows the forecast model of exports of cocoa and cocoa preparations from Ukraine to Romania.

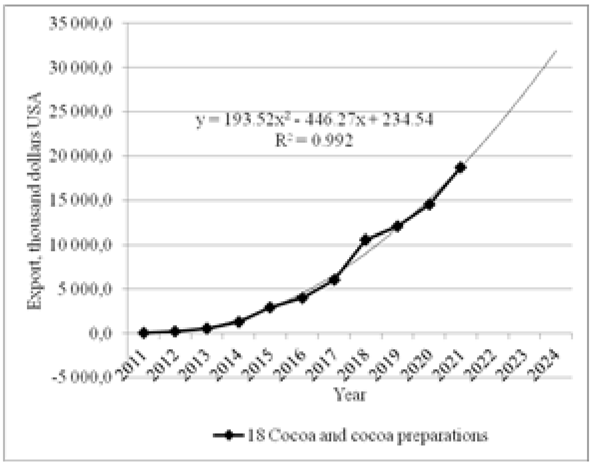

Fig. 2. Forecast model of exports of cocoa and cocoa preparations (thn USD)
Source: Author's calculation based on data from Table 1.

As can be seen from Fig. 2 and the forecast data in Table 1, the polynomial trend model assumes an increase in exports over the next three years. The value of R^2 is also very high (>0.9), which indicates a high probability of prediction.

The fourth column of Table 1 shows that in 2011-2021 exports of sugar and sugar confectionery ranged from 120.1 thn USD in 2011 to 19,362.1 thn USD in 2016.

The dynamics of the indicators was positive annually, except in 2017, when there was a decline in exports to 7,841.4 thn USD.

The average value of exports of sugar and sugar confectionery for the analyzed period amounted to 8,874.5 thn USD.

Figure 3 shows the forecast model of sugar and sugar confectionery exports from Ukraine to Romania.

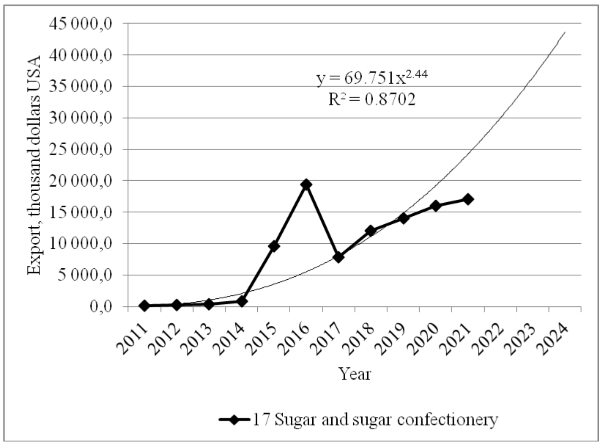

Fig. 3. Forecast model of exports of sugar and sugar confectionery (thn USD)
Source: Author's calculation based on data from Table 1.

As can be seen from Fig. 3 and the forecast data in Table 1, the power trend model assumes an increase in exports over the next three years.

Table 2 .Exports of agro-industrial complex products from Ukraine to Romania 2 (thn USD)

Year	15 Animal or plant fats and oils	02 Meat and meat preparations	22 Alcoholic and non-alcoholic beverages, vinegar
2011	1,146.7	-	234.8
2012	4,766.1	-	28.9
2013	1,418.4	-	80.7
2014	1,861.7	3,354.0	22.4
2015	7,311.5	2,088.1	39.7
2016	5,263.2	6,243.6	120.1
2017	7,167.0	8,998.2	575.3
2018	5,228.4	10,817.7	1,624.8
2019	2,236.1	1,964.3	401.4
2020	14,904.9	4,711.4	3,031.3
2021	14,562.6	10,962.0	9,594.8
Forecast data			
2022	16,125.4	8,290.7	9,401.9
2023	19,072.9	8,550.4	12,232.3
2024	22,310.7	8,785.3	15,409.3

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

The value of R^2 is quite high (>0.8), which indicates a high probability of prediction.

We will continue the analysis and forecasting of Ukraine's export trade operations with Romania on the basis of Table 2.

In it we will present actual and forecast data for the other three groups of agro-industrial products, which had the largest exports in 2021.

As you can see, exports of animal or plant fats and oils ranged from 1,146.7 thn USD in 2011 to 14,904.9 thn USD in 2020. The dynamics of the indicators did not have a clear trend: growth has repeatedly alternated with declines. The average value of exports of animal or plant fats and oils for the analyzed period amounted to 5,987.9 thn USD.

In Fig. 4 shows the forecast model of exports from Ukraine to Romania of animal or plant fats and oils.

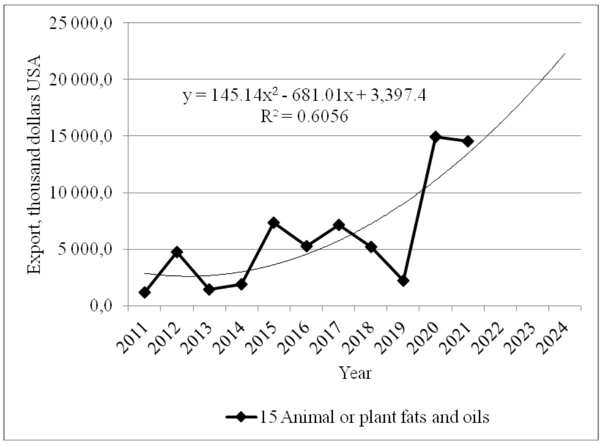

Fig. 4. Forecast model of exports of animal or plant fats and oils (thn USD)
Source: Author's calculation based on data from Table 2.

As can be seen from Fig. 4 and the forecast data in Table 2, the polynomial trend model assumes an increase in exports over the next three years. The value of R^2 is not high enough (>0.6), which indicates a low probability of forecast prediction.

The third column of Table 2 shows that in the analyzed period, exports of meat and meat preparations ranged from 1,964.3 thn USD in 2019 to 10,962 thn USD in 2021. The dynamics of indicators was positive in all years except 2015 and 2019. The average value of exports of meat and meat preparations for the analyzed period was 6,142.4 thn USD.

In Fig. 5 shows the forecast model of exports from Ukraine to Romania of meat and meat preparations.

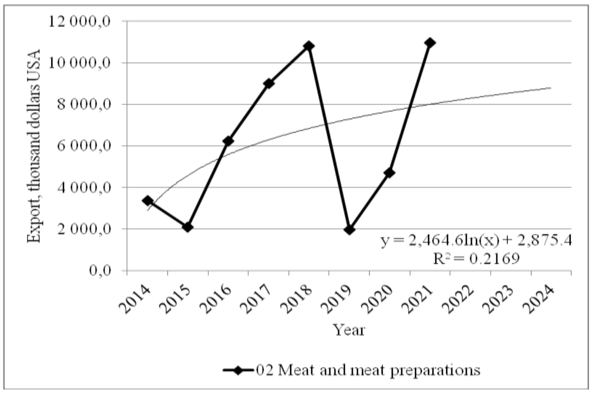

Fig. 5. Forecast model of exports of meat and meat preparations (thn USD)
Source: Author's calculation based on data from Table 2.

As can be seen from Fig. 5 and forecast data in Table 2, the logarithmic trend model assumes an increase in exports, but from a level below 2021. The value of R^2 is very low (>0.2), indicating a low probability of forecast fulfillment. The fourth column of Table 2 shows that in 2011-2021 exports of alcoholic and non-alcoholic beverages and vinegar ranged from 22.4 thn USD in 2014 to 9,594.8 thn USD in 2021. The dynamics of indicators was not clear, although the last two years have seen rapid growth. The average value of exports of alcoholic and non-alcoholic beverages and vinegar for the analyzed period amounted to 1,432.2 thn USD.

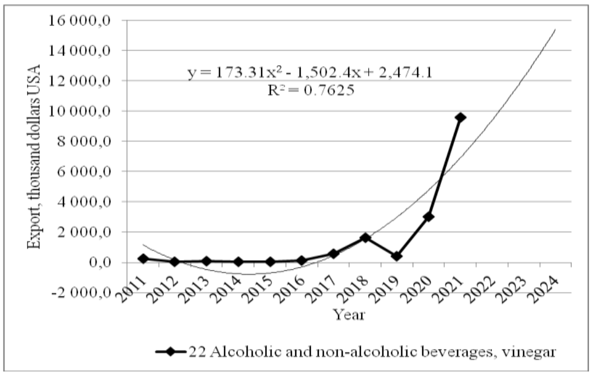

Fig. 6. Forecast model of exports of alcoholic and non-alcoholic beverages and vinegar (thn USD)
Source: Author's calculation based on data from Table 2.

In Fig. 6 shows the forecast model of exports from Ukraine to Romania of alcoholic and non-alcoholic beverages and vinegar.

As can be seen from Fig. 6 and forecast data in Table 2, the polynomial trend model assumes an increase in exports, but from a level below 2021. The value of R^2 is not high enough (>0.7), which indicates a low probability of forecast fulfillment.

Forecast models of import of agro-industrial complex products from Romania to Ukraine

The analysis of Ukraine's import trade operations with Romania will be conducted on the basis of Table 3. It will present actual and forecast data for the three groups of agro-industrial products that had the largest imports in 2021.

Table 3. Imports of agro-industrial complex products from Romania to Ukraine (thn USD)

Year	24 Tobacco and industrial substitutes of tobacco	10 Cereals	21 Other mixed foodstuffs
2011	551.6	52,843.3	3,019.4
2012	707.2	63,234.9	3,163.7
2013	977.3	63,148.9	4,740.6
2014	394.8	110,805.8	3,616.0
2015	200.7	38,858.8	2,132.0
2016	351.5	37,788.8	2,308.1
2017	1,148.5	42,456.0	1,845.7
2018	194.2	44,470.7	2,004.8
2019	421.8	41,366.3	3,997.7
2020	8,637.5	13,846.6	4,518.9
2021	29,378.2	11,168.4	5,438.5
Forecast data			
2022	28,116.3	15,976.2	6,156.9
2023	37,044.6	13,709.6	7,349.2
2024	47,102.1	11,764.6	8,708.4

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

As you can see, imports of tobacco and industrial substitutes of tobacco ranged from 194.2 thn USD in 2018 to 29,378.2 thn USD in 2021. The dynamics of indicators was not clear, although in the last two years there has been rapid growth.

The average value of imports of tobacco and industrial substitutes of tobacco for the analyzed period amounted to 3,905.7 thn USD.

Figure 7 shows the forecast model of imports of tobacco and industrial substitutes of tobacco from Romania to Ukraine.

As can be seen from Fig. 7 and forecast data in Table 3, the polynomial trend model assumes an increase in imports, but from a level below 2021.

The value of R^2 is not high enough (>0.7), which indicates a low probability of forecast.

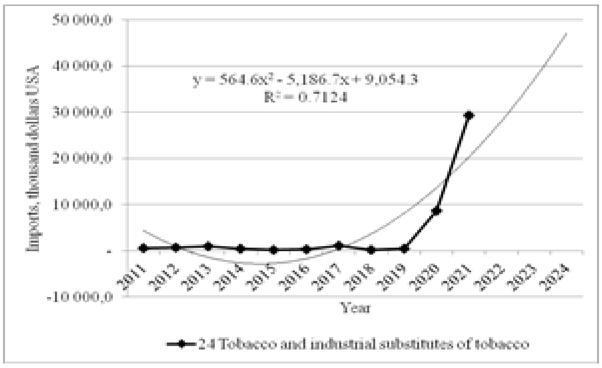

Fig.7. Forecast model of imports of tobacco and industrial substitutes of tobacco (thn USD)
Source: Author's calculation based on data from Table 3.

The third column of Table 3 shows that in the analyzed period, imports of cereals ranged from 11,168.4 thn USD in 2021 to 110,805.8 thn USD in 2014.

The dynamics of indicators was unstable, in the last three years there has been a trend to recession. The average value of imports of cereals for the analyzed period amounted to 47,271.7 thn USD.

In Fig. 8 shows the forecast model of imports of cereals from Romania to Ukraine.

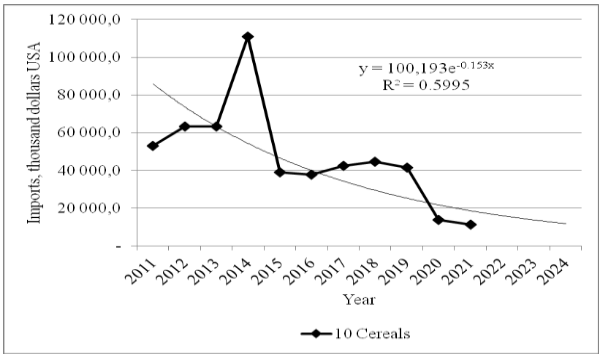

Fig. 8. Forecast model of imports of cereals (thn USD)
Source: Author's calculation based on data from Table 3.

As can be seen from Fig. 8 and forecast data in Table 3, the exponential trend model assumes a decrease in imports, but from a level higher than 2021. The value of R^2 is not high enough (>0.5), which indicates a low probability of forecast fulfillment.

The fourth column of Table 3 shows that in 2011-2021 imports of other mixed foodstuffs ranged from 1,845.7 thn USD in 2017 to 5,438.5 thn USD in 2021. The dynamics of indicators was unstable, but in recent years the growth trend has been observed for four years. The average value of imports of other mixed foodstuffs for the analyzed period amounted to 3,344.1 thn USD.

In Fig. 9 shows the forecast model of imports of other mixed foodstuffs from Romania to Ukraine.

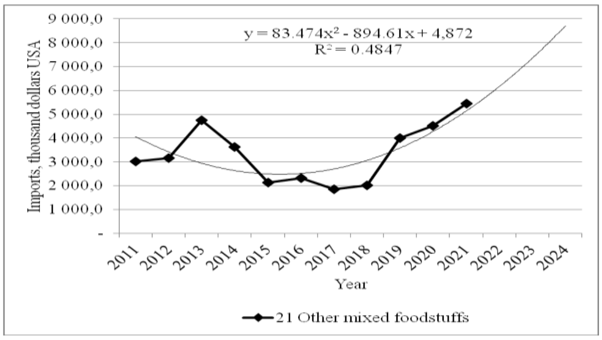

Fig. 9. Forecast model of imports of other mixed foodstuffs (thn USD)
Source: Author's calculation based on data from Table 3.

As can be seen from Fig. 9 and the forecast data in Table 3, the polynomial trend model predicts an increase in imports over the next three years. However, the value of R^2 is low (>0.4), which indicates a low probability of prediction.

CONCLUSIONS

In 2021, Ukraine exported to Romania the products of the agro-industrial complex in the amount of 147,705.5 thn USD. The largest shares in its structure were occupied by the following groups of goods: preparations of grains; cocoa and cocoa preparations; sugar and sugar confectionery; animal or plant fats and oils; meat and meat preparations; alcoholic and non-alcoholic beverages, vinegar. The trend models indicate a positive trend for the first four groups of goods in 2022-2024, for the last two – in 2023-2024.

At the same time, in 2021 Ukraine imported from Romania products of the agro-industrial complex in the amount of 61,746.6 thn USD. The largest shares in its structure were occupied by the following groups of goods: tobacco and its industrial substitutes; cereals; other mixed foodstuffs. Forecast models indicate an increase in imports of tobacco and its industrial substitutes in 2023-2024, a decrease in imports of cereals in 2023-2024, an increase in imports of other mixed foodstuffs in 2022-2024.

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ANALYSES OF AGRI-ENVIRONMENTAL INDICATORS AT REGIONAL LEVEL IN THE SLOVAK REPUBLIC

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Abstract

This paper focuses on evaluation of agri-environmental indicators at regional level in the Slovak republic. Parts of the territory that have characteristics in terms of agro-ecological landscape infrastructure, generating various public goods and externalities, have been identified. For following public goods: landscape formation, biodiversity, quality and availability of water resources, soil quality, air quality, climate stability and flood prevention, we have identified and quantified indicators that reflect the benefits provided by different types of landscape space, agricultural land or farming practices. The analysis showed a strong polarization based on the natural conditions that determine the production conditions.

Key words: *agriculture, agri-environmental indicators, public goods, externalities*

INTRODUCTION

Multifunctionality and, within it, the production and non-production benefits of the agri-resort are also an important issue in terms of the announced focus of the future EU CAP on a “greener“ direction of farming, as well as in terms of public interest [2]. The concept of “public goods and externalities“ (PGEs) responds to the needs of the European Commission related to the design and evaluation of public policies and specific programmes needed to stimulate or reduce the “environmental spillovers“ produced by the agricultural sector within the EU [6].

According to [7] “some public goods within agriculture, e.g. the maintenance of ecosystems, are considered positive externalities, i.e. they are side-effects of the production of agricultural commodities. If ecosystem maintenance were carried out for this specific purpose, e.g. as a contract between farmers and conservationists, it would still be a public good - biodiversity conservation - not an external benefit resulting from production carried out for another purpose“.

Increasing food production without further damaging biodiversity is a key challenge for contemporary societies [9]. In their study, the authors assess the trade-offs between agricultural production and two key agri-environmental indicators under four contrasting scenarios for Europe in 2040. The scenarios present different storylines involving assumptions about macroeconomic drivers (e.g. population growth and GDP growth rates), demand for food and livestock products, as well as policy decisions on trade liberalisation/protectionism, biodiversity conservation, land-use planning regulations and subsidies to farmers through the European Union's Common Agricultural Policy.

“Humanity is placing a heavy burden on agricultural landscapes, demanding sufficient food production, more ecosystem services and the preservation of biodiversity“ [8]. [3] found that areas with an increase in multifunctionality are also becoming more biologically and agriculturally diverse, without large losses in overall food production. This suggests the potential for complementarities between the objectives of food production, multiple ecosystem services, and biological and agricultural diversity in agricultural landscapes. Multifunctional agroecosystems are the result of complex adaptive interactions between humans and nature, with key trade-offs between food production and other ecosystem services [1].

MATERIALS AND METHODS

The aim of the paper is to analyse agri-environmental indicators at regional level in the Slovak republic. In designing the methodology, we drew on the evaluation framework of the JRC scientific and technical research report "Feasibility Study on the Valuation of Public Goods and Externalities in EU Agriculture" [7].

The first step was to identify the regions. Regions refer to coherent parts of the territory that are characteristic in terms of agro-ecological landscape infrastructure, generating various public goods and externalities (PGEs). For this purpose, regions were identified based on landscape and farming system variables that were assumed to be related to one or more PGEs and for quantifying which we had district-level data. Regions were identified based on variables that were not used as PGE indicators. This was necessary so that we could test associations between different PGEs and different regions. Unification of the underlying data was done by standardizing the data. Two variants of Cluster Analysis (CA) were used to identify regions. First, in the "classical" cluster analysis, we used hierarchical procedures as the exploratory clustering solution, and the resulting solution was performed by a non-hierarchical procedure. Second, we performed Principal Component Analysis (PCA) to reduce the number of variables and then performed cluster analysis (with the methodological choices described above) using only the first few principal components. By using PCA, we avoided that including too many variables representing a group of (correlated) variables would result in a solution that gives too much weight to that group.

The next step was to identify indicators that are characteristic of selected public goods and externalities provided by each type of landscape space or farming practice. Based also on the results of research works [11, 12] the following indicators were identified for selected PGEs - landscape formation, biodiversity, quality and availability of water resources, soil quality, air quality, climate stability and flood prevention. The indicators are listed in Table 1.

The final step was to associate PGE indicators with regions, which we analysed by comparing the mean values of PGE indicators for each region and factor analysis (FA) of the district-level data, using PGE indicators as variables and regions coded as binary code variables.

RESULTS AND DISCUSSIONS

Identification of regions

The regionalisation of Slovakia was carried out on the basis of indicators that have an affinity to the landscape dimension and partly also to the intensity of agriculture. The segmentation of districts into regions has been confirmed by several models (using cluster analysis and principal component analysis) and is quite unambiguous (Map 1).

It confirms the basic idea of dividing the districts of Slovakia into four different parts - districts of southern and south-western Slovakia with predominance of production areas, then the area of central and northern Slovakia with less favourable production and climatic conditions, the rest of Slovakia as a transitional area (due to the nature of Slovakia, areas with natural and other specific constraints prevail here as well), and distinct urban agglomerations.

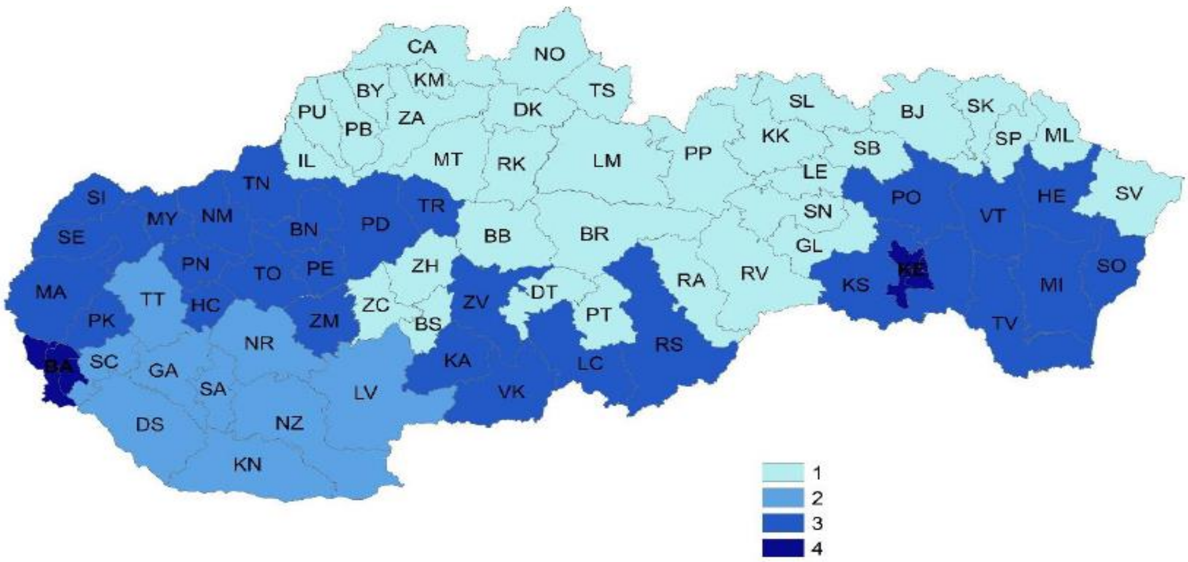
Indicators of public goods and agricultural externalities

Because of breadth of the set of indicators that characterize the selected public goods and externalities, we present only a fragment - indicators that relate to landscape and soil quality.

Landscaping

In recent years, several clearly defined indicators have been used to assess the diversity of the landscape mosaic, which allow to evaluate its changes in time and space and also to compare trends in the development of landscape structure in different regions.

Landscape space indicators can be classified into two main categories - composition and configuration, which encompass different aspects of the landscape mosaic [4]



Map 1. Identification of the regions
Map legend: Districts included in the cluster 1, 2, 3, 4
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics.

Landscape composition refers to the presence of different land cover types and their representation in each category. Indicators of landscape composition are not spatially explicit. That is, they measure what is present and in what relative quantities or proportions, without any spatial allocation of it to refer to where on earth it may be. Metrics (indicators) of landscape composition are very important descriptors, especially because the relative abundance of landscape cover types limits the potential value of spatially explicit indicators [10]. Landscape configuration refers to the geographic distribution of the landscape mosaic, while composition refers to the variety and extent of individual land cover types. The Shannon diversity index (SHDI) is a typical example of an indicator from the category of landscape composition and is often used in landscape ecology studies to describe landscape diversity.

The Shannon index quantifies landscape diversity using two components - the number of individual classes (compositional component) and the evenness of class distribution (structural component). The SHDI is the sum of the products - the area of the individual land cover classes and their natural logarithm. Its value increases if the number of different classes increases and/or the proportional representation of classes is more balanced. The maximum SHDI value for a particular number of classes is reached if all classes have the same area in the area under consideration. The different size of individual sites is reflected in the value of the Shannon index: the smaller the differences in the size of the sites, the higher the SHDI value [5].

In the calculations of the SHDI of the landscape cover of the Slovak Republic, the following classes formed the compositional component of the index: arable land, permanent grassland, vineyards, hops, orchards, gardens, forest land, water areas, built-up area and courtyard, other non-agricultural area.

The SHDI values of the landscape cover of the Slovak Republic in individual districts ranged from 0.81 (Gelnica district) to 1.79 (Bratislava IV district). The highest SHDI values of the SR land cover were recorded in the urban districts of Bratislava and Košice, also in the districts of Michalovce, Sobrance, Trebišov, Prešov, Myjava, Nové Mesto nad Váhom and Pezinok (SHDI values above 1.5). The lowest values were recorded in districts where one compositional component is significantly dominant (SHDI values less than

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1), in the case of dominance of arable land - Šaľa district, in the case of dominance of forest land - Gelnica and Brezno districts (Fig. 1).

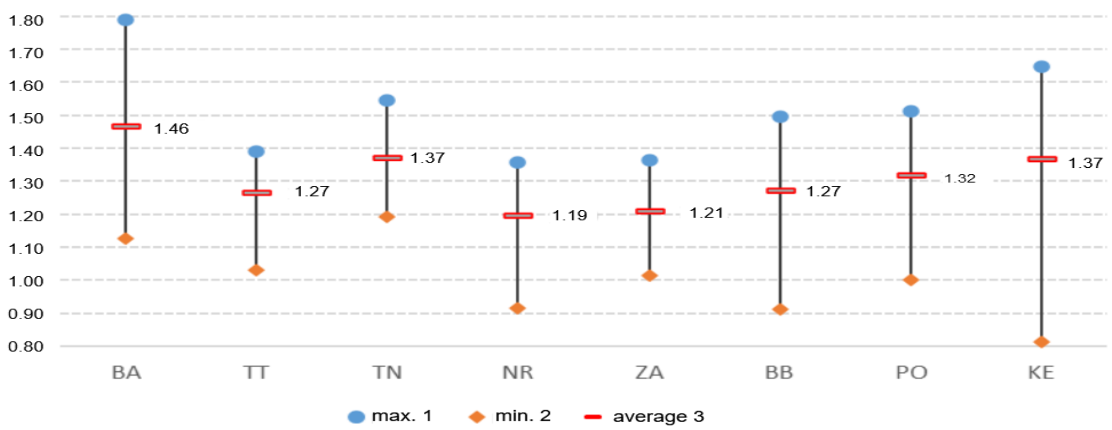

Fig. 1. SHDI of landscape cover of the Slovak Republic by regions
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Notes: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region

In the case of the Shannon index of agricultural land cover diversity, the composition consisted of the following classes of crops grown on arable land (cereals, maize, legumes, root crops, oilseeds, and fodder crops), permanent grassland, vineyards, orchards, vegetables and other areas. The highest average SHDI values of agricultural land cover were calculated for the Bratislava, Trnava, Nitra and Trenčín regions. The districts with the highest SHDI values of agricultural landscape include Pezinok, Veľký Krtíš, Nové Mesto nad Váhom, Rimavská Sobota and Bánovce nad Bebravou. The districts with the lowest SHDI values of agricultural landscape are Čadca, Medzilaborce and Gelnica, where one compositional component of the index (permanent grassland) accounts for more than 90% of the structure of agricultural landscape cover (Fig. 2).

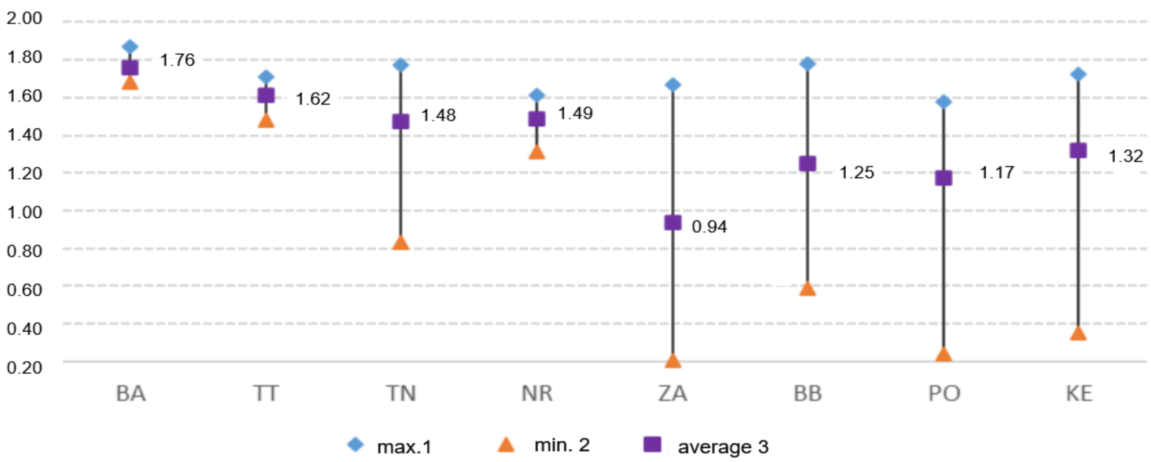

Fig. 2. SHDI of agricultural landscape of the Slovak Republic by regions
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics.
Notes: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region

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The Shannon Equal Distribution Index (SHEI) expresses the diversity of the landscape cover of the Slovak Republic, values range from 0 to 1. The value of the index is close to 1 if the land cover types have almost the same proportional representation or if a high abundance of the landscape types under consideration is present. Low values mean that one type of landscape cover dominates within the assessed landscape area (Fig. 3).

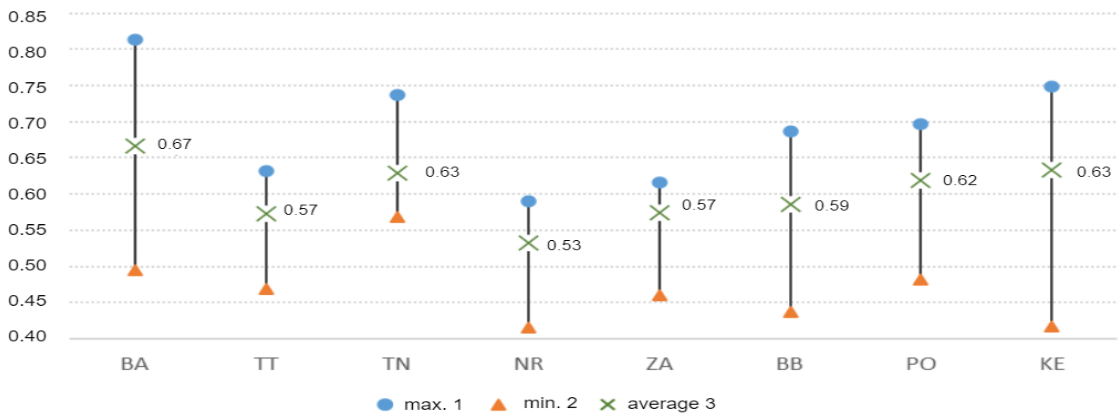
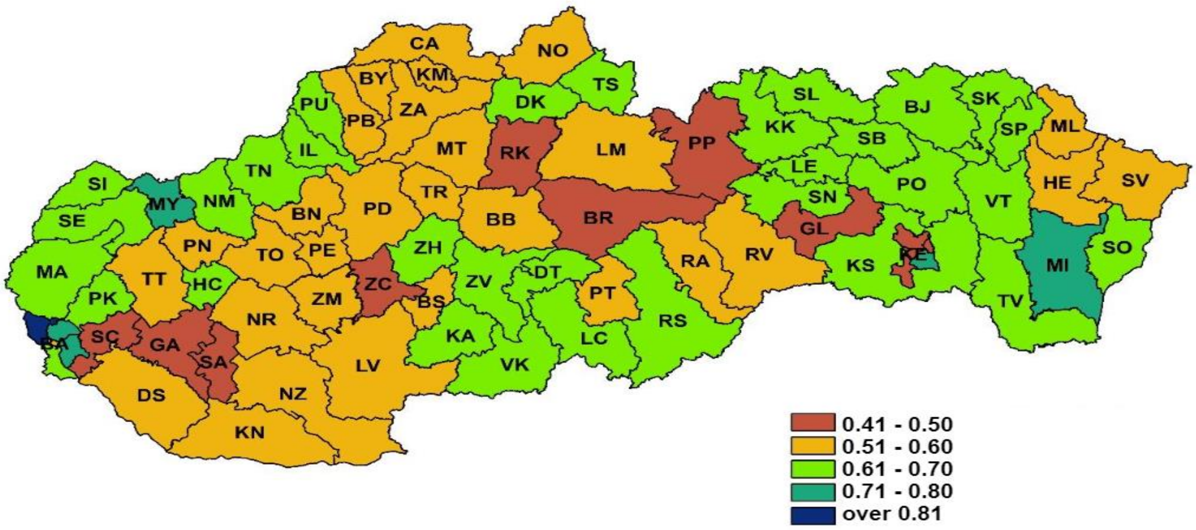


Fig. 3. SHEI (Shannon Equitability Index) land cover values of the Slovak Republic by regions
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics.
Notes: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region

Low values of the index were recorded in districts with dominance of arable land in the total landscape cover of the district (Senec, Galanta, Šaľa) and districts with dominance of forest land (Gelnica, Brezno, Poprad, Ružomberok). According to the index values, some urban districts of Bratislava and Košice show a high diversity of land cover types, as do the districts of Michalovce and Myjava (Map 2).



Map 2. SHEI values of land cover of the Slovak Republic by districts
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Map legend: Shannon equitability index of land cover of the Slovak Republic

The interpretation of resulting values of the index of uniform distribution of agricultural landscapes is similar to the index of uniform distribution of the entire landscape cover of the Slovak Republic, values range from 0 to 1. The different types of agricultural land cover consisted of selected classes of crops grown on arable land, permanent grassland, vineyards, orchards, vegetables and other areas. Districts with high value of the index of uniform distribution of agricultural landscape (above 0.7) are situated mainly in the Bratislava, Trnava and border districts of the Trenčín Region and the southern districts of the Banská Bystrica region (Fig. 4, Map 3).

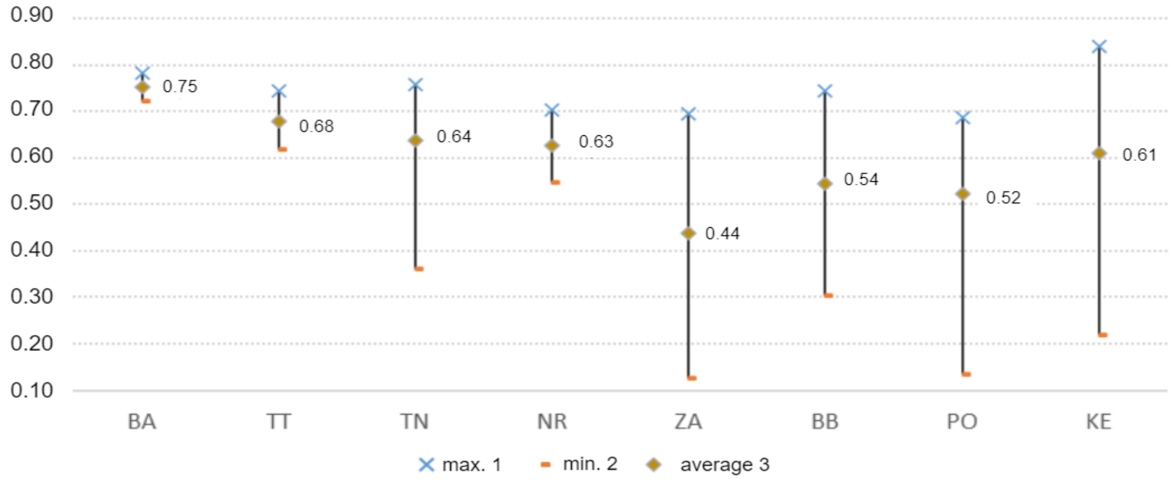
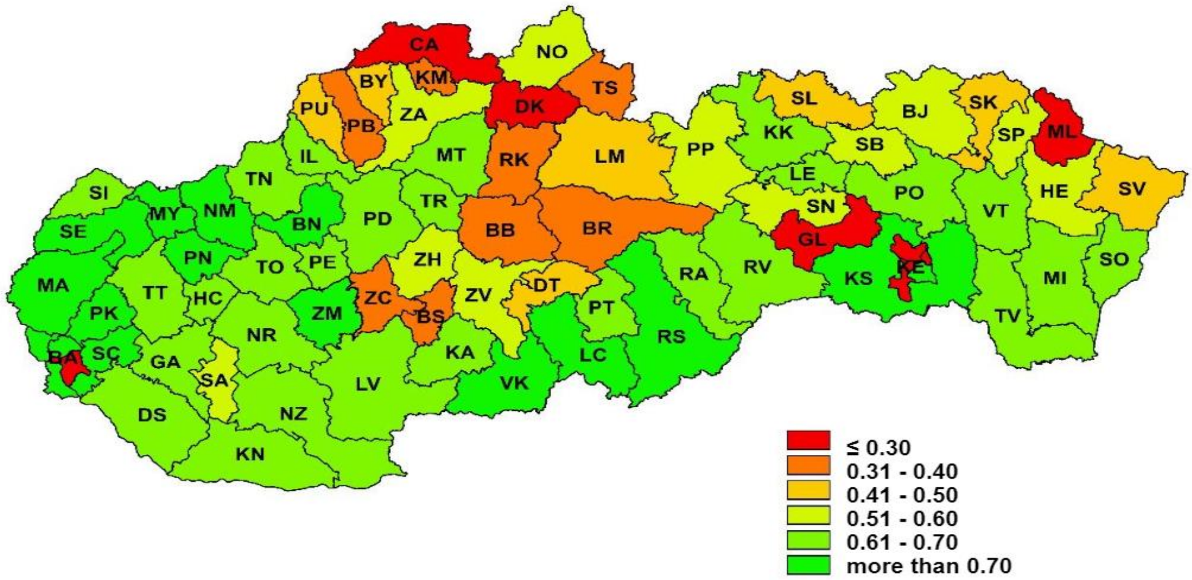


Fig. 4. SHEI values of the agricultural landscape by regions
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Notes: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region



Map 3. SHEI values of agricultural landscape of the Slovak Republic by districts
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Map legend: Shannon equitability index of agricultural landscape of the Slovak Republic

The Naturalness Index (NI) values reflect the natural value of heterogeneous ecosystems and in 2019 the NI values ranged from 15 (Bratislava I district) to 83 (Banská Štiavnica district).
As the value of the index increases, the self-healing capacity of the ecosystem increases and thus its intrinsic value increases.
The districts with the highest NI values were located mainly in the Žilina region (Fig 5, Map 4).
The urban districts of Bratislava and Košice had the lowest NI values, as well as districts with a high concentration of intensive agricultural production (Senec and Galanta districts).

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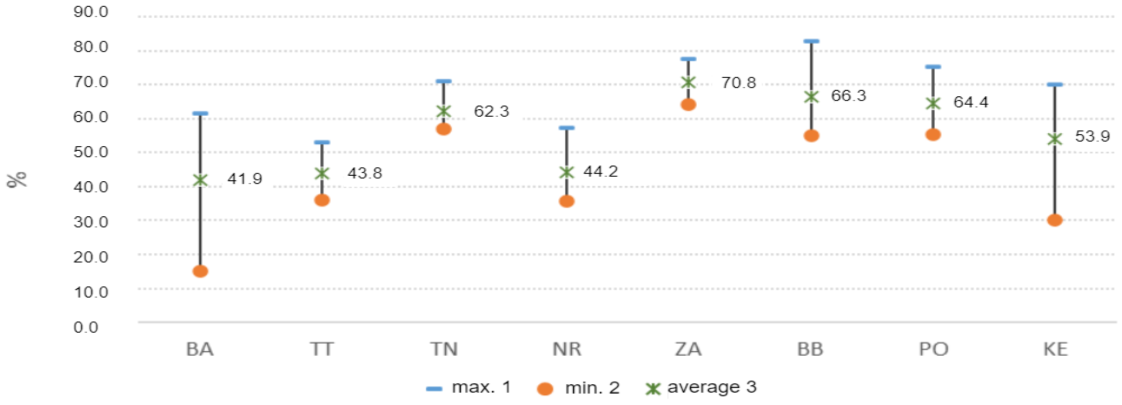
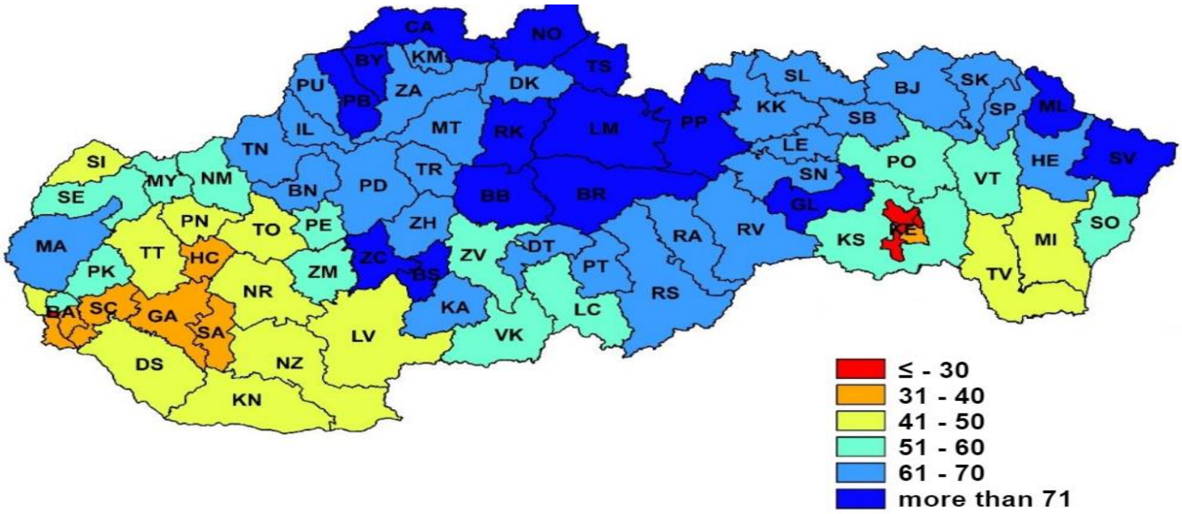


Fig. 5. Naturalness Index by regions
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Notes: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region



Map 4. Values of Naturalness Index by districts
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Map legend: Naturalness Index

Soil quality

The methodology for calculating potential water erosion represents the theoretical loss of soil mass conditioned by relatively stable erosion factors - rainfall erodibility (R-factor), soil erodibility (K-factor), slope length and slope gradient (ZS-factor). The highest average values of potential water erosion were recorded in the districts of the Žilina Region, where the values reached the level of extremely high erosion, especially in the districts of Bytča, Čadca, Dolný Kubín, Kysucké Nové Mesto, Ružomberok and Žilina. Extremely high values were also found in the districts of Gelnica and Žarnovica. The Figure 6 presents maximum, minimum and average values of potential water erosion by regions. Current erosion expresses the intensity of water erosion occurring in specific conditions, taking into account the influence of dynamic erosion factors, namely vegetation cover (C-factor) and human land management (P-factor).

The soil conservation efficiency of the vegetation cover is expressed by the C-factor, which is dependent on the density, structure and duration of the vegetation cover.

The P-factor is an expression of the effectiveness of anti-erosion measures, i.e. the method of agrotechnics or the effectiveness of technical measures to prevent surface outflow. It was necessary to simplify the expression of these factors at the district level.

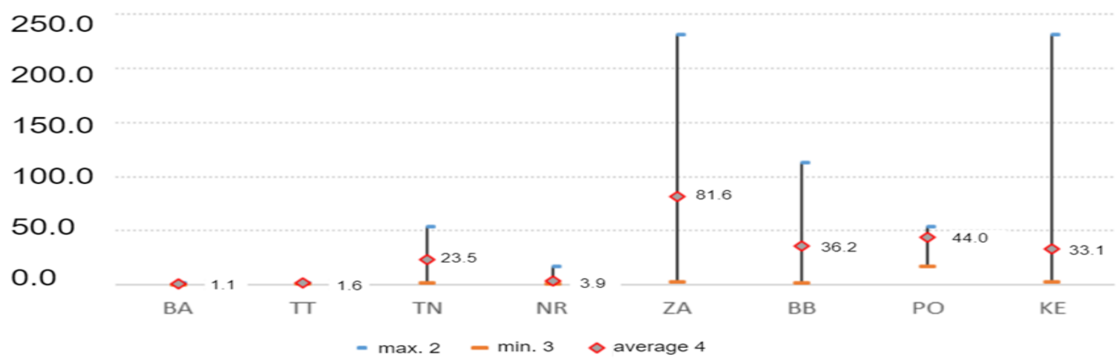


Fig. 6. Potential water erosion by regions, in tonnes per ha of utilised agricultural area
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Note*: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region, 7/
Note**: degree of potential water erosion (according to the Research Institute of Agricultural and Food Economics): 1. ≤ 1.0 slight; 2. 1.1-10.0 low; 3. 11.0-30.0 medium; 4. 31.0-60.0 high; 5. 61.0-100.0 very high; ≥ 100.0 extremely high

The C-factor has a different value for each crop. When calculating the value of the C-factor at the district level, we based on the data on harvested areas (Statistical Office of the Slovak republic) of individual cultivated crops on usable agricultural land. The P-factor was not taken into account in the calculations, as data on soil erosion control measures are not recorded. Resulting values of actual erosion at the district level were calculated as the product of potential erosion and the C-factor.

The lowest average values of current water erosion (degree of slight erosion) were found in the districts of Bratislava and Trnava regions. The highest (in the middle stage of current water erosion) were found in the districts of Žilina and Prešov regions, especially in the districts of Ružomberok, Bytča, Žilina, Prešov, Vranov nad Topľou. Values at the medium level of current water erosion were also recorded in the districts of Myjava, Trenčín, Revúca, Žarnovica and Rožňava (Fig. 7).

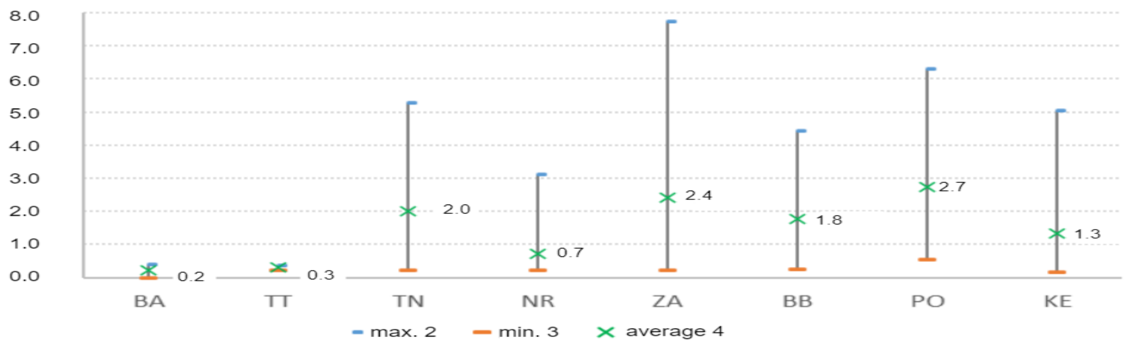


Fig. 7. Actual water erosion by regions, in tonnes per ha of utilised agricultural area
Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics
Note*: BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region, ZA – Žilina Region, BB – Banská Bystrica Region, PO – Prešov Region, KE – Košice Region, 7/
Note**: degree of actual water erosion (according to the Research Institute of Agricultural and Food Economics): 1. ≤ 1.0 slight; 2. 1.1-4.0 low; 3. 4.0-8.0 medium; 4. 8.1-13.0 high; 5. ≥ 13.1 very high

Relationships between PGEs and the regions

The association of PGE indicators to regions by comparing the mean values of PGE indicators for each region is documented in Table 1.

Table 1. Comparison of mean values of PGaE (public goods and externalities) indicators for regions

	Maintenance of the agricultural landscape		
Region	**Shannon diversity index of land cover of the Slovak Republic**	**Shannon diversity index of agricultural landscape**	**Shannon equitability index of land cover of the Slovak Republic**
1	1.22 (1.24)	1.01 (1.06)	0.58 (0.59)
2	1.14 (1.16)	1.52 (1.52)	0.52 (0.53)
3	1.41 (1.41)	1.62 (1.64)	0.64 (0.64)
4	1.51 (1.55)	1.51 (1.68)	0.7 (0.71)
	Maintenance of the agricultural landscape		**Biodiversity**
Region	**Shannon equitability index of agricultural landscape**	**Naturalness index**	**% share of protected areas on the district's total area**
1	0.46 (0.48)	69.02 (69.02)	35.61 (34.86)
2	0.63 (0.64)	39.64 (40.27)	6.73 (6.42)
3	0.69 (0.7)	56.44 (57.84)	18.32 (17.02)
4	0.7 (0.73)	39.65 (35.56)	14.44 (13.16)
	Biodiversity		**Quality and availability of water resources**
Region	**% share of NATURA sites from utilised agricultural land area**	**% share of organic farming from utilised agricultural land area**	**Precipitation total in mm per year**
1	3.2E-02 (0)	18.74 (15.01)	866.96 (864.74)
2	2.07E-02 (0)	1.05 (0.93)	593.72 (594.22)
3	2.1E-02 (0)	7.32 (2.38)	703.55 (698.11)
4	0.16 (0)	9.7 (2.47)	671.25 (651)
	Quality and availability of water resources		
Region	**% share of land with irrigation system from the district's total area**	**% share of irrigated land from the district's total area**	**% share of area with applied fertilizers from the district's total area**
1	7E-03 (0)	1.66E-03 (0)	16.48 (15.94)
2	8.29 (7.63)	3.02 (1.14)	65.77 (67.49)
3	1.17 (8.78E-02)	0.27 (8.37E-03)	33.5 (33.86)
4	0.17 (0)	0.17 (0)	93.23* (13.22)
	Quality and availability of water resources	**Soil quality**	
Region	**Amount of nitrogen applied (in kg) per ha of utilised agricultural area**	**Potential water erosion (in tonnes per ha of UAA per year)**	**Actual water erosion (in tonnes per ha of UAA per year)**
1	89.02 (82.61)	63.72 (53.67)	2.43 (2.16)
2	197.2 (198.45)	1.62 (1.66)	0.33 (0.33)
3	138.89 (142.07)	13.08 (2.32)	1.44 (0.38)
4	1258.84* (26.28)	3.11 (1.66)	0.26 (0.27)
	Air quality		**Climate stability**
Region	**NH3 emissions from animal production in kg/ha UAA**	**NH3 emissions from agricultural land in kg/ha UAA**	**% of organic carbon in soils**
1	6.84 (6.24)	1.04 (0.9)	1.82 (1.82)
2	6.96 (6.37)	5.82 (5.73)	1.97 (1.97)
3	9.57 (7)	3.54 (3.65)	1.82 (1.79)
4	3.04 (3.03)	51.58* (1.03)	1.7 (1.86)
	Climate stability		**Flood prevention**
Region	**Amount of nitrous oxide emissions from animal production in Gg N2O per ha of utilised agricultural land per year**	**Amount of nitrous oxide emissions from agricultural land in Gg N2O per ha of utilised agricultural land per year**	**Retention capacity of land in m3/ha of agricultural land**
1	2.1E-07 (2.07E-07)	1.76E-06 (1.63E-06)	928.2 (931.04)
2	1.43E-07 (1.31E-07)	3.76E-06 (3.79E-06)	1020.72 (1013.85)
3	1.94E-07 (1.83E-07)	2.68E-06 (2.74E-06)	1010.72 (1041.37)
4	4.46E-08 (8.94E-10)	2.38E-05 (4.96E-07)	789.61 (886.25)

Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics

Note: the values in the table are expressed as the arithmetic mean, in brackets the median. Region 4 (large urban agglomerations) is specific, for some indicators we have recorded extreme values (designation *), which may be related to discrepancies between the location of the company's official headquarters and the land management site.

Region 4 (large urban agglomerations) are specific. For some indicators we recorded extreme values, this may be due to a different location of the business as opposed to the location of record (company headquarters). We decided to exclude Region 4 from further examination on the basis of these facts and the low intensity of agricultural production (Košice district is not included in Region 4).

Table 2 presents scores of PGaE indicators and regions in each factor (after rotation).

Table 2. Scores of PGaE indicators and regions in each factor (after rotation)

	Factor 1	Factor 2	Factor 3	Factor 4
Shannon diversity index of agricultural landscape	**-0.881774**	0.036445	0.050656	0.060133
Shannon equitability index of land cover	**-0.529318**	-0.008019	**-0.424567**	0.151283
Shannon equitability index of agricultural landscape	**-0.891778**	0.140677	0.001123	0.082979
Naturalness index	**0.669963**	-0.016925	**-0.633639**	0.074742
% share of protected areas on the district's total area	**0.411495**	-0.051220	**-0.288867**	**0.270618**
/% share of NATURA sites from utilised agricultural land area	-0.105995	-0.060561	-0.062422	**0.624431**
/% share of organic farming from utilised agricultural land area	**0.414073**	-0.095481	-0.171614	0.103000
Precipitation total in mm per year	**0.745454**	0.059864	**-0.498832**	0.028118
% share of land with irrigation system from the district's total area	**-0.208486**	-0.015017	**0.793898**	0.005089
% share of area with applied fertilizers from the district's total area	-0.167299	**0.970715**	0.117173	-0.037666
Potential water erosion (in tonnes per ha of UAA per year)	**0.741421**	-0.076617	-0.178886	-0.045871
Actual water erosion (in tonnes per ha of UAA per year)	**0.376107**	-0.070461	**-0.298645**	-0.089788
NH3 emissions from animal production in kg/ha UAA	-0.065008	-0.093124	-0.057747	-0.189030
NH3 emissions from agricultural land in kg/ha UAA	-0.071840	**0.994892**	-0.046536	0.020438
% of organic carbon in soils	**-0.217745**	-0.040160	**0.553151**	**0.541841**
Amount of nitrous oxide emissions from agricultural land in Gg N2O per ha of utilised agricultural land per year	-0.068949	**0.993414**	-0.047955	0.034087
Retention capacity of land in m3/ha of agricultural land	-0.116684	0.046275	0.120875	**-0.729554**
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Region 1	**0.829258**	-0.081288	-0.241382	0.194457
Region 2	-0.096753	0.025713	**0.899826**	-0.045366
Region 3	**-0.647923**	-0.141783	-0.321674	**-0.377852**

Source: processed by authors, based on the data of Research Institute of Agricultural and Food Economics.

The associations between PGaE indicators and regions are weaker but in many cases substantial, so we used a lower threshold to identify stronger (modulus of scores no lower than 0.3) and weaker (modulus of scores between 0.2 and 0.3) associations.

CONCLUSIONS

The association of PGaE indicators to regions through factor analysis of district-level data, using PGaE indicators as variables and regions coded as binary code variables, demonstrated the following:

Areas of Region 1 (areas of predominantly higher elevation) are strongly positively associated with the natural state index, the percentage of protected area acreage of total district acreage, the percentage of organic farming of usable farmland acreage, rainfall, and both potential and actual water erosion; we did not observe weaker positive associations. Region 1 districts are strongly negatively associated with the Shannon index of agricultural landscape diversity, the Shannon index of even distribution of all land cover (similarly, the Shannon index of diversity of all land cover is highly correlated with it), and the Shannon index of even distribution of agricultural landscapes; they are more weakly negatively associated with the percentage of irrigable land out of the total county acreage and the percentage of organic carbon in the soil.

Areas of Region 2 (areas with good production conditions) are strongly positively associated with the percentage of irrigable land out of total district area and the percentage of soil organic carbon; we did not observe weaker positive associations. Areas of Region 2 are strongly negatively associated with the Shannon index of even distribution of all land cover (and similarly with the Shannon index of diversity of all land cover, which is highly correlated with it), then with the index of natural state of the landscape, rainfall; more weakly negatively associated with the percentage of acreage of protected areas in the total area of the district, and water erosion current. Factor 2 was characterized by a high association of indicators associated with high values of nitrogen inputs per hectare of usable agricultural land (this indicator was not directly included in the modelling due to singularities in the matrices, but is highly correlated with, e.g., the percentage of acreage with fertilizer applied out of the total acreage of the district that was included). Because Factor 2 was specified in this way, this was not taken into account in Factor 3, which is the priority for consideration for Region 2. Simply put, nitrogen inputs in production areas need to be given high consideration in the design of measures. This is also evident from the identification, quantification and localisation of the PGaE related to the nitrogen issue itself.

Areas of Region 3 (transition areas between Region 1 and 2) are not clearly associated with PGaE indicators.

The analysis showed a strong polarization based on the natural conditions that determine the production conditions. An interesting finding is the mostly strong associations of PGaE indicators for polarized areas in terms of agroecological structures. Another interesting finding is the “dispersion“ of the studied associations in the “transition“ region.

These findings were also valid for different combinations of input variables as well as for optional numbers of factors (while keeping the limit of still admissible characteristics of the models). This implies the validity of proposals for targeted measures to potentiate the positive and reduce the negative impacts of activities within the agricultural sector.

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ASSESSING THE APPLE SECTOR IN ROMANIA AND INSIGHTS ON THE CONSUMPTION

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Abstract

The present work proposes as an area of analysis the apple sector and the characteristics of apple consumption in Romania. For this, a theoretical and applied documentation of different approaches in specialized works was made. A series of themes and methods used were identified. In our article we addressed the descriptive analysis of the data procured from national and international databases. The results were presented in the form of tables, graphs and figures. Thus, we were able to note the fact that Romania is part of the top five European countries producing apples, owning areas and an important number of orchards. In order to complete the study and obtain some results on the consumption of apples in Romania, we applied a questionnaire, to which 663 valid answers were obtained, they showed us a complex profile of consumers of fresh apples in our country.

Key words*: *apple, Romania, survey, consumption

INTRODUCTION

It is known that in Romania there is a tradition in the cultivation of fruits. The share is 38.25% in the private system, and 30.06% is found in the individual family farm system, the farms with large areas being quite small, and many plantations are abandoned or aging. This led to a decrease in the production levels of domestic products, turning Romania from a predominantly exporting country into a fruit importing country. Although at the beginning of the 2000's there were legislative initiatives [11] regarding a national strategy aimed at increasing the competitiveness of Romanian products for export and thus, increasing the degree of employment in related fields. There was also a project on the strategy for the development of the agri-food sector in the medium and long term – on a period 2020-2030 [9]. In this sense, it is confirmed that there is a need for a reorganization of the system of production and utilization of fruits, considering the pedo-climatic conditions of our country. Although Romania's soil and climate offer favourable conditions for the cultivation of trees up to altitudes of almost 800 m, the total area cultivated with fruit trees is reduced, in 2020 being approximately 138 thousand ha, representing only 1% of the country's agricultural area, the plantations of apple occupying an area of 57,100 ha, a large part of which is in decline. At the European level, in the top 5 countries with areas cultivated with apple crops (EU-25), Romania is also on the 4th place, with a percentage of 11.1%, after Turkey, Poland - the main producer of apples in the EU by volume, the ranking being completed by France.
In order to carry out the present work, a documentation of the existing literature was made, on the subject addressed. Thus, we will mention part of the research that focused on the production and consumption of apples.
The hypothesis that there is a decrease in the apple consumption, has been taken into consideration by several authors. Thus, researchers covered a higher range of approaches evaluating that “in high-income markets where more local food production and consumption is desired, where consumers are increasingly conscious about seasonality,

a large choice of products, and health issues, the traditional apple may not have a bright future. In fact, a rather low-income elasticity of apples reflects the fruit's low attractiveness to food consumers".

Moreover "strategies of the apple industry to win back lost buyers in such markets may include variety innovation in particular to improve on the fruit's health properties and smaller and softer fruits to cater for the needs of aging consumers" [6]. Another paper started from the idea that "per capita apple consumption is falling in many European countries while overall fruit intake is growing or is stable, and consumption of other fruits is increasing" and concluded that "for the European apple growing industry, the decline in local per capita apple consumption may not be an economic problem if the industry decides to focus on emerging markets in the future. However, innovating fruit quality and better satisfying apple consumer preferences in high-income markets may prove to be more challenging" [1].

There are also papers that studied in depth the disease recognition of apples and inspection of quality of fruits where different types of diseases exist in different fruits. This kind of research is focus on quality evaluation of apple fruit [13].

Approaching a nutritional side of the apples consumption it was observed "an increasing appreciation and understanding of the link between dietary fruit and vegetable intake and improved health in humans" [8].

A more general approach of a paper stated that the apples are widely produced in temperate regions, "the fruit color development in apple is a major focus for both breeders and researchers as consumers associate brightly colored red apples with ripeness and a good flavor" [2].

There was also another kind to approach different types of apples, analyzing the shape of leaves. "The geometry of the leaf was studied by fractal analysis in order to characterize the cultivars studied. Regression analysis revealed the relationship of interdependence between leaf area and fractal dimensions for each apple cultivar" [12]. One paper focusing on the storage impact of apples, has shown that "correlating the results regarding storage losses, sensory properties and changes in major chemical components", and so, it can conclude that with a proper storage will lead to minimal losses in the quantity and quality fruits [3].

Another practical approach on the apples sector and the impact on the environment by using special measures stated that "Apple orchards and farmlands were graded with additional points starting from 36 to 100 by implementing the Expert System CROM and were classified into three classes: unrestricted, with some restrictions and unsuitable for apple cultivation" [4].

One paper that also used survey as tool for analyse the apple orchard found that "owners wanted to know both the consumers' perception of the apple juice they produce and market, as well as finding solutions to improve their marketing activity so that their products are as attractive as possible" [10].

A more complex method to take into consideration when approaching the apple orchard is the LCA (Life Cycle Assessment), which can conclude on a wide field of interest, including the impact on the environment. In this specific paper, the authors used the apple as a case study and "an LCA method was performed to obtain the impacts associated with young and old low productive trees, alongside those associated with trees in full production" [7].

This standardized method (LCA) focused on the environment impact has been covered in a wide range of fields and it is now used also in agriculture, horticulture etc. The paper mentioned below confirm once again that "Life Cycle Assessment is a valuable tool in identifying environmental hotspots, which can help inform targeted change to address sustainable concerns, where hard apple cider can be a component of sustainable agriculture as a means for low-impact, high-profit added value for an apple orchard" [14].

Sometimes, together with LCA method, there is a complementary method focused more on the monetary side of a field. This is the LCCA (Life Cycle Cost Analysis) method. There is a paper aimed “to establish a framework based on the two mentioned methods in order to select the best parameters of apple technology by identifying the particularities of fruit production technologies and providing practical recommendations on how to approach the two methods” [15].

Covering a relatively small part of the literature, we can conclude that there is a clear need for more research and innovation in the field of apple orchards and further in the industry transformation for one simple reason - increase high quality consumption of these fruits and so, research papers and progress will certainly be requested.

MATERIALS AND METHODS

The present article considered information regarding the orchard sector, more precisely the existing apple orchards. These were obtained by querying national and international databases. Thus, descriptive analysis methods were used on the data processed from the National Institute of Statistics (NIS) and Eurostat. With the help of these data, the dynamics of surfaces, productions, the number of trees and consumption in Romania and in some European countries were presented. In this sense, the graphic and tabular presentation was part of the methodology used to create this article. Also, a questionnaire was created (Google form) regarding the consumption of apples among the population of our country, which was disseminated online. Thus, we received the answers from 663 people. For the analysis and interpretation of the results, we used as a method the analysis of the frequencies of certain answers. The processing and interpretation of the questionnaire results using the SPSS program. In this sense, we followed the structuring of the results by age, gender, area of residence, education, job, etc. Then, we drew the profile of the consumer by the number of apples consumed, the type of apples, the place of supply for them, the influence of advertising on the products, the reason why they consume apples/fruits and the preference for domestic or imported fruits.

RESULTS AND DISCUSSIONS

Fruits are consumed as food or as vitamin supplements in the human diet, so the consumer is more oriented towards the quality and taste of the fruits, being generally willing to recognize these elements with a distinctive character, at a higher price.

Dynamics of surfaces and productions at European level

Although Romania ranks 4th in the area cultivated with apples, and the production is on an upward trend, we depend more and more on the import of apples.

Also, in the average annual consumption of apples/capita, an increase of 129.33% was observed, from 22.5 kg of apples/capita in 2010, to a consumption of 29.1 kg of apples/capita in 2020. According to Table 1 (Surface occupied by apple orchards), we can see that at the European level, in 2017, in the top 5 European countries, Romania is also included with a percentage of 11.1%, occupying the 4th place (out of the total the group of the first 5 large apple growers), after Turkey (34.95%), Poland with 32.46%, and Italy, which is very close to our country, with a percentage of 11.44%. France (10.05%) is the last of the top 5 countries with areas cultivated with apples, but very close to the percentages of the last 2 states.

In the period 2018 - 2020, the ranking of the surfaces is preserved, Romania oscillating insignificantly and thus occupying a percentage between 10.72% and 10.9%. In 2021, the situation changes, with Romania rising to 3rd place with a percentage of 15.38%, Germany reaching 2nd place, two new apple-growing states appearing, Spain and Hungary, with 12.36% and 11.35%, respectively, Turkey and France not being in the top 5 European countries with areas of apple orchards.

From the point of view of production, in the period 2017 - 2020, the EU-5 top of the 5 European apple-producing countries is correlated with the cultivated areas, Turkey being the top producer with an average of 30.76% in this period of 4 years, followed by Poland, with an average of 27.37% (Table 2).

Table 1. Area (cultivation/harvested/production) (1,000 ha), fresh consumption

Country	2017	% from top EU-5	Country	2018	% from top EU-5	Country	2019	% from top EU-5	Country	2020	% from top EU-5	Country	2021*	% from top EU-5
Turkey	175.0	*34.9%*	Turkey	175.0	*34.8%*	Turkey	174.0	*35.7%*	Turkey	171.0	*35.60%*	Poland	175.0	*50.6%*
Poland	162.5	*32.5%*	Poland	166.2	*33.0%*	Poland	155.6	*31.9%*	Poland	152.00	*31.6%*	Italy	54.2	*15.7%*
Italy	57.3	*11.4%*	Italy	57.4	*11.4%*	Italy	55.0	*11.3%*	Italy	54.91	*11.4%*	Romania	53.2	*15.4%*
Romania	55.6	*11.10%*	Romania	53.9	*10.7%*	Romania	52.7	*10.8%*	Romania	52.34	*10.9%*	Germany	33.9	*9.8%*
France	50.3	*10.1%*	France	50.5	*10.1%*	France	50.4	*10.3%*	France	50.15	*10.4%*	Spain	29.5	*8.5%*
Total top EU-5	500.7	*100%*	Total top EU- 5	503.1	*100 %*	Total top EU- 5	487.7	*100%*	Total top EU-5	480.40	*100%*	Total top EU- 5	345.8	*100%*

Source: own processing, based on Eurostat database [5].
*Apples for fresh consumption; no data for fruit processing.
*Data for 2021 is to be confirmed. Not validated yet.

At the same time, Italy and France remain on the 3rd and 4th places, but Romania is no longer included in this classification, appearing as a top 5 European producer, only from 2021, with a percentage of 11.75%, occupying the 4th place, with a small difference from Hungary on the 5th place (11.35%), now included in this ranking, of the 5 years studied in our article. In 2021, Spain also entered the market with apple production, occupying a percentage of 12.36%, on the 3rd place in the top EU - 5 productions at the European level.

Table 2. Harvested production in EU standard humidity (1,000 t), fresh consumption

Country	2017	% from top EU-5	Country	2018	% from top EU-5	Country	2019	% from top EU-5	Country	2020	% from top EU-5	Country	2021*	% from top EU-5
Turkey	3,032.0	*31.24%*	Poland	3,999.5	*30.69%*	Turkey	3,619.0	*30.80%*	Turkey	4,300.0	*33.18%*	Italy	2,149.1	*44.33%*
Poland	2,441.4	*25.15%*	Turkey	3,626.0	*27.83%*	Poland	3,080.6	*26.22%*	Poland	3,554.3	*27.43%*	Germany	979.4	*20.20%*
Italy	1,912.27	*19.70%*	Italy	2,466.9	*18.93%*	Italy	2,303.7	*19.61%*	Italy	2,462.4	*19.00%*	Spain	599.4	*12.36%*
France	1,723.1	*17.75%*	France	1,740.4	*13.36%*	France	1,753.5	*14.93%*	France	1,619.9	*12.50%*	Romania	569.8	*11.75%*
Germany	596.67	*6.15%*	Germany	1,198.5	*9.20%*	Germany	991.45	*8.44%*	Germany	1,023.3	*7.90%*	Hungary	550.5	*11.35%*
Total top EU- 5	9,705.5	*100.00%*	Total top EU- 5	13,031.4	*100.00%*	Total top EU- 5	11,748.2	*100.00%*	Total top EU- 5	12,959.9	*100.00%*	Total top EU- 5	4,848.2	*100.00%*

Source: own processing, based on Eurostat database [5].
*Apples for fresh consumption; no data for fruit processing.
*Data for 2021 is to be confirmed. Not validated yet

In Table 3, it was summarized Romania's position in relation to the European average, regarding the area and production of fresh apples intended for consumption in the period 2016-2020.

Table 3. Area and production of apples* in the EU-27** and shares for Romania

	2016	2017	2018	2019	2020
Apples Area (1000 ha) for fresh consumption, EU-27	506.48	505.55	507.24	491.08	484.01
Total Area, of which % Romania din UE 27	***10.96%***	***11.00%***	***10.63%***	***10.74%***	***10.81%***
Apples harvested production (1000 t) for fresh consumption, EU-27	12,112.22	9,594.86	13,333.43	11,585.41	11,832.51
Total production, of which % Romania din UE 27	***3.77%***	***3.54%***	***4.76%***	***4.25%***	***4.54%***

Source: own processing, based on Eurostat database [5].
*Apples for fresh consumption; no data for fruit processing.
**EU-27, from 2020

The area cultivated with apples for fresh consumption, at the EU-27 level, in the period 2016 - 2020, was on average 498.87 thousand ha, of which Romania, on average, owns 10.82% of this area. Analyzing the production of apples for fresh consumption, at the EU-27 level, in the period 2016-2020, an average of 11,693.68 thousand tons were recorded over the 5 years analyzed, with a peak in 2018, when - they produced 13,333.43 thousand tons of apples. From the average production at the EU-27 level, Romania produced a relatively small amount, covering a percentage of only 4.17% of the production.

Dynamics of the apple sector in Romania

Below, in Figure 1, we have represented the share of the number of apple trees in the total number of fruit trees, by the development regions of Romania and by property type, in 2020.

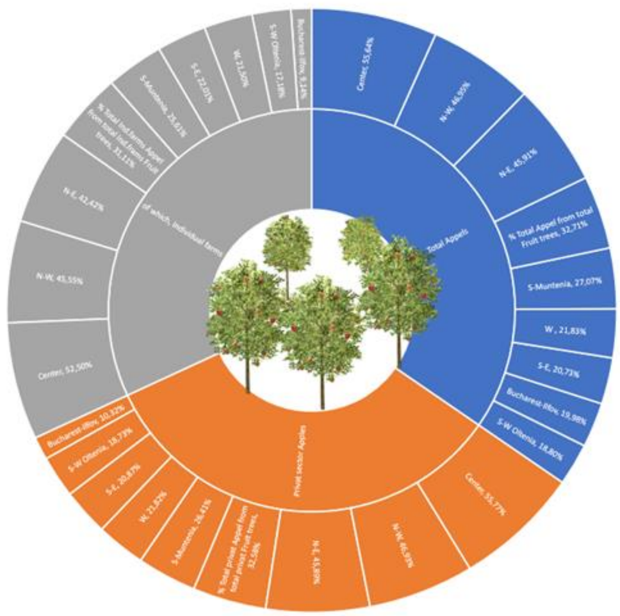

Fig.1. Shares of the Apple trees from Total number of Fruit trees, per Region, Romania (2020)
Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

When we analyze the share of the number of apple trees in the total number of fruit trees, by property type, at the level of our country, we observe the following that apple orchards are grown in 2 ownership systems: the individual farm system, which occupies an average of 30.06 %, the largest percentage being occupied by the Center area with 52.5% from Total number of Fruit trees. The private sector has an average share of 38.25%, where the Center area covers the largest number of trees, with a percentage of 55.77% from Total number of Fruit trees.

At the zonal level, Shares of the Apple trees from Total number of Fruit trees, the Central area is in first place, with 55.64%, followed by the West area with 21.83%, then the South-East area with one percent of 20.73% from Total number of Fruit trees.

The private sector in the area of fruit tree orchards in Romania has always occupied a privileged place. The orchard areas were, even during the communist period, an area where private property kept a wider place. We present in the following graph (Fig. 2) the share of the number of apple trees in the private area, in relation to the total number of apple trees at the country level and in the development regions of our country, in the year 2020.

Regarding the total number of apple trees, grown in private system, it occupies an average percentage of 99.12% of the total of our country, and a percentage of over 99.39% is found in all the development regions of Romania, except making Bucharest which occupies a percentage of only 43.65% and which is justified by the fact that it is not an area where fruit growing is practiced.

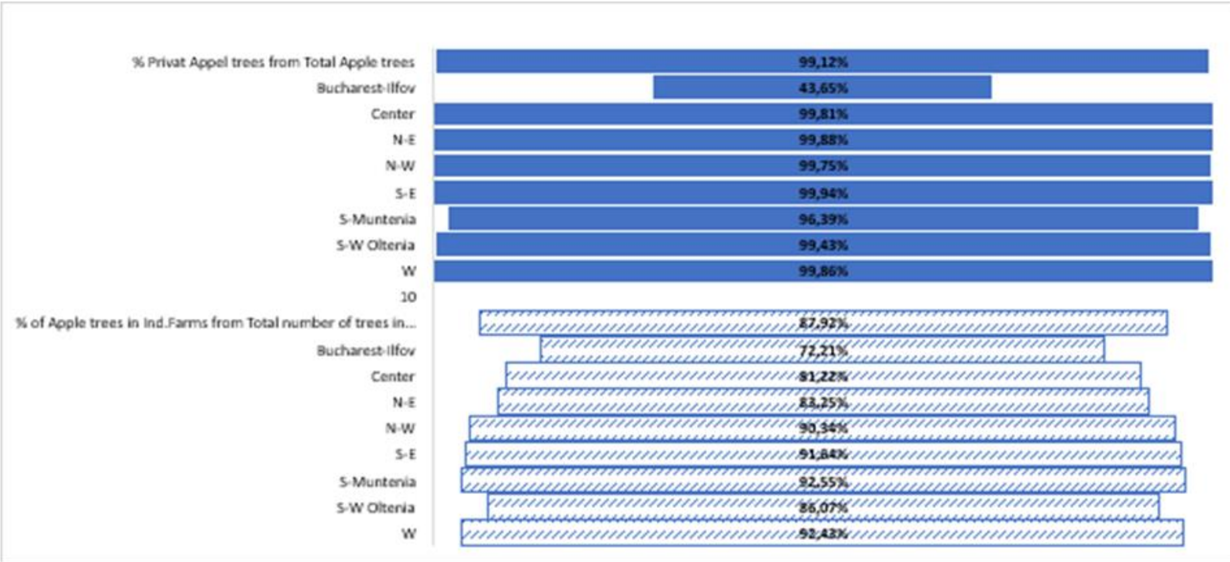

Fig. 2. Shares of the apple trees in Privat sector Apple, 2020
Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

When we also refer to apple trees, from individual farms, they cover a total percentage of 87.92% of total private apple trees, and in the rest of the regions the percentages vary in a small range of approximately 10 percent, from 81.22% and 92.55% from private farms, the exception is again Bucharest, which occupies a smaller percentage (72.21%).

Legal form	Region	2019	2020
Total	TOTAL	21	23
Total	South-Muntenia	28	31
	South-West Oltenia	28	28
	North-East	21	21
	West	20	19
	North-West	19	21
	South-East	19	18
	Center	17	19
	Bucharest-Ilfov	6	7
Privat Sector	TOTAL	21	23
Privat Sector	South-Muntenia	29	32
	South-West Oltenia	28	28
	North-East	21	21
	West	20	19
	North-West	19	21
	South-East	19	18
	Center	17	19
	Bucharest-Ilfov	13	11
out of which: Individual farms	TOTAL	23	24
out of which: Individual farms	South-Muntenia	30	34
	South-West Oltenia	29	32
	North-East	22	23
	Center	20	21
	South-East	20	19
	West	20	20
	North-West	19	21
	Bucharest-Ilfov	16	15

Fig. 3. Average apple production (kg/tree) by Legal forms and by region, Romania, 2019-2020
Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

The total average production of apples (kg/tree/apple) in Romania, at the level of 2020, indicates that in the Southern Region-Muntenia the trees give the best production, obtaining 31 kg/tree, followed by the Southern Region- West-Oltenia with 28 kg/tree, the other regions varying between 21-18 kg/tree, respectively the Bucharest-Ilfov Region with a rather small amount of 7 kg/tree, compared to the total average of Romania of 23 kg/tree (Fig. 3).

The differences are not very big, if we refer to the quantities obtained in the private sector as a whole and that from individual farms, this being only 1 kg/tree, which is obtained in addition in the private sector, respectively 24 kg/tree. The average difference between the private and the individual sector, at the level of kg/tree, is 2 kg/tree, this being found in the individual sector, where more attention is paid to these crops. In Table 4, we presented the quarterly consumption of apples, by social category and by residence, respectively rural and urban.

Table 4. Quantity of average quarterly fresh fruit consumption per social category, per rural and urban areas, Romania, 2015-2021*

		Q1	Q2	Q3	Q4**
Total	Urban (%)	119.48%	121.21%	129.99%	121.17%
Total	Rural (%)	77.38%	75.37%	64.78%	75.31%
Employed population	% from Total	108.15%	109.62%	111.16%	107.89%
Farmers		53.79%	48.98%	48.68%	53.60%
Unemployed population		74.90%	72.25%	63.81%	61.72%
Retired population		106.75%	104.98%	104.88%	106.30%

Average monthly quantity bought/person (2021)		Quarterly averages (2021)	Difference between urban and rural areas
Total	Urban (%)	122.96%	49,75%
Total	Rural (%)	73.21%	
Employed population	% from Total	109.21%	
Retired population		105.73%	
Unemployed population		68.17%	
Farmers		51.26%	

Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].
*For 2021 – provisory data,
**T4 was calculated without 2021

Regarding the total amount of apple consumption in rural and urban areas, in the 5 years analyzed and separately in 2021 (table on the right), we note that in the urban environment, on average, 49.75% is consumed (in 2021) more apples, respectively 122.96%, compared to the rural environment, where this consumption is 73.21% (in 2021). Also, on the left side of the table 5, we notice that the biggest consumers of apples by social category are employees, consuming on average 109.62% (Q2), followed by a very small percentage difference by retirees with a percentage of 106.75 % (Q1), the unemployed and farmers being at the tail of consumers, the difference between them being 16.91%, from 48.68% (in Q3) to 74.9% (in Q1).

Table 5. Share from the Total 2020/2015 of the fruit quantity bought quarterly, per region, Romania

	Q1	Q2	Q3	Q4	2020 / 2015
TOTAL	**120.63%**	**127.76%**	**120.97%**	**130.48%**	**124.96%**
North-West	131.09%	122.09%	135.53%	140.26%	132.25%
Center	125.11%	120.41%	121.65%	116.72%	120.97%
North-East	111.82%	114.35%	91.61%	104.07%	105.46%
South-East	121.58%	144.14%	155.90%	124.33%	136.49%
South-Muntenia	114.45%	131.17%	134.11%	136.35%	129.02%
Bucharest-Ilfov	116.68%	120.97%	101.86%	149.74%	122.31%
South-West Oltenia	119.11%	140.17%	128.65%	138.14%	131.52%
West	126.63%	140.89%	120.56%	139.73%	131.95%

Growth per total 2020/2015	
TOTAL	**24.96%**
S - E	36.49%
N-V	32.25%
V	31.95%
S - V Oltenia	31.52%
S - Muntenia	29.02%
Bucharest - Ilfov	22.31%
Center	20.97%
N - E	5.46%

Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

On the right side of Table 5, the Southeast Development Region is presented, with its six component counties, a region where, according to the data in the adjacent table, the largest increases were recorded in terms of the average amount of fruit purchased quarterly per social categories, in total, in rural and urban areas. It should also be mentioned that private apple orchards had the highest percentage in the country, as it was mentioned previously in this work, and the offer of these orchards came to support apple consumers. Consequently, reporting the average monthly amount of fruit bought by households, in the

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period 2020 compared to 2015, it was 124.96% at the national level, the largest amount of apples bought was in the S-E Region of Romania, which was 136, 94% (2020/2015), followed by the N-W Region with 132.25%, the west and S-W Oltenia reached an average percentage of 131.73%, followed by the S-Muntenia Region with 129.02%, the last regions, but with insignificant differences being Bucharest Ilfov (122.31%) and the N-E Region (105.46%).

The increases in the quantities of apples bought between 2015 and 2020 were a total of 24.96%, the S-E region being at the top with an increase of 36.49%, at the opposite pole being the N-E Region with an increase of only 5, 49%. And in the Bucharest-Ilfov area, the quantities of fruit bought increased by 22.31% in 2020 compared to 2015, which indicates a continuously growing consumer preference for these fruits.

Extending the analysis period for the consumption of fruit and fruit products and for apples, 2010-2020, Table 6, we note an increase of approximately 61% in 2020 compared to 2010 (Fruit&fruit products) and an increase of half (compared to the previous category), to apples (29%).

Table 6. Average consumption/capita, Fruit&fruit products and Apples, 2010-2020, Kg

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2020 / 2010
Fruit and fruit products	67.0	74.7	71.1	73.7	80.2	87.8	96.0	96.1	110.8	111.3	107.6	161%
Apples	22.5	26.2	24.3	23.5	25.2	25.9	28.4	26.3	31.7	34.5	29.1	129%

Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

Thus, it can be observed that the average annual consumption of fruit and fruit products per capita, registered an increase of 161% for the period 2010-2020, from 67 kg of fruit in 2010, to 107.6 kg of fruit in 2020 However, the highest value of this indicator was attributed to the year 2019, of 111.3 kg of fruit, the year in which the highest consumption of apples was also recorded, this being 34.5 kg. And the average annual consumption of apples, per capita, for the same period recorded an increase of 129%. If in 2010 an average of 22.5 kg of apples were consumed per inhabitant, in 2020 a consumption of 29.1 kg of apples was reached. Of the total fruits consumed on average, in 2020, apples represented 27.04%, as opposed to 33.58% in 2010, so we can conclude that apples have decreased in the preferences of those who consume fruit. Based on these Romanians' preferences for fruits, which we identified as continuously increasing, we presented in the following table (Table 7) the daily average consumption expressed in calories and nutritional factors. The table indicates the average consumption per inhabitant of calories and the large groups of nutritional elements, in Romania, in the period 2010-2020 and the share of the intake that fruits and fruit products have in this consumption for calories, proteins, lipids and carbohydrates.

Table 7. Average daily food consumption, per inhabitant, expressed in calories (number) and nutritional factors (grams)

Product groups for consumption expressed in calories and nutritional factors	Specific measurement units	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Calories	number	3400	3390	3287	3302	3320	3464	3462	3500	3549	3548	3555
Fruit and fruit products	*number*	*3.7%*	*4.1%*	*4.0%*	*4.2%*	*4.5%*	*4.8%*	*5.2%*	*5.3%*	*6.1%*	*6.1%*	*6.0%*
Proteins	Grams	109.4	110	106.7	108.4	108.6	112.3	112.4	114.1	117.4	117.7	117.4
Fruit and fruit products	*Grams*	*1.6%*	*1.7%*	*1.7%*	*1.8%*	*1.8%*	*2.1%*	*2.2%*	*2.5%*	*2.7%*	*2.7%*	*2.6%*
Lipids	Grams	112.1	104.3	103.6	99.6	106.6	111.7	113.6	116.2	118.1	118.7	120.2
Fruit and fruit products	*Grams*	*2.9%*	*3.4%*	*3.1%*	*3.4%*	*3.3%*	*3.8%*	*4.0%*	*4.5%*	*5.2%*	*5.1%*	*5.1%*
Carbohydrates	Grams	466.4	481.4	460.8	471.8	460.4	479.9	475.5	477.2	481.6	479.8	478.3
Fruit and fruit products	*Grams*	*4.7%*	*5.1%*	*5.1%*	*5.1%*	*5.7%*	*5.9%*	*6.6%*	*6.5%*	*7.5%*	*7.6%*	*7.4%*

Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

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It can be seen that the values of these indicators have increased for all categories, as follows (in descending order): in the category proteins from fruits and fruit products 172.22%, calories from fruits and fruit products 170%, lipids from fruits and fruit products 107.23 % and fruit carbohydrates and fruit products 162.67 %. For 2020, the percentage of fruit and fruit products was as follows: calories 6%; proteins 2.6%; lipids 5.1% and carbohydrates 7.4%. As expected, fruits and fruit products contribute the most to the carbohydrate category and the least to the protein category.

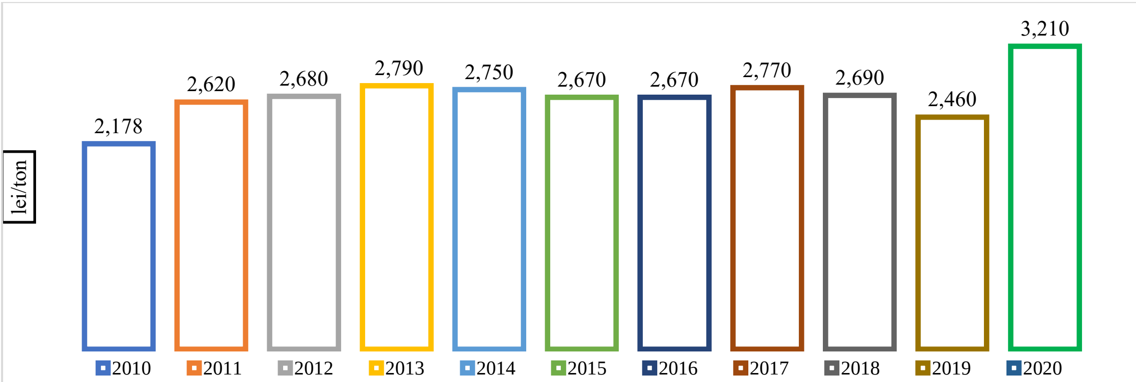

Fig. 4. Price dynamics of apples, Romania, 2010-2020, lei/tons
Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

Analyzing the basic prices for apples, in the period 2010-2020, we note that they had a fluctuating dynamic, from 2,178 lei/ton in 2010, to 3,210 lei/ton in 2020, which means an increase of 147.38%. Apart from 2020, where the biggest price difference was recorded (compared to 2010), the best price in the analyzed period was recorded in 2013 (2,790 lei/ton). Of course, price changes over the course of a year are variable. A representation of these quarterly differences between apple prices (lei/kg), in the period 2014-2020 can be seen in the figure below (Fig. 5).

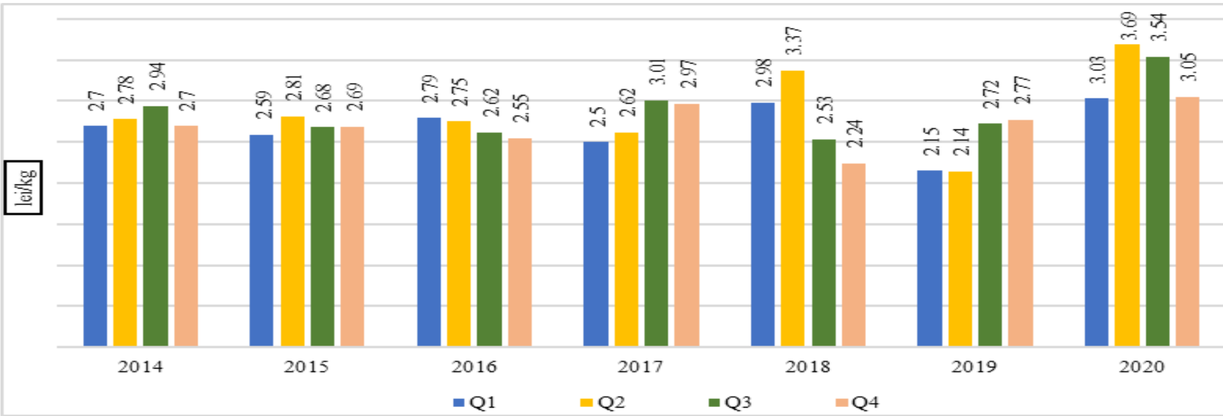

Fig. 5. Average prices of apples in Romania, per quarters
Source: own elaboration based in tempo online dataset (NIS, accessed on February 2022) [16].

Thus, it can be observed that at the level of average prices for table apples, for the whole country, by years and semesters, for the period 2010-2020, the lowest value was recorded in Q2, 2019, of 2.14 lei/kg, and the highest value in 2020, Q2, namely 3.69 lei/kg. We note the similar evaluation of prices, in the sense that, in the first 2 quarters, price increases are observed, and then they decrease. Exceptions were observed for the years 2015 and 2019, when slight increases in average price values were recorded.

In line with average and core apple prices, producer prices also showed an upward trend. Thus, the increase in the analyzed period was 148.61%, and for 2019 a slight decrease was noted, due to the fact that 2019 was not a good year for apples (NIS source).

Analysis of the results of the questionnaire

Following the application of the questionnaire regarding the preferences of apple consumers in Romania, we received 663 responses, which we have structured in the following table (Table 8).

Table 8. Table frequencies on the survey' answers

Questions	Possible answers	Frequency	Percent	Key word on the Apple consumer's profile
AGE	under 19 years old	17	2.6%	YOUNG
	20 -29 years old	262	39.5%	
	30 -39 years old	163	24.6%	
	40 – 49 years old	141	21.3%	
	50 – 60 years old	65	9.8%	
	over 60 years old	15	2.3%	
GENDER	female	383	57.8%	FEMALE
	male	280	42.2%	
RESIDENCE	urban	434	65.5%	CITY
	rural	229	34.5%	
EMPLOYMENT	private sector	413	62.3%	PRIVATE CORPORATION
	state sector	250	37.7%	
STUDIES	college	301	45.4%	EDUCATED
	university	362	54.6%	
CONSUMPTION BENEFITS	Yes	597	90.0%	INFORMED
	No	66	10.0%	
CONSUMPTION	Yes	624	94.1%	YES
	No	39	5.9%	
HOW MANY APPLES/WEEK	1-3 apples	310	46.8%	1-3 APPLES
	4 - 6 apples	185	27.9%	
	7 - 9 apples	69	10.4%	
	over 10 apples	59	8.9%	
	none	40	6.0%	
OTHER FRUITS	yes	293	44.2%	MAINLY APPLES
	no	370	55.8%	
ADVERTISING	Not at all	279	42.1%	NO INFLUENCE FROM MASS-MEDIA/ADVERTASING
	less	289	43.6%	
	relatively high	60	9.0%	
	high	24	3.6%	
	Very high	11	1.7%	
STATUS RESPONDENT	employed	416	46.7%	EMPLOYED / STUDENT
	entrepreneur	56	6.3%	
	farmer	45	5.1%	
	student	357	40.1%	
	unemployed	2	0.2%	
	retired	13	1.5%	
	Home working	2	0.2%	
PLACE TO BUY	market	412	39.4%	BUY ON THE MARKET
	supermarket	335	32.0%	
	Self production	259	24.7%	
	other	41	3.9%	
VARIETY OF APPLES	Florina	210	22.2%	YELLOW AND RED
	Idared	136	14.4%	
	Golden_delicios	339	35.8%	
	Jonatan	237	25.0%	
	Voinesti	2	0.2%	
	Granny_Smith	10	1.1%	
	Starkrimson	5	0.5%	
	others	8	0.8%	
TYPE OF CONSUMPTION	fresh	651	83.4%	FRESH APPLES
	transformed	130	16.6%	
REASON	dessert	383	47.2%	AFTER MEAL, AS A DESSERT
	diet	125	15.4%	
	meal	58	7.2%	
	others	245	30.2%	
PLACE OF PRODUCTION	Romania/local market	653	92.6%	FROM ROMANIA
	imported	52	7.4%	

Source: own representation on the questionnaire.

The analysis of the frequencies of the answers obtained showed us a certain profile of the apple consumer in Romania.

Thus, we were able to have the personal characteristics of age, gender, residence, job, professional training. Later, we noted the characteristics of the consumption itself, namely the knowledge of the benefit brought by the consumption of fruit, the number of apples per day, the preference for other fruits, the influence of advertising on consumption behaviour, the professional status, the

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provenance, the variety, the type, the reasons and the place of purchase of apples.

All these figures being based on descriptive analysis's results and the frequencies can be summarized in a short "story", such as the following.

Romanian apple/fruit consumer is a young (20-29 years old 39.5%), female 57.8% (male 42.2%), living in a city (65.5%) and working in a private corporation (62.3%). She is highly educated (54.6%) and informed on the benefits of fruit consumption (90%). She also enjoys eating fruit - up to 3 apples/day (46.8%), mainly Golden delicious (35.8%), Jonathan (25.0%) and Florina (14.4%), without being influenced by the advertising (42.1%). She could be also a student (40.1%), buying fruit on the market 39,4% (and on the supermarket 32.0%), targeting the fresh (83.4%), yellow or red apples, as a dessert (47.2%) and buying these fruits widely from a local market (92.6%). The figure below (Fig. 6), resumes in a picture the apple consumer's profile, based on the survey.

Fig. 6. Apple consumer representation, based on the survey, Romania, 2022.
Source: own representation.

CONCLUSIONS

The results obtained following the analyses carried out in this paper showed a presence of Romania in the top European countries in terms of surface area and production, in the analyzed periods. At the national level, the dynamics of the number of fruit trees, the production, the quantities purchased and the consumption of fruit, and in particular that of apples, were analyzed. The results of the article were also based on the analysis of Romanians' consumption preferences, results that we obtained following the application of a questionnaire. Thus, we had 663 respondents who gave us answers that allowed us to create a profile of the apple consumer in Romania. We were able to identify a consumer characterized by young age (20-29 years; 39.5%), female gender (57.8%), with urban residence (65.5%), who works in the private sector (62.3 %), with higher education (54.6%) and knowledgeable about the benefits of fruit consumption (90%). Regarding the actual consumption of apples, we could identify a preference for 1-3 apples/day – Golden delicious (35.8%), Jonathan (25.0%), Florina (14.4%), but also others fruits, bought from the market, originating from Romania, and this consumer is not influenced in the consumption process by advertising or mass media.

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ANALYSIS OF PRODUCTION COST AND PROFITABILITY OF ANISE PRODUCTION IN BURDUR, TURKEY

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Abstract

This study aimed to determine the socio-economic structure of farms producing anise and analyse the cost and profitability of anise production. The marketing structure has also changed with the changing trade and agricultural policies. As a result of these changes, price instability has been experienced in the anise market. Anise is an essential source of income in the research region. The research area is Burdur province because Burdur province has an important position in Turkey's anise production. The data were obtained by survey method from 159 anise farms. The production cost in anise production was determined as 739.33 TRY per unit area (Gross Production Value (GPV) 1,224.27 TRY, gross profit 635.38 TRY, and relative profit were 1.66. The Total Cost/GPV ratio was calculated as 0.60. In recent years, significant reductions in anise production in the region and increased cultivation areas in other provinces; fluctuations and volatility in anise producer prices substantially impacted these decreases. It is essential to provide anise-specific support and carry out extension activities about anise to producers through relevant institutions. To prevent price instability, institutions such as TEKEL and the TMO, which had a decisive influence on the anise market in previous years, were significant. It seems very difficult for such institutions to operate again. It is recommended that anise producers establish organisations to act together to eliminate the problems of anise producers and eliminate price instabilities specific to anise.

Key words*: *anise, cost, profit, Burdur

INTRODUCTION

Anise (*Pimpinella anisum* L.), which finds its place among medicinal and aromatic plants, is a species from the Apiaceae (Parsley family) family and is an essential plant with different usage areas. It is widely used in pharmaceuticals, cosmetics, and alcoholic and non-alcoholic beverage production [3] [13]. The seeds of the anise plant, widespread in Turkey and especially in the Lakes Region, are used as a tonic, antispasmodic, expectorant, antiseptic, antifungal, sedative, antidepressant and galactagogue [10]. Anise, which is used in the production of raki in Turkey, is also one of the medicinal and aromatic plants used in food, pharmacy and perfumery [5]. Anise fruits, which are cult in many countries, are among the essential export products among medicinal plants, so it is a plant with high economic value for Turkey [13]. Especially with the privatisation works that started in Turkey in the 1990s and the reorganisation of the policies in the agricultural sector in the 2000s, the production and marketing structure of anise has changed. With the withdrawal of the Turkish Grain Board (TMO) and TEKEL from the market, anise growers were adversely affected.

In addition, it can be said that the import of anise, which has become entirely free with the market liberalisation of alcohol and alcoholic beverages (taking into account that agriculture is supported in different systems in important producing countries and sometimes given with government subsidies), causes a significant contraction in Turkey's anise agriculture. Therefore, knowing the marketing structure, problems and costs of the producers in anise production, which takes place in the free market order, will benefit policy practitioners, intermediaries and producers.

In the first place in the anise cultivation area in Turkey in 2020, Denizli, Ankara and Burdur were determined as the research region, respectively. These provinces are followed by Konya, Afyonkarahisar, Uşak and Antalya. Denizli province constitutes 19.19% of Turkey's anise cultivation area, Ankara province 17.47%, and Burdur province 16.33%. When the development of anise production in Turkey over the years is examined, Burdur province, which ranks third in Turkey's anise cultivation area, ranks first in Turkey's anise production amount. Anise production amount, which was 11,000 tons in 2004 in Turkey, decreased by only 3% to 10,716 tons in 2020, and there was no significant decrease in the amount of production. Konya and Ankara provinces, which started anise production activities in 2011, showed a substantial increase in anise production amounts in 2020. In Burdur, the production amount, 4,959 tons in 2004, decreased by 62% in 2020 to 1,891 tons (Table 1).

Table 1. Development of anise production in Turkey (tons)

Years	Burdur	Denizli	Konya	Ankara	Afyonkarahisar	Antalya	Muğla	Balıkesir	Bursa	Turkey
2004	4,959	3,369	-	-	502	1,570	16	273	276	11,000
2005	4,403	2,663	-	-	235	1,473	150	250	287	9,500
2006	3,118	2,810	-	-	275	1,566	150	260	259	8,479
2007	4,503	1,692	-	-	255	606	455	200	269	8,006
2008	4,682	1,928	-	-	248	606	600	231	275	8,594
2009	5,478	1,979	-	-	217	620	600	235	317	9,472
2010	8,449	1,985	-	-	290	620	2,000	235	393	13,992
2011	7,312	3,441	170	12	731	820	1,500	460	412	14,879
2012	4,268	3,171	188		475	995	1,201	260	444	11,023
2013	4,246	2,055	221	15	620	1,130	800	230	483	10,046
2014	4,021	1,998	183	3	554	930	900	184	440	9,309
2015	3,777	2,004	224	2	574	940	900	136	423	9,050
2016	3,927	2,387	204	2	540	883	950	85	429	9,491
2017	3,371	1,722	319	79	545	871	960	42	413	8,418
2018	3,432	1,464	525	232	937	697	1,000	35	188	8,664
2019	3,483	2,167	5,339	1,761	1,664	904	880	35	167	17,589
2020	1,891	1,849	1,651	1,349	1,321	974	440	27	13	10,716
Index*	38	55	971	11,242	263	62	2,750	10	5	97

*2020 (2004=100; 2011=100 for Konya and Ankara)
Source: [14].

When the shares of the provinces where anise production is realised in Turkey in 2020 within the total amount of anise production are examined, while the province of Burdur ranks first, making up 17.65% of Turkey's total, Denizli province, which makes up 17.25% of Turkey's total, ranks second. These provinces are followed by Konya, which accounts for 15.41% of Turkey's total (Fig. 1).

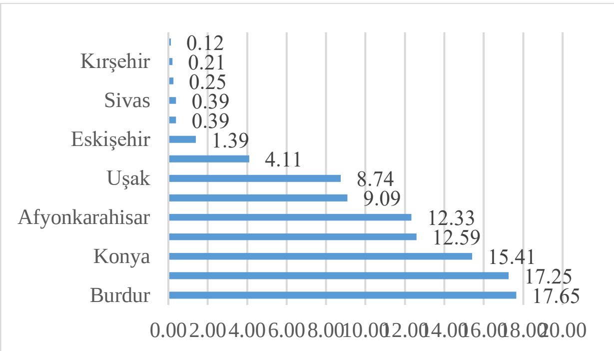


Fig.1. Share of anise production in Turkey in 2020 (%)
Source: Own design and calculation based on [14].

When the proportional shares of Burdur province in Turkey anise cultivation area and production amount are examined as of 2020, its share in cultivation area and production amount show parallelism. While Burdur province met more than 60% of Turkey's anise production in 2010, it decreased below 20% in 2019 and 2020.

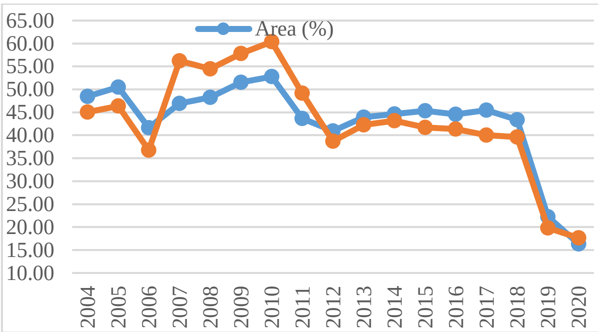


Fig. 2. Development of Burdur province in Turkey anise cultivation area and its share in production
Source: Own design and calculation based on [14]

The fact that the share in the production amount was higher than the share in the cultivation area in 2007-2010 can be explained by the fact that the anise yield of Burdur province per unit area in the mentioned years was higher than the anise yield values of Turkey (Fig. 2).

In 2020, the most crucial anise producing districts in Burdur province at the district level was Tefenni, Çavdır, Yeşilova, Karamanlı and Gölhisar, respectively. These mentioned districts also constitute the research area and cover almost the entire province of Burdur both in anise cultivation area and anise production amount. The Tefenni district, which shares 41.40% of the Burdur anise cultivation area, is 52.46% of the production amount. This is explained by the fact that the anise yield of the Tefenni district is above the anise yield average of Burdur province. Suppose the shares of other neighbourhoods forming the research region in the cultivation area of Burdur province are above the shares of Burdur province in the amount of anise production. In that case, it indicates that the anise yield of these four districts is below the anise yield average of Burdur province (Table 2).

Table 2. Burdur anise cultivation area, yield and production (2020)

Districts	Cultivation area (da)	The share of cultivation area in Burdur province (%)	Yield (kg/da)	Production (ton)	Share of production in Burdur province (%)
Tefenni	10,500	41.40	94	992	52.46
Çavdır	6,243	24.62	56	350	18.51
Yeşilova	4,190	16.52	65	272	14.38
Karamanlı	2,000	7.89	60	120	6.35
Gölhisar	1,900	7.49	60	114	6.03
Merkez	275	1.08	84	23	1.22
Kemer	170	0.67	65	11	0.58
Altınyayla	60	0.24	117	7	0.37
Bucak	24	0.09	83	2	0.11
Burdur	25,362	100.00	75	1,891	100.0

1 decares = 0.1 hectares
Source: [14].

Anise is one of the medicinal and aromatic plants with high economic returns in Turkey and Burdur, which is also essential in rural development. It is seen that there has been a decrease in anise production in Burdur, which is a historically critical province in anise production. This study aimed to determine the economic structure and the factors that cause the production shrinkage in the region, identify the emerging problems, and develop solutions.

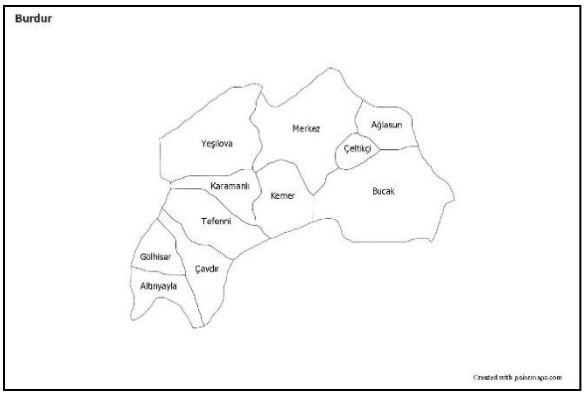
MATERIALS AND METHODS

The material of the study consisted of the data obtained by using the survey method from the agricultural farms and stakeholder engaged in anise cultivation in the province of Burdur. The research data belonged to the 2020 production season.

The main mass of the enterprises from which the data used in the research were obtained consisted of farms operating in the field of anise cultivation in Yeşilova, Tefenni, Karamanlı, Çavdır and Gölhisar districts of Burdur province (Fig. 3) (98% of anise production in Burdur province). Since it would not be possible to survey all farms in the main population in terms of time and economy, the farms to be observed were selected by the Stratified Sampling method [16]. The Neyman Method was used to determine the number of samples for the survey application and distribute the sample numbers to the strata [4]. It was calculated from the main population that 159 anise farmers should be interviewed with a 5% deviation from the anise field average and within the 95% confidence limit (Table 3).

The enterprises engaged in anise production were divided into three layers according to the frequency distribution, taking into account the size of the anise cultivated area. Farmers with an anise cultivation area of 14.99 decares or less formed the I. group, and it was calculated that 58 anise producers from this group should be interviewed. The farms that realise anise cultivation area between 15.00-29.99 decares expressed as an II. group. It was determined that 28 anise producers from this group should be interviewed. Enterprises with an anise cultivation area of 30.00 decares or more were created in the III. group. It was calculated that 73 anise producers from this group should be interviewed. Therefore, the sample size and the number of anise producers to be interviewed were 159 farms (Table 3).

In Burdur province, 159 farm samples were calculated by considering the anise cultivation areas in 2019. The distribution was made taking into account the cultivation area share of the districts. Accordingly, 71 farms from Yeşilova district, 33 farms from Karamanlı district, 31 farms from Tefenni district, 19 farms from Çavdır district and five farms from Gölhisar district were calculated.



Map 1. Research area map
Source: [17].

Table 3. Sampling size in anise cultivation

Groups	Anise area lower and upper limits (da)	N	Standard deviation	Variance	Average anise field size (da)	n
I	1.00-14.99	888	3.7	13.7	7.2	58
II	15.00-29.99	378	4.2	17.8	20.7	28
III	30.00 +	221	18.7	350.3	50.0	73
Total		1,487	16.9	286.7	17.0	159

Source: Own calculation.

In the study, to determine the product's situation for the stakeholders in the anise marketing channel, data were obtained by interviewing one processor factory operating in the research area.

The necessary data for the analysis were obtained through face-to-face surveys from the farms operating in anise cultivation in Burdur province. The questionnaire form, which was created according to the purpose of the research from the determined farms, was filled by the researcher by going to the producers in the villages in the relevant research region through face-to-face interviews, and these data were transferred to the computer environment, calculations were made in statistical package programs and charts were created. These charts were interpreted with absolute and relative distributions and simple weighted averages.

The single product budget analysis method was used to determine the operating costs in anise farming. According to this method, income and expense status was calculated only for anise, the research subject, not for all products grown in an agricultural enterprise. Production period cost charts were created in anise production. The charts included the labour force, tools and equipment, and the amounts used in performing various operations. The amount of labour and tool equipment used in the production activity was calculated in hours.

The family labour wage provision calculation was determined by taking into account the foreign labour wages in the research region. The amount of fertiliser used per decare in anise production was given as the total of plant nutrients. Since the partial budget analysis was made in the research, the machine rental prices were taken as a basis, although the farmers use their own machines. 3% of total variable costs were calculated as general administrative expenses. Revolving fund interest, variable costs were calculated as half of the current interest rate applied by T.C. Ziraat Bank to crop production loans. Land rent costs for anise were also considered in the cost of land rent in the research area, even though the farmers' owners use their own land.

The gross production value was calculated by multiplying the amount of product obtained due to anise production activity and the sales price. In calculating the gross profit for anise, the formula "gross production value of anise – variable costs of anise" was used. Absolute (net) profit was determined by subtracting the total cost of anise production from the gross production value. The relative profit was calculated as the ratio of the gross production value of anise to the total production costs for anise [1], [6], [9].

RESULTS AND DISCUSSIONS

The "Neyman Method" used for sampling takes more samples from the layer with high variance. For this reason, the regional weighted average was also determined. Gül [7] and Gül [8]'s regional weighted average approach was used. Therefore, the number of frequencies and the total number of frequencies were proportioned to the population of the enterprise size groups. A coefficient was obtained for each layer, and the values calculated for each group (layer) were multiplied by this coefficient and the region weighted average was calculated.

Some Characteristics of Farmers and Farms

The average age of the farmers in the examined enterprises was 52.37 years. As the anise planting scale of the farms grew, the average age decreased. The average education period of the farmers was determined as 8.00 years. The experience period of the operators in crop production was found to be 28.65 years, and the experience period in anise production activity was found to be 25.74 years. Approximately 60.00% of the surveyed enterprises had non-agricultural income (Table 4). It was determined that 57.86% of the operators were engaged in livestock production activities. The credit card usage rate in businesses was found to be 69.18%. As the anise farms scale grew, the rate of credit card usage increased. When the debt status of the examined enterprises in the last five years was questioned, 43.40% of the operators had an increase in their debt situation in the previous five years. Almost all of the interviewed operators had social security (98.74%). The enterprises' leaf and soil analyses were very low. 71.07% of the operators were members of an agricultural organisation, 44.65% were members of Agricultural Credit Cooperative, and 52.20% were members of Pankobirlik. 43.40% of the operators reported that they received livestock support, 52.83% fertiliser and 50.94% diesel support (Table 4).

The knowledge level of the operators in anise production, their satisfaction level in anise production and their tendency to continue anise production were found to be slightly above the medium level. As the scale of anise farmland grew, these three levels increased. The debt per enterprise in the examined enterprises was calculated as 39,393.09 TRY (Table 4).

Table 4. Some characteristics of the operator

	Groups			
	I	II	III	Farms average
Operator age (years)	55.53	51.96	50.01	52.37
Operator education level (years)	8.34	8.46	7.55	8.00
Experience of the operator in plant production (years)	31.00	28.93	26.67	28.65
Experience of the operator in anise production (years)	27.97	23.93	24.66	25.74
Has non-agricultural income (%)	67.24	71.43	49.32	59.75
Animal husbandry (%)	55.17	50.00	63.01	57.86
Credit card ownership (%)	62.07	64.29	76.71	69.18
Borrower (%)	51.72	60.71	61.64	57.86
Increasing indebtedness in the last five years (%)	37.93	53.57	43.84	43.40
Having social security (%)	98.28	96.43	100.00	98.74
Having had leaf analysis (%)	0.00	0.00	2.74	1.26
Soil analysis (%)	0.00	3.57	6.85	3.77
Member of an agricultural organisation (%)	67.24	71.43	73.97	71.07
Member of Agricultural Credit Cooperative (%)	50.00	39.29	42.47	44.65
Pankobirlik member (%)	50.00	53.57	53.42	52.20
Using agricultural credit (%)	41.38	46.43	54.79	48.43
Receiving livestock support (%)	34.48	35.71	53.42	43.40
Receiving fertiliser support (%)	44.83	60.71	56.16	52.83
Receiving diesel support (%)	43.10	57.14	54.79	50.94
Tendency to continue anise production	2.98	3.36	3.57	3.32
Knowledge level in anise production	3.09	3.1	3.15	3.12
Satisfaction level with anise production	2.55	2.64	3.13	2.82
Number of credit cards	1.96	2.28	2.6	2.31
The debt amount (TRY)	32,367.94	29,166.67	50,902.99	39,393.09

Source: Own calculation. 1 USD = 7.02 TRY

The average household population on farms was between 3-4 people. As farm size groups increased, the household population also increased. 51.74% of the household population of 3.25 people in enterprises was male, and 48.26% was female.

The majority of the farm's population consisted of primary, secondary and high school graduates. The proportion of the household population who graduated from primary school was 44.03%, middle school 15.17%, high school 26.64%, associate degree 3.46%, and undergraduate 7.33%.

Anise production activity constituted 13.79% of the total gross production value obtained from agricultural production in the examined enterprises. In the research region average, the contribution of anise production activity to GPV was 9.94%. While the share of GPV obtained from other plant production activities in the total GPV was 36.80%, the percentage of GPV obtained from animal production in the total GPV was 45.56%. The rate of 3.85% was the share of agricultural support received from the state in the total GPV.

The anise cultivation area of the examined enterprises was 28.33 decares on average. The enterprise itself owned 67.77% of the total anise cultivation area. The remainder consisted of lands that were rented out. Among the farm width groups, the rate of anise land being owned by the operator varied between 61.40% and 86.28%. The farm group in which the operator's rate of anise land was the highest first group. Large-scale enterprises used to lease 38.60% of the land they cultivated anise.

The anise cultivation area, which was 28.33 decares on the farm average, was 13.65 decares (48.19%) of irrigated land and 14.68 decares (51.81%) of dry land. As the farm width groups increased, the irrigation rate of the anise land increased. However, anise cultivation in the region was generally grown on barren lands.

The areas where anise cultivation was carried out in the enterprises consisted of an average of 3.79 parcels. The average parcel width was 7.47 decares. As the scale of anise cultivation grew, the number of parcels and the width of the parcels also increased. The number of parcels of anise land in the farm width groups varied between 2.00 and 5.45. The parcel size in the farm width groups also differed between 5.22-8.28 decares (Table 5).

Table 5. Number and size of anise land plots

Groups	Number of parcels	Parcel size (decare)
I	2.00	5.22
II	3.18	6.80
III	5.45	8.28
Farms average	3.79	7.47
Regional average	2.81	6.55

Source: Own calculation.

Use of Labour and Machinery in Anise Production

On average, 498.79 hours of foreign labour and 112.92 hours of family labour were used in anise production. The use of foreign labour was calculated as 17.60 hours per decare. It was determined that family labour was used for 3.99 hours per decare. On the average of farms, 81.54% of the workforce use was met by the foreign workforce and 18.46% from the family workforce. Machine usage within the enterprise width groups changed between 1.43-2.50 hours per decare. Machine usage was calculated as 1.64 hours per decare in the average of enterprises (Table 6).

Table 6. Use of labour and machinery in anise production

	Groups				
	I	II	III	FA	RA
Foreign workforce (hours)	189.16	484.39	750.33	498.79	347.61
Family workforce (hours)	74.79	88.71	152.51	112.92	89.88
Total workforce (hours)	263.95	573.11	902.84	611.72	437.49
Foreign labour per decare (hour)	18.13	22.42	16.62	17.60	18.86
Family labour per decare (hour)	7.17	4.11	3.38	3.99	4.88
Total workforce per decare (hour)	25.30	26.52	20.00	21.59	23.74
Foreign workforce (%)	71.66	84.52	83.11	81.54	79.46
Family workforce (%)	28.34	15.48	16.89	18.46	20.54
Total workforce (%)	100.00	100.00	100.00	100.00	100.00
Machine power (hours)	26.12	40.61	64.63	46.35	35.53
Machine power per decare (hour)	2.50	1.88	1.43	1.64	1.93

FA: farms average; RA: Regional average
Source: Own calculation.

As the farm width groups increased, machine power per decare decreased (Table 6).

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Production Costs in Anise Production

Production cost is the sum of fixed and variable costs. Fixed cost is the costs that occur whether or not production is realised and are not dependent on production volume. Fixed costs consist of general administrative expenses, permanent workforce and land rent [12].

On the other hand, variable costs are expenses that vary according to the production volume and occur as long as the production takes place. Variable cost elements are machinery rent, seeds, fertilisers, pesticides, irrigation costs, temporary labour wages, marketing costs and revolving fund interest [12].

According to the groups, the variable cost total in the enterprises was an average of 632.31 TRY per decare in the I. group, 657.95 TRY per decare in II. group, and it was found as 568.24 TRY per decare in the III. group. The variable cost of 588.89 TRY per decare was used based on the enterprise and was calculated as 616.63 TRY in the region average (Table 7).

While the total cost that changes based on the enterprise was 16,685.19 TRY on average, the regional average was 11,364.52 TRY. Among the variable cost elements, temporary labour, machinery rental, and fertiliser costs accounted for more than half of the variable costs (59.46%). Temporary labour costs were 29.25%, machinery rental 17.82%, fertiliser 12.39%, marketing 10.16%, irrigation 8.58%, seeds 8.15% and pesticides were 7.99% among the total variable costs (Table 7).

Fixed cost elements in anise production activity were general administrative expenses, permanent labour expenses and land rent. The total fixed cost per unit area (decare) in farm width groups changed between 140.05 TRY and 181.27 TRY. The fixed cost per unit area (decare) was calculated as 150.44 TRY in the average of the enterprises interviewed. It was determined that the fixed cost per unit area in anise production in the region average in 2020 was 164.57 TRY. The most important fixed cost element was land rent (Table 7).

Table 7. Production cost in anise production

Cost elements	Groups			FA	RA
	I	II	III		
	Amount per decares (TRY)				
Machine rental	156.83	108.48	94.80	104.97	119.84
Seed	44.59	48.43	48.56	48.01	47.18
Fertiliser	75.85	75.47	71.95	72.95	74.32
Pesticide	38.19	49.32	48.25	47.05	45.17
Water	46.79	47.17	51.79	50.50	48.72
Temporary workforce	179.09	228.09	160.75	172.26	187.02
Marketing	55.19	63.75	59.96	59.83	59.47
Revolving fund interest	35.79	37.24	32.16	33.33	34.90
Variable cost total	632.31	657.95	568.24	588.89	616.63
General administrative expenses	18.97	19.74	17.05	17.67	18.50
Permanent-family workforce	82.36	46.91	38.82	45.75	55.94
Land rent	74.92	114.62	84.19	87.03	90.12
Fixed cost total	176.24	181.27	140.05	150.44	164.57
Production cost	808.55	839.21	708.29	739.33	781.19
	Share (%)				
Machine rental	19.40	12.93	13.38	14.20	15.34
Seed	5.52	5.77	6.86	6.49	6.04
Fertiliser	9.38	8.99	10.16	9.87	9.51
Pesticide	4.72	5.88	6.81	6.36	5.78
Water	5.79	5.62	7.31	6.83	6.24
Temporary workforce	22.15	27.18	22.70	23.30	23.94
Marketing	6.83	7.60	8.47	8.09	7.61
Revolving fund interest	4.43	4.44	4.54	4.51	4.47
Variable cost total	78.20	78.40	80.23	79.65	78.93
General administrative expenses	2.35	2.35	2.41	2.39	2.37
Permanent-family workforce	10.19	5.59	5.48	6.19	7.16
Land rent	9.27	13.66	11.89	11.77	11.54
Fixed cost total	21.80	21.60	19.77	20.35	21.07
Production cost	100.00	100.00	100.00	100.00	100.00

Source: Own calculation.

The land rent, which was 87.03 TRY on average for farms, was 90.12 TRY on the regions' average. It was calculated that the permanent labour cost varied between 38.82 TRY and 82.36 TRY per decare. General administrative expenses varied between 17.05 TRY and 19.74 TRY per decare in farm groups (Table 7).

The permanent labour cost per decare in I. group enterprises was 82.36 TRY, 46.91 TRY in II. group enterprises, and 38.82 TRY in III. group enterprises. Land rent values differ within enterprise width groups. The land rent paid per decare is 74.92 TRY in I. group enterprises, 114.62 TRY in II., and 84.19 TRY in III. group farms (Table 7).

The share of general administrative expenses in total fixed costs in operating averages was 11.74%. The percentage of permanent labour costs in total fixed costs was 30.41%. The share of land rents in total fixed costs was 57.85% (Table 7).

In their anise feasibility report, Ayhan et al. [2] calculated that the total costs per decare in anise production was 721.40 TRY. Production cost calculations made in this study were also done by Ayhan et al. [2] and were close to the findings.

Profitability Indicators in Anise Production

It was determined that the average production cost per decare was 739.33 TRY. The production cost per decare ranged between 708.29 TRY and 839.21 TRY in the farm's width groups. Anise yield was 83.93 kg in the average enterprises and 85.02 kg in the region's average (Table 8).

GPV per decare was 1,224.27 TRY in anise producing enterprises where the research was conducted. GPV per decare varied between 1,208.80 TRY and 1313 TRY in enterprise width groups (Table 8).

In their anise feasibility report, Ayhan et al. [2] determined the GPV per decare of anise production as 1,760 TRY. In our study, the GPV was around 1,200-1,300 TRY. We calculated the gross profit by subtracting the total variable costs from the gross production value. The average gross profit per decare of the interviewed enterprises was 635.38 TRY. Gross profit per decare was calculated as between 587.47 TRY, and 655.06 TRY in enterprise width groups (Table 8).

Ayhan et al. [2] calculated the gross profit per decare in anise production as 1,038.60 TRY in the anise feasibility report. Our study determined that the gross profit per decare ranged between 590-655 TRY. It was calculated that the gross profit per unit area in the research area was lower.

In anise production, the absolute profit per decare was determined as 484.93 TRY in the average of the enterprises. This value varied between 411.23 TRY and 500.51 TRY in farm width groups (Table 8).

The relative profit in anise production activity in the average of enterprises was 1.66. It was calculated that every 1 TRY used for production provides a profit of 66 kuruş. This value was calculated as 1.59 in the regional average. Relative profit in anise operating width groups varied between 1.51 and 1.71 values (Table 8).

Variable Cost/GPV was 0.48, and Fixed Cost/GPV was 0.12 in the average of enterprises. Therefore, the Total Cost/GPV ratio was calculated as 0.60. Since the production costs are the sum of the variable cost and fixed cost, 60% of the GPV from the anise production was used for the production costs. In other words, 60 kuruş of every 1 TRY of income generated constituted the production costs. 12 kuruş of 1 TRY GPV was going towards fixed costs. The portion of 48 kuruş was the variable cost (Table 8).

Ayhan et al. [2], in the anise feasibility report they prepared, found the benefit/cost ratio in anise production activity as 2.44. They stated that anise production activity was a profitable production activity.

In the enterprises where anise production activities were carried out, the production cost of 1 kg of anise was 8.81 TRY, and 9.19 TRY in the region's average. As the farm width groups increased, the production cost of 1 kg anise decreased. The production cost of 1 kg of anise was 9.66 TRY in I. group farms, 9.44 TRY in II., and 8.53 TRY in III. group farms. In addition, the average sale price of 1 kg of anise was 14.59 TRY, and 14.63 TRY in the regional average (Table 8).

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Table 8. Profitability indicators in anise production

Indicators	Groups			FA	RA
	I	II	III		
Variable cost (TRY per farm)	6,595.66	14,216.34	25,648.49	16,685.19	11,364.52
Variable cost (TRY per decare)	632.31	657.95	568.24	588.89	616.63
Fixed cost (TRY per farm)	1,838.39	3,916.67	6,321.37	4,262.60	3,032.96
Fixed cost (TRY per decare)	176.24	181.27	140.05	150.44	164.57
Production cost (TRY per farm)	8,434.05	18,133.01	31,969.86	20,947.79	14,397.48
Production cost (TRY per decare)	808.55	839.21	708.29	739.33	781.19
Production (TRY per farm)	873.17	1,920.79	3,749.07	2,378.04	1,566.90
Yield (TRY per decare)	83.71	88.90	83.06	83.93	85.02
GPV (TRY per farm)	12,723.56	28,370.29	54,561.56	34,687.60	22,919.03
GPV (TRY per decare)	1,219.78	1313.00	1208.80	1,224.27	1,243.57
Gross profit (TRY per farm)	6,127.90	14,153.94	28,913.07	18,002.41	11,554.51
Gross profit (TRY per decare)	587.47	655.06	640.56	635.38	626.94
Absolute profit (TRY per farm)	4,289.51	10,237.27	22,591.69	13,739.81	8,521.55
Absolute profit (TRY per decare)	411.23	473.79	500.51	484.93	462.37
Relative profit	1.51	1.56	1.71	1.66	1.59
Production cost/GPV	0.66	0.64	0.59	0.60	0.63
Variable cost/GPV	0.52	0.50	0.47	0.48	0.50
Fixed cost/GPV	0.14	0.14	0.12	0.12	0.13
Per 1 kg anise cost (TRY)	9.66	9.44	8.53	8.81	9.19
Per 1 kg anise sales price (TRY)	14.57	14.77	14.55	14.59	14.63

Source: Own calculation.

The real price and volatility

Anise farmers' prices were calculated as real prices (2003 prices), taking into account the 2003=100 monthly Producer Price Index (PPI)[14]. The volatility in agricultural product prices, and the associated uncertainty, is one of the main factors affecting the income security of producers and traders, which threatens the performance of agriculture and the welfare of consumers [11][15].

When the prices of anise per kilogram of real producers for Turkey and Burdur in 1980-2021 were examined, they exhibited a strongly fluctuating and increasing trend. Anise prices, which farmers received from Turkey, were in the band of 1.146 TRY-3.733 TRY per kg in 1980-1989, reached their peak value in 1987, prices were very fluctuating and tended to increase. The price volatility received by the producer was 51.56%. Anise prices in Burdur were very volatile and tended to increase. Price volatility was also above the Turkey average with a rate of 67.90%. Anise real prices, which were in the band between 1.781 TRY and 3.213 TRY per kg in 1990-1999, became less volatile. Price volatility declined to 19.56%. For the province of Burdur, it was in the range of 1.743 TRY-3.263 TRY per kg, and price volatility decreased to 19.77%. However, it was above the Turkey average (Fig. 3).

Anise's actual prices in Turkey were 2.373 TRY per kg on average between 2000 and 2010 and rose to 1.841 TRY-3.885 TRY per kg, and followed a more fluctuating course compared to the 1990s. It had its lowest values in 2006, 2008 and 2007, and kg anise prices were below 2.0 TRY in these years. Prices were more volatile than in the 1990s, and the price volatility increased to 25.88%. Anise prices in Burdur were very volatile and continued to grow, and price volatility increased to 45.17%, and price volatility in Burdur was above the Turkey average (Fig. 3).

In Turkey, real prices of kg anise increased to 2.479 TRY on average in 2011-2021 and fluctuated less in the band of 1.969 TRY-3.525 TRY compared to 2000-2010. It reached its peak value in 2019 and the lowest value in 2017. Price volatility dropped to 22.16%. After anise prices in Burdur were in the band of 1.814 TRY and 2.443 TRY in 2011-2018, the kg price increased by more than 3.0 TRY in 2019 and 2020 and decreased to 2.709 TRY in 2021. Although the price volatility decreased to 35.69%, this rate was high, and the price volatility in Burdur was also above the Turkey average (Fig. 3).

When the producers' prices of anise per kg of real for Turkey and Burdur in 1980-2021 were examined, there was a strongly fluctuating and increasing trend in prices, which were

2.428 TRY and 2.405 TRY per kg on average. The coefficient of variation was 23.37% for Turkey and 24.76% for Burdur. Price volatility was 28.10% for Turkey and 40.51% for Burdur province. The coefficient of variation and price volatility in Burdur were above the Turkey average (Fig. 3). Therefore, one reason for the decline in the anise cultivation areas in Burdur province was this change and price volatility.

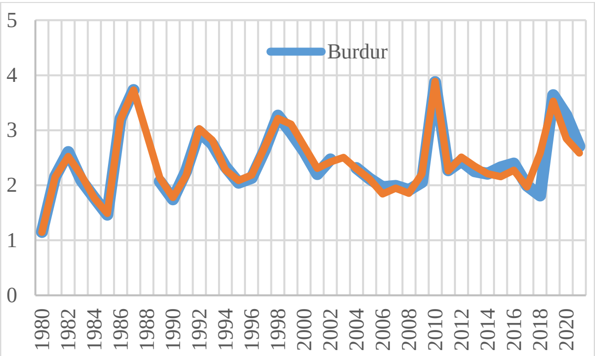

Fig. 3. Anise real prices (TRY per kg) received by farmers in Turkey and Burdur
Source: Own design and calculation based on [14].

There was a direct and high correlation between the prices of anise per kg that real producers in Burdur have obtained and the anise cultivation areas of Turkey, anise production in Turkey and anise prices in Turkey.

CONCLUSIONS

This study covers the data of 159 anise producers in the province of Burdur, which has an essential place in Turkey's total anise cultivation area and production amount, and the data of the 2020 production period, the socio-economic structures of the farms were examined. In addition, the profitability of anise production activity was analysed in line with production costs and profitability indicators.

The average age of anise producers was 52.37 years, their education period was 8.00 years, their experience in crop production was 28.65 years, and their experience in anise production was 25.74 years. Most of the anise producers were primary, secondary and high school graduates (86.26%).

The household size of anise producers was 3.25 people on average. The population ratio between 15-49 made up 51.55% of the total population. This ratio is also essential in meeting its own workforce needs.

The surveyed farms' farmland width was 113.90 decares on average. 81.49 decares of these lands were property, and 32.16 decares were rented. Anise land width was 28.33 decares on average, 3.79 parcels and 7.47 decares on average. In addition, 63.01% of the farm interviewed were engaged in livestock production. Farms' non-agricultural income rate was 59.75%.

Anise production accounted for 13.79% of the GPV obtained by farms. On the farm's average, anise production cost was calculated as 739.33 TRY per decare. The cost of 1 kg of anise was 8.81 TRY, and the selling price of 1 kg was 14.59 TRY. The profit margin was 5.78 TRY for 1 kilogram of anise.

GPV per decare obtained from anise production activity was calculated as 1224.27 TRY. The gross profit was determined as 635.38 TRY per decare. The relative profitability of the anise production activity was 1.66. This value meant that every 1 TRY used by enterprises in anise production returned to the enterprise as 1.66 TRY. Therefore, this situation explained that farms made a profit of 0.66 TRY for every 1 TRY.

It is essential to give anise-specific support because the anise plant is a more sensitive product than other products. It is more affected by natural conditions, and its cultivation requires more effort than other products.

For Turkey and Burdur province, the prices of kg anise received by real producers were 2.428 TRY, and 2.405 TRY in the average of 1980-2021 years. There was a severe fluctuation in prices and showed an increasing trend. The coefficient of variation was relatively high. The coefficient of variation was calculated as 23.37% for Turkey and 24.76% for Burdur. Likewise, the real price volatility of anise was relatively high. The volatility was 28.10% for Turkey and 40.51% for Burdur province. The coefficient of variation and price volatility in Burdur were also above the Turkey average. At this point, one of the reasons for the shrinkage in anise cultivation areas in Burdur province can be expressed as the high variation and volatility in these prices. To eliminate price instability and volatility of anise producers and overcome the problems encountered in anise production, producers should act in an organised manner as a union/cooperative. For this, anise producers should establish their organisations.

In addition to these, extension activities should be carried out. The relevant institutions of the state should hold information meetings through experts for producers who are engaged in anise production activities and intend to produce anise in the coming years.

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INVESTMENTS IN AGRICULTURE OF UKRAINE

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Abstract

The article is devoted to issues of foreign investment in Ukraine, since the effective implementation of investment activity is important for the development of the Ukrainian economy at the present stage and increasing the competitiveness of enterprises, necessary for its integration into the European socio-economic space The development trends in foreign investment to agriculture have been analysed. Gradual deterioration of the prerequisites for the development of agricultural foreign investments has been found by studying the trends of foreign investment to agriculture on the basis of statistical analysis of the dynamics of indicators of the amount of attracted foreign direct investment, their share in gross value added, gross agricultural income, labour productivity in agricultural production, and others. The investment attractive factors contributing to the expansion of investment ties of Ukraine, namely, the presence of rich natural resources and production capacities are analyzed; developed infrastructure; relatively cheap and skilled labor; large capacious and almost competitive unlimited domestic market for most commodity items; scientific potential, etc. The threats of foreign investment for the host country are identified.

Key words: *investment activity, investment attractiveness, capital investment, foreign direct investment, agriculture*

INTRODUCTION

Investment is a key factor in ensuring economic growth and innovation, increasing productivity, increasing incomes, sustainable economic development. Investment in agriculture is important because it contributes to the economic age and poverty reduction, food security and the rational use of nature. The amount of investment, their structure depends on many factors. After the global financial crisis in this period, the weakness of investment activity in the world economy is noted and it is argued that the left share of declining productivity growth in this period in both developed and developing economies is due to slow investment. With the development of the pandemic, the expectations regarding the investment activity of pessimistic experts. But there are differences in the dynamics of investment in different countries and industries.

A special place in the sectoral structure of Ukraine's economy is occupied by agriculture. Investments in agriculture of Ukraine should ensure its technical and technological renewal, increase factor productivity, competitiveness of the industry in domestic and foreign markets, sustainable development of the agricultural sector as a whole. Investment activity in agriculture is very sensitive to many factors: macroeconomic conditions, political stability, the state of institutions, infrastructure development, innovation potential, profitability of certain industries and financial instruments. The study of trends, factors of influence, interdependence of investment in agriculture and land reform creates the necessary scientific basis for making sound management decisions at both micro and macro levels, forecasting possible changes in the development of the industry.

MATERIALS AND METHODS

The purpose of the article is to identify trends and factors of investment in agriculture of Ukraine and the impact of land reform measures to liberalize the circulation of agricultural land on the volume of investment in agriculture. The research hypothesis is based on identifying the characteristics of the dynamics of investment in agriculture in

Ukraine, the factors influencing the volume of investment and testing expectations for their increase by deepening land reform. The study used such methods as logical operations (analysis, synthesis, generalization, induction, deduction) to determine the characteristics of investment trends, the index to identify quantitative changes in nominal and real investment, impact factors; trend analysis to determine trends in the construction and construction of investment trend functions in different periods, factor and correlation analysis to identify factors of investment density and dependence (profits, prices, interest rates, government support); graphics to visualize the dynamics of investment. The research was performed on the basis of statistical data of the State Statistics Committee, the National Bank of Ukraine, reports of agricultural enterprises and data of own observations.

RESULTS AND DISCUSSIONS

The issues of increasing innovation and investment activity were considered in the works of N. Burlaka, V. Ilchuk, TV Shpomer, Yu. Shubravska, and others. Domestic and foreign scientists, in particular Onegina V., Vitkovsky Y., Chernyshev V., Okara D., Kovaleva I. and others, in their scientific works discussed the problems and prospects of increasing the investment attractiveness of agricultural enterprises. In recent years, there has been a decline in investment and innovation activity of agricultural enterprises, which led to destructive processes in the productive forces of the industry, deteriorating land resources, reduced efficiency of agricultural production, declining and deteriorating quality of life of the rural population. Therefore, it is expedient to substantiate the theoretical principles of increasing innovation and investment activity and attractiveness of agricultural entrepreneurs.

Research shows that much more investment in agriculture, including foreign direct investment, is needed to eradicate hunger and poverty and promote rural development. Investing in agriculture by domestic and foreign investors can bring a wide range of benefits, such as higher productivity, increased food availability, job creation, poverty reduction, technology transfer and access to capital and markets (Impact, Challenges and Opportunities).

Ukraine is often called a potential global agrarian superpower. More than 70% of the total area of the country is occupied by agricultural land. This is just over 42 million hectares, of which 32 million are arable land suitable for growing cereals and vegetables. Approximately 25% of the population of Ukraine is employed in the agricultural sector [7, p. 197].

The agricultural sector is one of the most promising sectors of Ukraine's economy, accounting for more than 20% of GDP. Ukraine is one of the five largest grain exporters in the world and ranks first in the world in terms of sunflower oil exports (58%).

Most of Ukraine's current agricultural output is a diverse combination of grains and fodder crops, including wheat, corn, barley, sunflower, sugar beets, tobacco, legumes, fruits and vegetables [2, p. 40].

Ukraine occupies a leading position as a major producer of grain, including wheat. The entire annual grain harvest can reach 90-100 million tons.

Agribusiness remains a top priority for the Ukrainian government, especially in connection with the EU-Ukraine Association Agreement and the implementation of the Deep and Comprehensive Free Trade Agreement (DCFTA). Since the signing of the Association Agreement, exports of agricultural products from Ukraine to the EU have increased by 37% (from 4.5 billion in 2013 to 6.1 billion in 2018 and 6.6 billion by December 2020) (Fig. 1).

Moreover, according to the European Commission's monthly monitoring of trade in agricultural products, Ukraine ranked 3rd among the largest suppliers of agricultural products to the EU for the period from November 2018 to October 2020, exporting agricultural goods totaling 7.3 billion euros.

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Since the creation of the free trade zone in 2017, Ukraine has been able to obtain preferential quotas for duty-free exports of honey, grape juice, processed tomatoes, pearl barley, oats, wheat, barley and corn.

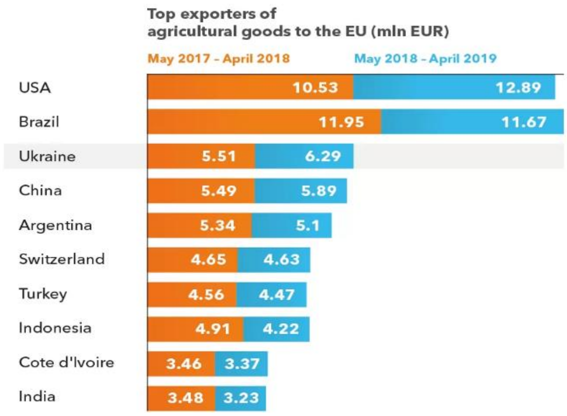

Fig. 1. Top exporters of agricultural goods
Source: according to the State Statistics Service of Ukraine and the National Bank of Ukraine.

The huge potential of the Ukrainian agro-industrial complex makes it a key sector of the economy in terms of investment, both domestic and foreign. According to the State Statistics Service of Ukraine, for the period from 2014 to 2018, the volume of investments in the Ukrainian agribusiness tripled and amounted to UAH 300 billion (about $ 11.2 billion), while UAH 100 billion (about USD 3.7 billion) was invested in food production. In 2020, agriculture, forestry and fisheries received UAH 55.25 billion (about USD 1.95 billion) in investments.

Foreign investors often choose agribusiness in Ukraine because it provides a relatively quick return on investment and stable conditions, despite unpredictable factors such as bad weather.

It is well known that Ukraine has many advantages in the development of agriculture, including fertile soils and favorable location. But now the Ukrainian agribusiness is attracting the attention of foreign investors due to the high level of high-tech innovations. Ukrainian agro-technological companies are developing innovative solutions aimed at improving traditional methods of agriculture and the development of organic production. According to the Law of Ukraine "On Foreign Investment Regime", foreign investments are all values invested by foreign investors in objects of investment activity in accordance with the legislation of Ukraine in order to make a profit or achieve a social effect.

Investors can be:

• foreign countries;
• international organizations;
• entities;
• individuals, including citizens of Ukraine living abroad.

The legislation of Ukraine defines the following forms of foreign investment:

• creation of enterprises that are fully owned by foreign investors, branches and other separate divisions of foreign legal entities, or acquisition of full-fledged enterprises;
• partial participation in enterprises created jointly with legal entities and individuals of Ukraine, or acquisition of a share of existing enterprises;
• acquisition of the right to use land and use natural resources on the territory of Ukraine independently or with the participation of Ukrainian legal entities or individuals;
• acquisition of real estate or movable property not prohibited by the legislation of Ukraine, by direct acquisition of property and property complexes or in the form of shares, bonds and other securities;
• economic (entrepreneurial) activity on the basis of production sharing agreements;
• acquisition of other property rights;
• without creating a legal entity on the basis of agreements with business entities of Ukraine.

This list is not exhaustive and, given the constant development of the business sector, the existing forms of investment activity in Ukraine can be changed or supplemented.

Digital technologies and innovations are already greatly changing the way agribusiness is run, bringing its efficiency to a new level [10]. The use of drones or unmanned aerial vehicles (UAVs) in agriculture is considered one of the most promising innovations in this field due to its high economic feasibility. The use of UAVs has a variety of applications, in particular for effective agricultural planning, strengthening control at each stage of agricultural production, as well as chemical treatment of crops and more. UAVs are able to provide important information in real time, such data that is collected over time can also be used for a better dynamic understanding of each process. UAVs are equipped with special sensors that provide detection of contaminated crops, targeted fertilization, spot spraying and irrigation [4].

Recently, the field of land legislation of Ukraine has undergone significant changes. On March 31, 2020, the Verkhovna Rada of Ukraine adopted the Law "On the Circulation of Agricultural Land", which provides for the right to purchase land only to Ukrainians. The law also sets limits on the maximum area that one person can own and preferential terms for Ukrainian farmers.

According to Presidential Decree № 449/2020, agricultural lands from state to communal ownership, all newly created communities have received lands in communal ownership and will be able to use funds from land use for their development.

These and other innovations require study and analysis to properly implement them in practice. To achieve this goal, Ukraine has launched the Program "Acceleration of Private Investment in Agriculture", which in 2020 concluded an agreement between the International Bank for Reconstruction and the Ministry of Finance of Ukraine to raise $ 200 million. The purpose of the Program is to alleviate certain restrictions by increasing the participation of the private sector, in particular small and medium enterprises, in the agricultural market of factors of production and the market of goods of Ukraine.

The transfer of annual investments in US dollars shows that the growth of investments was not as impressive as estimated on the basis of their volumes in the Ukrainian currency (Fig. 2).

In practice, private land users face many problems. Most often people ask legal questions about land lease agreements (conclusion, change, termination and renewal), land ownership (registration, acquisition of rights, joint ownership. Many questions about the right to use someone else's land for agricultural purposes or for construction) [8].

It is important to prevent violations of registered rights of use or property rights, better knowledge of land legislation and procedural rules among landowners and professionals who carry out their activities [6].

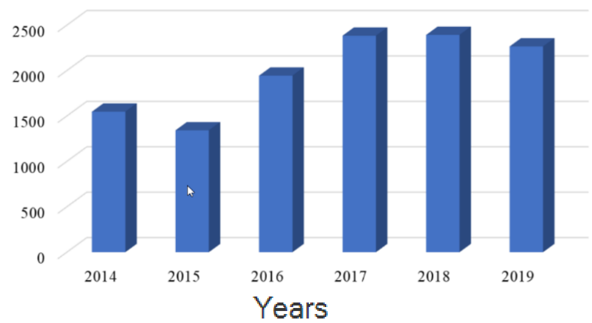

Fig. 2. Investments in agriculture in Ukraine, million dollars USA
Source: according to the State Statistics Service of Ukraine and the National Bank of Ukraine [9].

In the regions of Ukraine, remote access points to free legal aid have been organized, including in village, settlement councils and united territorial communities. all issues, including in the field of land relations.

The analysis of statistical data confirmed that during 2014-2018 the volume of investments in agriculture of Ukraine increased annually (Table 1).

Table 1. Capital investment in agriculture in Ukraine

Indicators	2015	2017	2018	2020	2020 to 2015, %
Capital investment in agriculture and hunting, UAH million	29,310	63,401	65,059	58,555	199.8
Index of capital investment, %	159	128	103	90	-69
Net profit, UAH million	101,912	68,277	70,462	90,167	88.5
Fixed assets, UAH million	205,575	335,303	399,526	365,456	177.8

Source: State Statistics Service of Ukraine [9].

The exception to the growing trend of investment in agriculture was 2020, when the annual volume of investment decreased by 10% compared to the previous year. This decrease in investment occurred when agricultural enterprises received UAH 70.5 million last year. net profit, which is even 3.2% higher than last year's profit.

With a fairly stable economic situation in the country, agricultural enterprises use the following methods of financing innovation [1, p. 39]:

1. Foreign direct investment. Foreign capital is invested in those countries where the economic crisis has hardly affected the real or financial sectors of the economy.
2. Credit collateral - obtaining loans from banking institutions either by issuing bond loans or by financial leasing. However, in a crisis, agricultural enterprises can only rely on leasing operations for long-term means of production.
3. Schering - attracting investment resources through the issuance of securities, including shares. This method is considered one of the most effective for businesses in industry, trade, financial sector of the economy. The number of joint stock companies in the agricultural sector is very small, and therefore only some companies can count on obtaining the necessary financial resources for investment activities subject to the issuance of new shares.
4. Share financing is carried out by private investors or owners of cooperatives, limited liability companies. Such financing of investment activities can take place under any conditions, including during the financial crisis, as some private investors have the necessary financial resources, and to increase the efficiency of their own agricultural production, they can invest in their investment activities.
5. Self-financing from own funds created on the basis of such sources as depreciation and profit. Due to the crisis in the economy, the profits of most agricultural enterprises are low, so investing is possible only with the necessary amount of depreciation. In most agricultural enterprises, fixed assets have decreased significantly in recent years, so the amount of depreciation cannot be significant [3, p. 38].

Thus, among the main reasons for the decline in investment activity in the country, in particular in agriculture, are the following:

-low level of investment protection and weak stock market development;
-certain inconsistencies and imperfections of the legislation;
-difficulty in obtaining a loan and high interest rates;
-low solvency of the population and state enterprises;
-high level of bureaucracy in decision-making on investment activities;
-high tax rates;
-low level of state support for agricultural producers.

The slowdown in investment can be explained primarily by the presence in the country of high investment risks, which investors seek to avoid under any circumstances [5, p. 6]. This can have negative consequences for the development of the agricultural sector, which can be manifested in reduced productivity, reduced production, higher prices of manufactured products, deteriorating quality and, as a consequence, reduced competitiveness.

CONCLUSIONS

One of the main problems hindering the development of agriculture in Ukraine and the expansion of its innovation and investment activities is, first of all, the low investment attractiveness of agricultural enterprises. Increasing innovation and investment activity and attractiveness of agricultural enterprises will contribute to the formation of a strong production potential that will provide a comprehensive solution to the problems of agricultural development. The introduction of a comprehensive investment program in the agricultural sector of the economy will stimulate its transition to a qualitatively new innovative type of development and promote the growth of competitive agricultural enterprises. Timely assessment of the investment attractiveness of the enterprise in order to forecast the prospects for further effective development of the agricultural sector will open new opportunities for diversification for domestic and foreign investors, as well as increase investment guarantees for foreign investors in investment projects.

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