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CONTENT

ANALYSIS OF THE COMPETITIVENESS OF TURKEY'S AGRICULTURAL SECTOR AND THE CONSISTENCY AMONGST ALTERNATIVE MEASURES

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Abstract

In international trade and economics, comparative advantage index is one of the key instruments for measuring competitiveness. This study examined the static and dynamic agricultural sector competitiveness of Turkey by the RCA and NRCA indices. The dynamics of the competitiveness indices were estimated by OLS regression, Markov matrices, and trend analysis. The study, further, analyzed the consistency between the RCA, NRCA, and RSCA indices. The results revealed that, Turkey, generally obtains strong competitiveness in the crop sectors whilst it has weak competitiveness in livestock and processed food sectors. Turkey achieved competitiveness in 6 and 13 sectors, respectively. It revealed a convergent pattern of agricultural competitiveness with high stability of the uncompetitive and weak competitive sectors. Turkey's agricultural export strategy and competitiveness pattern are based on natural-resource-intensive and traditional agricultural products. Turkey obtained the gaining trends in 6 and 16 agricultural sectors, respectively. The RCA, NRCA, and RSCA indices are strongly consistent in identifying the degrees of competitiveness and in determining whether or not the country obtains competitiveness.

Key words: *agriculture, competiveness, static, dynamic, consistency*

INTRODUCTION

International agricultural trade plays a critical role in the distribution of food and industrial raw materials to consumers worldwide. International agricultural trade has become a very important element in the economies of most developing countries across the world. Since the year 2000, trade in agro-food products has experienced significant growth. As world markets responded to a more rules-based trading environment, falling tariffs, and reductions in trade-distorting producer support, in real terms, growth rate of close to 8% recorded between 2001 and 2014, relative to 2% recorded between 1990 and 2000. At the same time, global agricultural production has also continued to increase [15]. Turkey is the 27th largest export economy in the world. In 2017, Turkey engaged in a total export value of $166 billion and total imports of $214 billion, resulting in a negative trade balance of $48.6 billion. In 2017, Turkey's GDP was $851 billion and its GDP per capita was $10.499. Turkey's largest agricultural exports includes staple food products ($7.10 billion), vegetable products ($7.36 billion), wood products ($766 million), animal products ($2.23 billion) [2]. In the last decade, Turkey has emerged as an important exporter of agricultural products for both the Middle East and other markets [18]. In recent centuries, the concept of trade competitiveness has been embedded in the traditional trade theories relating to comparative advantage, which asserts that if there exist relative difference in the opportunity costs of producing goods among countries, then there is potential for gains to be derived from specialization and trade [19]. This is responsible for the application of various comparative advantage indexes in measuring the static competitiveness trade sectors within a given market. However, recent theoretical and empirical international trade studies have stressed on the significance of researching into both the static and dynamic trade performances due to the unstable and changing economies, politics, strong technology development, and the global economic linkages [9]. This is particularly useful for developing countries such as Turkey, whose food and agricultural sectors presents great potentials to boost economic growth and development. Competitiveness is defined by the traditional economic theory based on Smith's concepts of absolute advantage Ricardo's comparative advantage which evaluates the concept by basic production indicators such as productivity, price, and cost. However, due to the inaccessibility of productivity, price, and cost data, scholars have developed measuring models for the empirical studies based on the revealed trade data. Centered on the traditional trade theory and [3] Balassa (1965) established the revealed comparative advantage (RCA) index. By using export flow data, the RCA estimates the ratio of a country's export share of a given commodity in the international market to the country's export share of all other commodities. Following the establishment of the RCA index, some economists have identified a number of constraints of the RCA namely; the distribution of the RCA indicators is asymmetric and non-normal; the RCA is static and does not present the dynamics of comparative advantage over time, amongst others [9]. In spite of castigations and controversies over the effects of trade mishaps due to government interruption and the inability to ascertain the sources of comparative advantage, many scholars and authors have asserted that the RCA index, when appropriately utilized, still gives useful manifestation of the comparative advantages in agricultural sectors. The RCA is also amongst the most cited and utilized measures to investigate comparative advantage in several empirical studies such as [9] [6] [14] [12] and [1]. Other RCA variants have been established to vanquish the weaknesses of Balassa's RCA. Among others alternatives are the, RCA log [20], Symmetrical Revealed Comparative Advantage (SRCA) [13], Weighted Revealed Comparative Advantage (WRCA) [16], Additive Revealed Comparative Advantage (ARCA) [10]. Despite the fact that these indices developed some aspects of RCA's limitations, none of them could be applicable to comparison between spaces (commodities or geographical regions) and time. To deal with the limitations of RCA and some other alternative comparative advantage indices, [21] transformed RCA index into a Normalized Revealed Comparative Advantage (NRCA). NRCA possesses properties that can indicate ranking and makes it comparable in terms of comparative advantage across commodities, countries, and time spans. It is expected to show a country's trade pattern, thus enabling identification of commodity types that have good potential in a given market and at a specific time. NRCA index value for each commodity from each country as a whole is set at neutral or zero. This asserts to the assumption that no country has a comparative advantage for all commodities [7]. The NRCA index has demonstrated to be capable of revealing the extent to which a country has comparative advantage in a commodity in a more precise and consistent manner than the other alternative comparative advantage CA indices. Thus, the NRCA index provides a useful tool for quantitative regional research, especially for studies on regional comparative advantage [21]. The main objective of the study is to analyse the competitiveness of Turkey's agricultural sectors and to test the consistency amongst alternative measures. The specific objectives are to; 1. Measure the static agricultural comparative advantage indexes of Turkey by using the RCA and the NRCA indices. 2. Assess the dynamics of the trade competitiveness indicators over time by three ways: OLS method (using RSCA and NRCA), Markov matrix, and trend analysis. 3. Test the consistency among RCA, RSCA and NRCA indices.

MATERIALS AND METHODS

Data source

International agricultural trade data covering the period 2006 to 2017 were collected for this study. This data was obtained from the International Trade Centre (ITC)'s Trade Map application. Trade Map is based on the Harmonized System.

Research Design
A quantitative research approach was adopted for this study. This study calculates the comparative advantages at 2-digit with 28 selected agricultural commodity groups over the period 2007–2017. The agricultural commodity groups represent their respective sector. In this write-up the commodity HS codes were used to identify the respective sector. The Harmonized System (HS) is an international nomenclature defined by the World Customs Organization (WCO) for the classification of products. It allows participating countries to classify traded goods on a common basis for customs purposes. At the international level, the Harmonized System for classifying goods is a six-digit code system for classifying goods [11]. This study determines and analyses the static and dynamic agricultural competitiveness of Turkey in the world market using international agricultural export data.

Static Agricultural Competitiveness
Revealed Comparative Advantage (RCA) and Normalized Revealed Comparative Advantage (NRCA) indexes were selected for the computation of the static agricultural competitiveness.

RCA index: This study adopted Balassa's Revealed Comparative Advantages (RCA) index, which is the most widely used indices. Revealed comparative advantage (RCA) indices offer a useful way of analyzing a country's comparative advantage, based on demonstrated (i.e. actual) export performance. According to Balassa, RCA is the relative share of a country's export of a given product in the world export of the same product, divided by the overall share of the country in total world exports. That is to say, the revealed comparative advantage index of product j exported from country i (RCA_{ij}) is expressed as follows:

$$RCA_{ij} = \left[\frac{X_{ij}}{X_i}\right] / \left[\frac{X_{wj}}{X_w}\right] \text{ or } RCA_{ij} = \left[\frac{X_{ij}}{X_{wj}}\right] / \left[\frac{X_i}{X_w}\right]$$

where:
RCA_{ij}: Revealed comparative advantage index of product j exported from country i;
X_{ij}: Exports of product j from country i;
X_{wj}: World exports of the product j;
X_i: Exports of country i;
X_w: World exports.

The value of RCA falls within the ranges of 0 and + ∞, where comparative-advantage-neutral point stands at 1. Where the RCA value is > 1 implies that the country possesses comparative advantage in the product. In such conditions, the higher the Positive RCA value, the stronger the comparative advantage. For instance, RCA index of 1.1 implies that the country's share of the commodity's exports is 10% higher than its share of the total exports. Where the RCA value is < 1, implies a comparative disadvantage in the product. It should be noted that the RCA index asymmetrical, thus both sides of its neutral point cannot be compared.

NRCA index: [21] Yu et al (2009) formulates the Normalized Revealed Comparative Advantage (NRCA) index as a deviation of the actual export value from the expected export of a country. As attested by the scholars, the concept of the normalized revealed comparative advantage index is to measure the degree of deviation of a country's actual export from its comparative advantage-neutral level such that it indicates its relative scale with respect to the world export market. Thus, enabling its comparability across commodity and country. A country's export of commodity **j** at the comparative-advantage-neutral point, $\hat{X}_{ij}$ is derived from the comparative-advantage-neutral point of the RCA index as expressed below:

$$RCA_{ij} = \left[\frac{\hat{X}_{ij}}{X_i}\right] : \left[\frac{X_{wj}}{X_w}\right] = 1$$

From the RCA formular, $\hat{X}_{ij}$ is characterized by X_iX_{wj}/X_w. The deviation of the actual export, X_{ij}, and comparative-advantage-neutral point (expected export), $\hat{X}_{ij}$ can be expressed as: $\Delta X_{ij} = X_{ij} - \hat{X}_{ij} = X_{ij} - \frac{X_i X_{wj}}{X_w}$

After the normalization of ΔX_{ij} by the world total export, X_w, the NRCA index is obtained as follows:

$$NRCA_{ij} = \frac{\Delta X_{ij}}{X_w} = \frac{X_{ij}}{X_w} - \frac{X_i X_{wj}}{X_w X_w}$$

The value of NRCA falls within the ranges of -0.25 to 0.25. The comparative-advantage-neutral point is zero (0) when the actual export is equivalent to the expected export of the country. Economically the values of NRCA index are interpreted as follows: NRCA > 0 signifies that, the value of commodity j's actual export from country i is higher than its expected export (at comparative advantage neutral point) of the commodity, hence country i has comparative advantage in the commodity j. NRCA < 0 signifies that, the value of commodity j's actual export from country i is lower than its expected export (at comparative advantage neutral point) of the commodity, hence country i has comparative advantage in the commodity j. The higher the NRCA value, the higher comparative advantage it possesses, likewise the lower the NRCA value, the lower comparative advantage it possesses in a given market. In accordance with [21], [9], this study magnifies the NRCA values by multiplying them by multitudes of a constant 10,000 to facilitate the presentation of the results without affecting the result.

Dynamic agricultural competitiveness: In analyzing the dynamics of the agricultural competitiveness, [9], emphasized that there are at least three types of dynamics of comparative advantage (CA) indicators: The stability of the distribution of competitiveness indicators from one period to another; OLS regression method was used to calculate this parameter. The mobility and stability of competitiveness indicators for each year of the period; Markov matrix method was used to calculate this parameter. And the trends of the competitiveness indicators over the period and in the future; for which Trend analysis was used in the analysis of this parameter.

The OLS regression method: Following [5] and [5], the stability of the distribution of the trade performance indices from one period to the next is analyzed by using OLS method which was first utilized by [4] in the context of specialization. The OLS regression of comparative advantage dynamics may be presented as follows:

$$CA_{ij}^{t2} = \alpha_i + \beta_i CA_{ij}^{t1} + \varepsilon_{ij}$$

where:

CA: the agricultural comparative advantage indices;

t_1 and t_2: the initial years and final years;

j: the agricultural sector under study;

α: constant;

β: regression coefficient;

εj : residual term.

The CA value at time t2 for the agricultural sector j represents the dependent variable which is tested against the independent variable of the CA value at time t1 for the agricultural sector j. In this study, the regression is assumed to be linear in parameters and the residual εij is normal and identically distributed. The regression result is interpreted as follows; The β = 1 correlates to an unchanged pattern of the competitiveness from t1 to t2. β > 1 correlates to the state where the country obtains comparative advantage in sectors with initial strong competitiveness and losses comparative advantage in sectors with initial weak competitiveness. β < 1 correlates to the state where, sectors with initial weak competitiveness gain comparative advantage, whilst sectors with initial strong competitiveness lose comparative advantage. β = 0 correlates to the state where, there is no relation between the CA indicators in two periods. β < 0 correlates to the state where, the competitiveness positions of the agricultural sectors are reversed. In other words, those CA indicators which were initially below the average value will finally end up above the average, and vice versa. According to [5] and [9], another feature of the regression analysis is to test whether the degree of competitiveness changes over time and whether β > 1 is not a necessary condition for growth in the overall specialization pattern. It can be shown that [8]: $\frac{\sigma_i^{t2}}{\sigma_i^{t1}} = \frac{|\beta_i|}{|R_i|}$

where: R is the correlation coefficient from the regression model and σ is the standard deviation of the dependent variable.

The dispersion of a given distribution is unchanged when β = R. If β > R (equivalent to the increase in the dispersion), then the degree of the specialization rises. If β < R (equivalent to the decrease in the dispersion), then the degree of specialization falls.

RSCA index: The asymmetric problem, however, violates the assumption of normality of the error term in the regression analysis, which makes the t-statistics unreliable. The values of the NRCA indicators are in (-0.25, 0, +0.25), thus it eliminates the asymmetric problem. However, the values of the RCA indicators are in (0, +∞), the distribution thus violates the assumption of normality of the error term in the regression analysis. Additionally, using the RCA indicator in regression analysis gives much more weight to values that are above one, as compared to observations that are below one. To deal with the asymmetric problem, [5] transformed the RCA index into the Revealed Symmetric Comparative Advantage index (RSCA) bearing the same economic implications as follows: $\mathrm{RSCA} = \frac{\mathrm{RCA}-1}{\mathrm{RCA}+1}$

The RSCA value ranges from -1 to + 1. The RSCA index translates the values from the intervals of RCA index (0, 1]; [1, +∞) into (-1, 0]; [0, +1). The main advantage of this index is that it makes below the unity the same weight as changes above the unity.

Markov matrix (M index): The mobility and stability of the competitiveness values for every year of the period is assessed by the analyses of the mobility degree of CA by the mobility index (M index). The index identifies the degree of mobility throughout the entire distribution of the CA values and facilitates direct cross-sections comparisons over the full period. The M index, following [17], assesses the trace of the transition probability matrix. This M index, thus, directly captures the relative and medium magnitude of diagonal and off-diagonal terms, and the equation of M index can be shown as follows:

$$\mathbf{M} = \frac{\mathbf{n} - \mathbf{tr(P)}}{\mathbf{n} - \mathbf{1}}$$

where:
M is Shorrocks index,
n is the number of classes,
P is the transition probability matrix, and
tr(P) is the trace of P.

The higher values of M index indicate greater mobility while the lower values of M index show lower mobility of the CA value among the classes of comparative advantages. The zero value of M index means the perfect immobility.

Trend analysis: The research finally employed the trend analysis to examine and predict the CA trend of a particular agricultural sector over the period and in the future. This tool identifies the CA gaining, losing, or maintaining trends in an agricultural sector based on comparing the changes of the CA values over time. The time trend model can be presented as follows:

$$\mathbf{CA_{ij}^{t} = \alpha_{ij} + \beta_{ij} t + \varepsilon_{ij}^{t}}$$

where:
α_{ij} is a constant;
β_{ij} is the regression coefficient showing the CA trend;
t is the time index; and
εtij is a residual term.

Turkey's CA in agricultural sector j can be considered stable if the estimated β_{ij} is close to zero (with the significance level of 10 percent).

The value of $\beta_{ij} > 0$ indicates a trend in gaining the competitive advantage while the value of $\beta_{ij} < 0$ means a trend in losing the competitive advantage.

RESULTS AND DISCUSSIONS

Measuring the static agricultural competitiveness

This section of the study determines the static agricultural sector competitiveness of twenty-eight (28) selected agricultural sectors of Turkey over the period 2006 to 2017. The static competitiveness is evaluated by their Revealed Comparative Advantage (RCA) and Normalized Revealed Comparative Advantage (NRCA) indices.

Table 1. Turkey's competitiveness indices by RCA and NRCA

No	Hs Code	Agriculture Sector/Product Group	RCA 2006	RCA 2017	NRCA 2006	NRCA 2017
1	01	Live animals	0.082	0.176	-0.080	-0.092
2	02	Meat and edible meat offal	0.061	0.490	-0.380	-0.322
3	03	Fish and crustaceans, mollusks and other aquatic invertebrates	0.518	0.751	-0.182	-0.150
4	04	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere ...	0.301	0.913	-0.198	-0.038
5	05	Products of animal origin, not elsewhere specified or included	0.881	0.601	-0.004	-0.021
6	06	Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	0.366	0.458	-0.059	-0.057
7	07	Edible vegetables and certain roots and tubers	2.571	1.541	0.361	0.200
8	08	Edible fruit and nuts; peel of citrus fruit or melons	6.329	3.759	1.682	1.645
9	09	Coffee, tea, maté and spices	0.440	0.385	-0.075	-0.162
10	10	Cereals	0.562	0.119	-0.131	-0.462
11	11	Products of the milling industry; malt; starches; inulin; wheat gluten	4.948	7.974	0.215	0.624
12	12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal ...	0.509	0.325	-0.094	-0.337
13	13	Lac; gums, resins and other vegetable saps and extracts	0.112	0.188	-0.020	-0.030
14	14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	3.424	2.330	0.008	0.007
15	15	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal ...	1.605	1.166	0.162	0.084
16	16	Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates	0.154	0.253	-0.147	-0.184
17	17	Sugars and sugar confectionery	1.305	1.353	0.054	0.087
18	18	Cocoa and cocoa preparations	1.641	1.216	0.089	0.053
19	19	Preparations of cereals, flour, starch or milk; pastrycooks' products	1.698	2.549	0.138	0.559
20	20	Preparations of vegetables, fruit, nuts or other parts of plants	4.346	3.398	0.721	0.755
21	21	Miscellaneous edible preparations	1.374	1.108	0.074	0.038
22	22	Beverages, spirits and vinegar	0.301	0.311	-0.286	-0.403
23	23	Residues and waste from the food industries; prepared animal fodder	0.041	0.299	-0.185	-0.250
24	40	Raw hides and skins (other than furskins) and leather	1.400	1.512	0.285	0.481
25	41	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles ...	0.493	0.906	-0.088	-0.012
26	44	Wood and articles of wood; wood charcoal	0.423	0.628	-0.383	-0.258
27	51	Silk	1.908	1.265	0.074	0.018
28	52	Wool, fine or coarse animal hair; horsehair yarn and woven fabric	3.659	3.384	0.813	0.688
		MAXIMUM	6.329	7.974	1.682	1.645
		AVERAGE	1.480	1.406	0.084	0.088
		COMPETITIVE (COMPARATIVE ADVANTAGED) SECTORS (RCA>1) (NRCA>0)	13	13	13	13
		UNCOMPETITIVE (COMPARATIVE DISADVANTAGED) SECTORS (RCA<1) (NRCA<0)	15	15	15	15

Source: Author's calculations.

Table 1 presents Turkey's agriculture sector competitiveness by RCA and NRCA indices. The results indicate that, in 2017, Turkey experienced the strongest competitiveness by RCA index in sector HS11 (Products of the milling industry; malt; starches; inulin; wheat gluten) with RCA index of 7.974, likewise, by NRCA index, obtained the strongest competitiveness in sector HS08 (Edible fruit and nuts; peel of citrus fruit or melons) with an index value of 1.645. In the same year, the next top 5 competitive sectors by RCA in descending order were HS08, HS20, HS52, HS19 and HS14 with RCA index values of 3.759, 3.384, 3.659, 2.549 and 2.330 respectively. Likewise by NRCA index were HS20, HS52, HS11, HS19 and HS40 with NRCA index values of 0.755, 0.688, 0.624, 0.559 and 0.481 respectively. There were relative differences between the sectors that appeared as top 6 competitive sectors by RCA and NRCA indices in 2017. In ascending order of competitiveness, the top 5 weakest agriculture sectors in Turkey by RCA indices were; HS10, HS01, HS13, HS16 and HS23 with corresponding indices 0.119, 0.176, 0.188, 0.253 and 0.299 respectively. However, by NRCA index, were; HS10, HS22, HS12, HS02 and HS44 with corresponding indices -0.462, -0.403, -0.337, -0.322 and -0.258 respectively. There were relative differences between the top 5 weakest agriculture sectors by RCA and NRCA indices in 2017. By RCA indices, Turkey was competitive in thirteen (13) agriculture sectors in both 2006 and 2017 with average RCA values of 1.480 and 1.406 respectively. Likewise by NRCA indices, Turkey was competitive in thirteen (13) agricultural sectors in both 2006 and 2017 with average NRCA values of 0.084 and 0.088 respectively. Within the country's set of attained comparative advantage indices, the RCA and NRCA values were put into five classes by quartile method according to their degree of competitiveness (Table 2). This classified degree of competitiveness as comparative disadvantage, weak comparative advantage, medium comparative advantage, strong comparative advantage and super-strong comparative advantage groups.

Table 2. Classification and interpretations of Turkey's RCA and NRCA values with their respective counts

Categories	Interpretation	RCA VALUES			NRCA VALUES		
		Range	2006	2017	Range	2006	2017
Class 1	Comparative disadvantage	≤ 1	15	15	≤ 0	15	15
Class 2	Weak comparative advantage	≤ 1.393	2	5	≤ 0.034	1	2
Class 3	Medium comparative advantage	≤ 2.439	5	3	≤ 0.098	4	4
Class 4	Strong comparative advantage	≤ 4.290	3	4	≤ 0.500	5	2
Class 5	Super-strong comparative advantage	> 4.290	3	1	> 0.500	3	5

Source: Author's own calculations based on data from ITC trade map (2019.)

According to degree of competitiveness by RCA index, in 2006, Turkey had three (3) super-strong competitive agriculture sectors, three (3) strong competitive agriculture sectors, five (5) medium competitive agriculture sector, two (2) weak competitive agriculture sectors and fifteen (15) uncompetitive agriculture sectors. However in 2017, there were only one (1) super-strong competitive agriculture sector, four (4) strong agriculture sector, three (3) medium competitive agriculture sector, five (5) weak competitive agriculture sector and fifteen (15) uncompetitive agriculture sectors. Even though there were equal numbers of competitive and uncompetitive sectors in 2006 and 2007, there were relative variations in the number of observations under each class of competitiveness. This indicates changes in the RCA values over time. According to degree of competitiveness by NRCA index, Turkey in 2006 had three (3) super-strong competitive agriculture sectors, five (5) strong competitive agriculture sectors, four (4) medium competitive agriculture sector, one (1) weak competitive agriculture sectors and fifteen (15) uncompetitive agriculture sectors. However in 2017, it indicated five (5) super-strong competitive agriculture sector, two (2) strong agriculture sector, four (4) medium competitive agriculture sector, two (2) weak competitive agriculture sector and fifteen (15) uncompetitive agriculture sectors. There were relative variations in the number of observations under each class of competitiveness between the NRCA values of 2006 and 2017. Even though there were equal number of competitive and uncompetitive sectors in 2006 and 2007, there were relative variations (declining trend of competitiveness) in the number of observations under each class of competitiveness. Hence, changes in the RCA values over time. Between the volume of observations recorded for each class of competitiveness by RCA and NRCA indices, there were noticeable variations. However, there were equal numbers of competitive and uncompetitive sectors across both RCA and NRCA values as well as for both 2006 and 2017 observations. In summary, by RCA indices, all top 5 competitive sectors belong to the natural resource based traditional crop subsector (HS08, HS20, HS52, HS19 and HS14). However, by NRCA indices, except for one animal product sector (HS40- Raw hides and skins (other than furskins) and leather), Turkey recorded all top five competitiveness in the crops subsectors. Namely; sectors (HS20, HS52, HS11, HS19 and HS40)-2017. The result implies that, Turkey was able to maintain competitiveness in the same number of sectors between 2006 and 2017 by both RCA and NRCA indices. The nature of the competitive sectors may also imply that, Turkey's agricultural export strategy is based on natural resource-intensive and traditional agricultural products. This natural resource-intensive export strategy may be important at the initial phase of economic development and globalization. However, it may not be appropriate and effective for the sustainable development of the country's economy in the medium and long terms.

Analysis of the dynamics of the comparative advantage indicators of the agriculture sector: This section analyses the dynamics of the various comparative advantage indices under this study. This is to reveal how the pattern of competitiveness and export strategy of the countries evolved over time.

The general pattern of agriculture sector competitiveness (RSCA and NRCA) by OLS method: The values of the NRCA indicators are in the range; (-0.25, 0, +0.25), thus it eliminates the asymmetric problem. However, the values of the RCA indicators are in the range; (0, +∞). This distribution therefore, violates the assumption of normality of the error term in the regression analysis. To deal with this RCA asymmetric problem, the RCA values were converted to the revealed symmetric comparative advantage (RSCA) index, whose values are in the range; (-1, 0, +1) whiles maintaining the same economic implications. The RSCA index translates the values from the RCA intervals of (0, 1]; [1, +∞) into (-1, 0]; [0, +1). Following Hoang et al (2017), in order to reveal and explain detail changes in competitiveness pattern from one period to another, three periods were created for the regression analysis namely; (2006-2011, 2012-2017 and 2006-2017).

Table 3. The OLS estimation results for Turkey's RSCA indicators over the three periods

2006-2011			2012-2017			2006-2017		
β	R	β/R	B	R	β/R	β	R	β/R
0.926	0.938	0.987	0.876	0.978	0.895	0.760	0.897	0.847

Source: Author's own calculations based on data from ITC trade map (2019).

Results of the estimation for the RSCA (Table 3) indicators over all three periods produced the values of $0<\beta<1$. This signifies a convergent pattern of Turkey's agricultural sector competitiveness. This implies that, Turkey loses competitiveness in the agricultural sectors which had initial strong competitiveness whilst it gains competitiveness in the agricultural sectors which had initial weak competitiveness. The estimation results also indicated values of $\beta/R < 1$ ($\beta < R$) over the three periods. This signifies a process of de-specialization in Turkey's agricultural export competitiveness during the entire period. The possible explanation for this pattern is that, since Turkey's agricultural competitiveness pattern is based on the production and trade of natural resource intensive products, a fall in aggregate demand or price of that product may result in the diversion of resources into the production of an alternative natural resource-based product. This may imply that Turkey may be exploring other new promising sectors which are causing a diversion of certain limited resources.

Table 4. The OLS estimation results for Turkey's NRCA indicators over three periods

2006-2011			2012-2017			2006-2017		
β	R	β/R	B	R	β/R	β	R	β/R
1.024	0.962	1.064	1.048	0.989	1.060	0.997	0.933	1.068

Source: Author's own calculations based on data from ITC trade map (2019).

The estimation results for the NRCA indicators (Table 4) produced the values of $\beta > 1$ for 2006-2011 and 2012-2017. However, the general period 2006-2017 recorded the value $\beta < 1$, but with a value very close to 1 (0.997). This indicates a divergent pattern in agricultural competitiveness for the periods; 2006-2011 and 2012-2017. However, the general estimation for the period 2006-2017 may suggest an approaching convergent pattern. The production of value $\beta/R > 1$ for all three periods implies an increase in the overall specialization trade pattern. In other words, Turkey gains the increasing competitiveness in the initial strong competitive sectors whilst it loses the competitiveness in the initial weak competitive sectors. This result of the NRCA, however, seems to be contrary to those of the RSCA indicators.

The mobility and stability of the competitiveness indicators by Markov matrix: The RCA and the NRCA values are classified into five groups including the comparative disadvantage, weak comparative advantages, medium comparative advantages, strong comparative advantages and super-strong comparative advantage groups (Table 2). The boundary of uncompetitive RCA and NRCA values are maintained as one group whilst the competitive groups are sub-divided into 4 classes of weak, medium, strong and super-strong comparative advantage groups by quartile method (Table 2). Let pij (i , j = 1, 2, 3, 4, 5) denote a one-step transition probability, that is the transition probability for the agricultural sectors that are in class i of year t moving to class j of year t + 1. The stability and mobility of the RCA indicators are investigated by using the Markov transition probability matrix and mobility index for values of the RCA and NRCA values from 2017 to 1 year in the future. The values along the diagonal line of the Markov matrix show the probability of the agriculture sectors remaining persistently in the initial class. The other values of the Markov transition probability matrix provide further information pertaining to the mobility of the RCA values. Specifically, they show the probabilities of agriculture sectors moving from one class to another from the year t to the year t+1. A 5 x 5 matrix was constructed for this mobility and stability analysis.

Table 5. The M-Shorrocks and Markov transition matrix for the Turkey's RCA values

RCA CLASSES		Class 1	Class 2	Class 3	Class 4	Class 5
M-Shorrocks	Class 1	0.54	0.18	0.11	0.14	0.04
0.87	Class 2	0.18	0.54	0.11	0.14	0.04
Average stability	Class 3	0.11	0.54	0.18	0.14	0.04
30.20%	Class 4	0.14	0.54	0.18	0.11	0.04
Average mobility	Class 5	0.04	0.54	0.18	0.11	0.14
17.45%						

Source: Author's own calculations based on data from ITC trade map (2019).

The result indicates that there is an average probability of the RCA indicators remaining in their initial class (values along the diagonal). The sectors within the uncompetitive as well as those within the weak competitive class showed the highest probabilities (54% each) of remaining stable and persistent in their initial classes. In other words, the sectors with initial comparative disadvantage seem to stay comparative disadvantage whilst the sectors with initial weak competitiveness maintain to be weakly competitive. There is also a high (54%) probability of the sectors in classes 3, 4 and 5 moving backwards to class 2. The average stability of the sectors in their initial class is 30.20% whilst the average mobility to other classes is 17.45%. The M-Shorrocks index of 0.87 generally, shows a relatively high degree of mobility between the classes in the Markov matrix (Table 5).

Table 6. The M-Shorrocks and Markov transition matrix for the Turkey's NRCA values

NRCA Classes		Class 1	Class 2	Class 3	Class 4	Class 5
M-Shorrocks	Class 1	0.54	0.07	0.14	0.07	0.18
0.91	Class 2	0.07	0.54	0.14	0.07	0.18
Average stability	Class 3	0.14	0.54	0.07	0.07	0.18
27.14	Class 4	0.07	0.54	0.07	0.14	0.18
Average mobility	Class 5	0.18	0.54	0.07	0.14	0.07
18.21						

Source: Author's own calculations based on data from ITC trade map (2019).

The result in Table 6 indicates average stabilities in the NRCA indicators over time. The sectors in class 1 and class 2 obtained the highest probabilities of stabilities with 54% each. In other words, there exists a 54% probability of the initial uncompetitive and weak competitive agricultural sectors steadily continuing to stay in their class over time. There is also a high (54%) probability of the sectors in classes 3, 4 and 5 moving backwards to class 2. The average probability of stability or diagonal elements is 27.14% whilst the average value of mobility or off-diagonal elements is 18.21%. The M-Shorrocks index of 0.91 confirms a high degree of mobility of the NRCA indicators.

Trend of the RCA and NRCA indicators: This section analyses the trend of agriculture sector competitiveness over the period 2006-2017 for Turkey. Using the RCA and NRCA values, a trend analysis was performed to examine the comparative advantage trend of the various agricultural sectors over the period 2006-2017 and to predict the direction of trends in the future.

Result of a trend analysis for Turkey's RCA indicators during the period of 2006–2017 illustrates that the country had the gaining trends in sixteen (16) agricultural sectors with $\beta > 0$ and the losing trends in twelve (12) agricultural sectors with $\beta < 0$. The sectors of HS11, HS19, HS04, HS02 and HS41 obtained the most growing trend in comparative advantage. This implies that Turkey has a strong tendency to continue obtaining a stronger comparative advantage in these sectors in the future. However, during the same period, the sectors of HS08, HS14, HS07, HS51 and HS52 incurred the most decreasing trends in comparative advantage (Table 7).

Table 7. Turkey's gaining and losing trends of the agriculture sector competitiveness by the RCA indicators

HS CODE	COMMODITY	β	P-VALUE	R^2	RCA 2006	RCA 2017
HS 11		0.279	0.000	0.761	4.948	7.974
HS 19		0.105	0.001	0.697	1.698	2.549
HS 04		0.061	0.000	0.884	0.301	0.913
HS 02		0.044	0.002	0.626	0.061	0.490
HS 41		0.035	0.000	0.883	0.493	0.906
HS 15		0.026	0.336	0.093	1.605	1.166
HS 18		-0.031	0.045	0.344	1.641	1.216
HS 52		-0.032	0.083	0.271	3.659	3.384
HS 51		-0.074	0.000	0.841	1.908	1.265
HS 07		-0.101	0.000	0.862	2.571	1.541
HS 14		-0.133	0.085	0.268	3.424	2.330
HS 08		-0.175	0.002	0.625	6.329	3.759
	GAINING TREND COMMODITIES	16				
	LOOSING TREND COMMODITIES	12				

Source: Author's own calculations based on data from ITC trade map (2019).

Table 8. Turkey's gaining and losing trends of the agriculture sector competitiveness by the NRCA indicators

HS CODE	COMMODITY	β	P-VALUE	R^2	NRCA 2006	NRCA 2017
HS 19		0.047	0.000	0.932	0.138	0.559
HS 11		0.037	0.000	0.884	0.215	0.624
HS 04		0.019	0.000	0.832	-0.198	-0.038
HS 08		0.017	0.307	0.104	1.682	1.645
HS 20		0.016	0.059	0.312	0.721	0.755
HS 40		0.016	0.004	0.574	0.285	0.481
HS 09		-0.007	0.001	0.674	-0.075	-0.162
HS 22		-0.007	0.048	0.337	-0.286	-0.403
HS 52		-0.008	0.097	0.251	0.813	0.688
HS 12		-0.017	0.000	0.719	-0.094	-0.337
HS 07		-0.019	0.005	0.563	0.361	0.200
HS 10		-0.020	0.035	0.372	-0.131	-0.462
	GAINING TREND COMMODITIES	13				
	LOOSING TREND COMMODITIES	15				

Source: Author's own calculations based on data from ITC trade map (2019).

The trend analysis result of the NRCA values over the period 2006-2017 reveals that Turkey obtains the gaining trends in thirteen (13) agricultural sectors with $\beta > 0$ and the losing trends in fifteen (15) agricultural sectors with $\beta < 0$. The country had the most increasing comparative advantages in the sectors of HS19, HS11, HS04, HS08 and HS20. It also predicts that Turkey has the tendency to continue on the path of obtaining stronger comparative advantage in these sectors in the future. Conversely, Turkey has the most decreasing comparative advantages in the sectors of HS10, HS07, HS12, HS52 and HS22 (Table 8).

In general, by the RCA indicators over the study period, Turkey had relatively more agriculture sectors with a gaining trend of competitiveness as compared to number of sectors with a losing trend of competitiveness. Conversely by the NRCA indicators, Turkey had relatively more sectors with losing trends than sectors with gaining trend. The Preparations of cereals, flour, starch or milk; pastry cooks' products (HS19) and Products of the milling industry; malt; starches; inulin; wheat gluten (HS11) sectors experienced one of the most gaining trends by both RCA and NRCA indicators whiles the Edible vegetables and certain roots and tubers (HS07) and Wool, fine or coarse animal hair; horsehair yarn and woven fabric (HS52) sectors are amongst those who experienced the most loosing trends by both indicators.

CONCLUSIONS

The results show that, in 2017, Turkey obtained the strongest RCAs in sectors; HS11, HS08, HS20, HS52, HS19 and HS14 with RCA index values of 7.974, 3.759, 3.384, 3.659, 2.549 and 2.330 respectively. Likewise achieved the strongest NRCAs in sectors; HS08, HS20, HS52, HS11, HS19 and HS40 with NRCA index values of 1.645, 0.755, 0.688, 0.624, 0.559 and 0.481 respectively. In the same year, Turkey by the RCA indices, achieved competitiveness in 13 agricultural sectors constituting 1 super-strong competitive sector, 4 strong competitive sectors, 3 medium competitive sectors and 5 weak competitive sectors whiles it remained uncompetitive in 15 sectors. By the NRCA indices, it also gained competitiveness in 13 agricultural sectors constituting 5 super-strong competitive sector, 2 strong competitive sector, 4 medium competitive sectors, and 2 weak competitive sectors whiles it remained uncompetitive in 15 sectors. Overall, by both indices, except for 1 animal product sector (HS40), Turkey recorded all top five competitiveness in the crops subsector. Namely; the starch/cereal products, edible fruits and nuts, preparations of vegetables and fruits, silk industry and the preparations of cereals and starch subsectors. In other words, Turkey has agricultural export strategy and competitiveness pattern based on the natural resource intensive and traditional agriculture sectors. OLS estimation for the RSCA values shows that over the study period, Turkey displayed a convergent pattern in the agricultural sector competitiveness. In other words, the country loses the competitiveness in the initial strong competitive sectors whilst it gains the competitiveness in the initial weak competitive sectors. The estimation result also implies a general de-specialization pattern. However, OLS estimation for the NRCA values results in a divergent pattern in agricultural competitiveness. In other words, Turkey gains the increasing competitiveness in the initial strong competitive sectors whilst it loses the competitiveness in the initial weak competitive sectors. The estimation result also did indicate a general specialization pattern. Markov matrices for both Turkey's RCA and the NRCA, also generally indicated that the comparative disadvantage (uncompetitive) sectors and weak comparative advantage sectors are the most stable to remain in their initial class. However, sectors in the medium to super strong comparative advantaged classes showed a high probability of moving to the weak comparative advantage class. The trend analysis reveals that, by the RCA indices, Turkey obtains the gaining trends in 16 agricultural sectors and a losing trend in 12 sectors. By the NRCA indices, it obtains the gaining trends in 13 agricultural sectors and a losing trend in 15 sectors. The dynamic analysis also proves that, in general, Turkey's export strategy and comparative advantage pattern are relatively dependent on the natural-resource-intensive and traditional agricultural sectors mostly the crop subsectors over time. Though there has been a significant positive difference in the competitiveness rankings of their strongest competitive commodities between the period 2006 and 2017 which may be considered as a small improvement of the export and economic growth pattern, the natural-resource intensive and traditional products are the strongest competitive and main export agricultural sectors of the country. The natural-resource-intensive export strategy is important in the initial period of economic development and globalization but not appropriate and effective in the medium and long terms. Therefore, Turkey need to restructure its sectors by implementing effective and efficient agricultural production strategies by focusing on high value-added, technology and capital intensive and market-oriented products based on the regional and global integration process.

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THE TAX POTENTIAL, AS AN INSTRUMENT FOR PERFORMANCE MANAGEMENT OF AGRICULTURAL BUSINESS

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Abstract

The paper studies and argues for the fact that estimates of the tax burden of agricultural producers should be made, based on its comparison with tax potential. We have analysed various views on this financial and economic item, the procedure for its definition and calculation and the cases when it is applied. The significance of negative estimates of reducing the tax burden in the economy of farms through the application of special tax treatment, first and foremost the Single Agricultural Tax, was highlighted. We proposed the term "taxpayer effectiveness ratio" and developed a detailed specification on how to calculate it. Taxpayer effectiveness ratio demonstrates the differentiation of farm crops (groups of crops) and animal species, and we dare to assert that this allows us more effectively analyse the potential for optimizing the production structures. We also formulated a procedure for calculating the potentials of different taxes and insurance premiums, reduced into a series of their different combination in the context of tax and fiscal economic models. The information base for calculating these potentials was both the general economic and sectoral results of the activities of commodity producers, reflected in their annual accounting reports. Calculation procedures clearly demonstrate that labour costs play an excessively significant role in the formation of the total load-potential. We found a contradiction that adversely affects rural areas development, during the study. There are on the one hand, the scientific and technological development of agriculture, that caused of reduces labour costs, and on the other hand, the insurance-budget system of financing of the region, which needs to increase tax and insurance income to the budget. The application of the new indicator and its calculation can become an important tool for managing the efficiency of agricultural production.

Key words: *tax and fiscal potential, agricultural producers, taxpayer effectiveness ratio*

INTRODUCTION

On the one hand, scientific and technological progress in the agricultural sector has an undeniable positive contribution to the economy, on the other hand, some negative consequences. These consequences are reflected, firstly, in the budget deficit of the pension fund, which caused an increase in the age of exit of civilians to retire, and secondly, decrease in tax revenues to regional and municipal budgets, as well as decrease in insurance contributions to extra budgetary funds.
Indeed, scientific and technological progress and taxation system have become kind of communicating vessels: modernization of productions reduces the need for so many labour force, and reduces the total payroll costs. At the same time, according to statistics for 2019 in the Saratov region, the budgets of three extra budgetary insurance funds in agricultural organizations and personal income tax (45% of all taxes and insurance premiums in the region) consisted of 43% consisted of contributions from labour costs. By the way, a fact that is not obvious at first glance, in the Russian economy value added tax (VAT) is also 20% of these costs.
As a result, the flow of money into insurance funds and government bodies' budget are reduced. Moreover, this has more impact on the economy of regions and their municipalities (personal income tax is a local tax).
If the level of scientific and technological development of the region does not increase or is constant, the situation in the budgetary structures is restored or, at least, ceases to deteriorate due to indexation of wages.

Indexation applies to wages due to inflation and some increase production in general.

Thus, one of the economic development in the regions is both the creation of new workplaces and the increase in the average monthly wage. It goes without sitting, that new modern workplace should be equipped according to the cutting edge course of scientific and technical development which is possible, then these workplaces will make up tax and insurance underfunding. This prompted us to return to the study of the problem of the consequences of scientific and technological progress in the agrarian sphere of the economy.

The aim of the study is about and procedures for assessing " tax and insurance potentials" for various industry, sub-industry, farm crops, animal species, as well as other industries of agribusiness, ensuring an increase in the efficiency of agribusiness and a balance of the economic interests of three beneficiaries: the state, society and taxpayers.

The theory of a question

In recent years, regional authorities have demanded in exchange for subsidies that the agribusiness increase the deductions due to an annual increase in the average monthly wage for agricultural workers. However, it seemed more expedient, if subsidies direct not to increase wages, but to further innovative development of agriculture. Due to higher profitability and new value added, this will allow funds and government to receive more total tax and fiscal refund, make up losses of insurance premiums due to the redistribution of the inflow of tax resources. For this to become possible, taxation system need to evolve taking into account innovative processes. In any case, there are serious grounds for deep analysis. In addition, the terms "tax and fiscal burden" and "tax and fiscal potential" should be considered.

The Federal Tax Service uses the term "tax burden" in the sense of "the share of the company's revenue allocated to the budget." The Service sets the tax burden for the current year in the form of average coefficients for types of economic activities calculated according to data for the previous year to control the col-lection of taxes. It should be noted that that if the enterprise did not overcome a minimum in the sphere, then there are bases to doubt law-abidingness of the executive that can cause tax audit. [1, p. 1].

The authors in the source show the ratios in two columns: the tax burden (%) and the financial burden on insurance contributions to extra budgetary funds (%). Amelina Tatyana explains that the data change annually based on statistical reporting information. To compare the values of these columns with each other in order to identify some patterns seems to us very interesting thing. In particular, the tax burden (11.2%) was 3.2 times higher than the burden from insurance premiums in general for all types of activities in the Russian Federation in 2019. That meant that the country's economic complex worked cost-effectively. Value added tax and profit tax are the majority of all taxes Based on these data, we can define a rule (extractive industries and excise industries are excluded): if the difference is significant, the profitability is also large; if the tax burden is less than the fiscal one, there is loss-making of production; if the tax burden is lower than fiscal one, but there is profit, then enterprises (organizations) use tax privileges or violate tax laws. In addition, the increase in the difference in ratio over the years indicates the presence of scientific and technological development, and the value of the ratio indicates the level of development.

In 2020, the production of agriculture, forestry, fisheries, fish farming, and producers of crop and animal husbandry was identified as high-intensive labour and scientifically and technically underdeveloped industries. Therefore, they enjoy tax benefits and the ratios for them have been set accordingly. The fiscal burden factor (from insurance premiums) for 4.8% of revenue, and the tax burden - only 3.4% (or 1.4 times less). Of course, do not forget the fact that in general, the country's agriculture is considered an industry with low profitability and a large share of productions with preferential tax treatment. However, for agricultural organizations of the Saratov region in 2019, the actual tax burden was 2.3 times higher than the established one, and the fiscal burden was only 81.4% of the established one. This means that for the conditions of the region it is necessary to develop our own standards, not only in general, but also in individual industries and sub- industries, taking into account the micro zonal specifics.

We want to determine the adequacy of the tax burden, its acceptability for taxpayers and sufficiency for the budget and insurance system, which means that the tax burden must be compared and contrasted with potential. "Potential," regardless of specificity, is "the totality of available tools, capabilities in any area" [10, p. 844], or "all tools, resources, inventories that may be used for a purpose if necessary" [2, p. 330]. "Tax potential" could be viewed in two ways: as "the maximum possible amount of tax revenues calculated under cur-rent legislation" [7, p. 127] and as "the total amount of taxable resources of the territory" [7, p. 128].

Most authors researching this area of taxation use "tax potential" as the "possible amount of tax revenue" [15, 3]. In particular, the authors of the paper "Tax potential of the region and methods of its assessment" (for Primorsky Krai) - consider actual tax revenues as a realized part of the tax potential [11, p. 203]. To assess potential, they propose three trivial methods. In one of them (simplified), I.V. Gorsky [4] proposed adding debts and amounts lost (due to tax benefits) to the taxes actually received. The growth of tax potential, ac-cording to the authors [11], may happen, for this we need several things. First, tax legislation in the field of optimizing the granting of tax benefits should be improved. Second, the tax collection system must evolve; thirdly, the state should stimulate business activity of the people by creating favourable conditions for business development; and tax administration in general should go to a new level. Nevertheless, these are fiscal steps, without reference to the fact that the tax system should balance the interests of taxpayers and tax recipients. On the other hand, Kortieva T.Yu interprets the tax potential as "the possibility of the state receiving income in the form of tax payments..." [8, p. 11], used to calculate the tax burden by applying it to the results of economic activity taxpayer [8, p. 18]. There is the need to balance between the interests of the state and the taxpayer in the text, and highlights "the possibility of economic and mathematical modelling of the tax potential of the economic entity and the determining of directions for its implementation" [8, p. 22].

D.E. Kusrayeva [9] emphasizes the importance of determining tax potential and indicates three directions of its use. Direct purpose is "improvement of the financial and budgetary system of the subject of the Russian Federation". However, it is equally important, including for the growth of taxable resources, "regulation of inter-budget relations," as well as "management of the reproduction of the economic complex". The author characterizes the tax potential, focusing on the indicators of tax income formation as well as the authors of other articles [11, 16, 6, 5], and V.I. Kataev and I.V. Kataev pay much more attention to the tax potential as a combination of taxable resources of the territory [7, p. 4].

They argue that it is profitability, which determines the tax potential of economic entities. They believe that taxes should increase in the event of an increase in both sales volume and financial results (The Golden Rule of the Economy) [7, p. 5]. At the same time, assessing the taxable resources of one of the leading agricultural enterprises of the Ulyanovsk region using the "innovative methodology," the authors came to the conclusion that the Unified Agricultural Tax (preferential taxation regime) is "a financial booth for agricultural producers who reduce the tax potential of taxpayers and, accordingly, the regions in general" [7, p. 6-7]. It should be noted that D.Z. Zalibekova in her paper "Tax Potential for Agricultural Producers," analyses the pros and cons of the Unified Agricultural Tax and relates the "possibility of reducing the tax burden" to the undeniable advantages of this tax regime [16, p. 397].

Based on the analysis of literary sources, we propose our own term «tax and fiscal potential," as a combination of tax and insurance (fiscal) items. It is determined by the share of three main taxes (without preferences) of the proceeds from the sale of products (works, services, etc.). They are production income tax; value added tax, and personal income tax, as well as insurance contributions to extra budgetary funds, if there are any. On this basis, we develop a methodology that demonstrates the differentiation of the efficiency of taxation of various industries and activities in the agro-industrial complex, contributes to the optimization of agricultural production and its increase in efficiency.

MATERIALS AND METHODS

Papers of domestic and foreign scientists on various organizational and economic aspects of taxation, as well as materials of the Federal State Statistics Service (Rosstat) and materials from regional agro-industrial complex management bodies became the theoretical, methodological and information base of the our study. We used both nationwide scientific methods of economic research (scientific abstractions, analysis and synthesis, induction and deduction) and statistical-economic, monographic and calculation-constructive methods, as well as Internet resources and "Methodological support for scientific research of economic problems of the development of the agro-industrial complex of Russia".

All formulas in paper are created by the authors. We used the following notation:

P_{tgr} – revenue burden potential, %; GP – gross profit, thousands of roubles.; R_{gp} - income tax rate of organizations.; RV – revenue, thousands of roubles; P_{at}– revenue burden potential; R_{at}– value added tax rate.; LC – labour costs with social contributions, thousand roubles.; A – amortization, thousand roubles; P_{pit} – revenue burden potential, %; R_{pit} – personal income tax rate , R_{ir} - insurance premium rate; P_{is} - potential insurance premiums burden, %; P_{total} - full tax burden potential - the tax component of the aggregate (tax and fiscal) potential, %.

RESULTS AND DISCUSSIONS

One of the goals of the development is to stimulate taxpayers to develop (expand) production; this will entail an increase in tax potential due to taxable resources. Nevertheless, we consider the tax and fiscal potential since this approach allows us to identify the negative consequences for the modern tax and insurance system of scientific and technological progress in agriculture, which we mentioned in the introduction.

We believe that it is advisable to determine the tax and fiscal potential of agricultural producers using information from annual reports of agricultural organizations. Previous studies in the field of analysis and forecast of the development of the agro-industrial complex [12], reproduction processes [13] and economic growth based on innovative products and technologies [14] confirm this.

As a first option, you can include only three in the calculations, but at full tax rates: income tax on organizations, value added tax and personal income tax, as well as full insurance contributions to extrabudgetary funds. Calculations show that this can lead to an increase in the total amount of taxes and contributions. This is due to the fact that many organizations use simplified tax regimes, such as the Basic Tax System, (the tax regime in which the income tax rate is zero), and the Unified Agricultural Tax, which reduces the size of this tax and VAT. However, individual producers want to abandon the UEFA, the above studies, confirm the feasibility of such a step [7]. Therefore, the option of determining the tax potential that we propose can be considered justified, especially since the dynamics of taxes and contributions in agricultural organizations of the Saratov region over the past three years (2017-2019) is positive, with a noticeable acceleration due to the growth of VAT (Fig. 1).

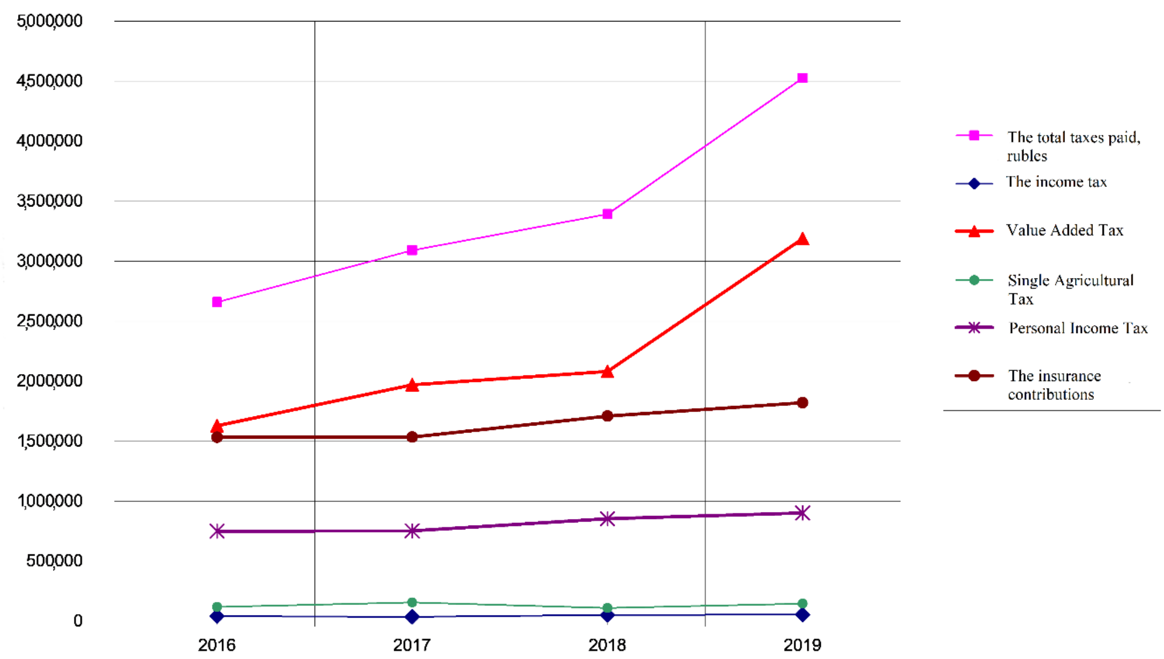

Fig. 1. Dynamics of the main tax and fiscal indicators in agricultural organizations of the Saratov region in 2016-2019
Source: Own calculation.

It is self-apparent that personal income tax and insurance premiums are growing very slowly because labour costs are also growing slowly, and the value-added tax has provided the main increase. By the way, preferential taxation reduced the potential of the tax part and income tax, whose share in revenue in 2019 was less than 0.5%.

The potential of the tax and fiscal burden of agricultural producers can be determined from the data of their annual accounting reports. Based on information about the revenue from the sale of products and its full cost, as well as the amounts of wages and depreciation deductions, we calculate gross profit (revenue minus full cost of production), profitability and the share of profit in revenue. Then, according to the algorithms for accruing three main taxes and calculating the amounts of insurance premiums to extra budgetary funds, establish the role of each of the main taxable resources in the formation of relevant taxes and insurance premiums.

Calculations should be made not only in general for organizations (taxpayers) and their certain collections, but also for individual crops and their groups, species and groups of animals, etc. The potentials of the taxes burden and insurance premiums, as their ratio to the revenue from the sale of products (shares in revenue), are calculated using the same algorithms that determine the size of a particular tax (contribution), but in this way the shares in the revenue from the sale of products are calculated. In particular, the potential for income tax burden is equal to the rate of this tax multiplied by the share of profit in revenue (formula 1):

$$P_{t_{gp}} = R_{gp} * \frac{GP}{RV} * 100\% \quad , \quad (1)$$

Value added tax (VAT) burden potential is calculated as the sum of the shares of three components of value added in revenue multiplied by the VAT rate. (formula 2):

$$P_{at} = R_{at} * \frac{GP + A + LC}{RV} * 100\% \quad , (2)$$

Personal income tax burden potential (in percentage) is defined as the product of the personal income tax rate and the share in the income of labour with premiums reduced by the amount of contributions by dividing by the rate of insurance premiums increased by one (R_{ir} +1) (formula 3):

$$P_{pit} = R_{pit} * \frac{LC}{(R_{ir}+1) * RV} * 100\% \quad ,(3)$$

The obtained results of calculations of tax loads potentials are summed up, forming a full tax potential according to formula 4:

$$P_{total} = P_{pit} + P_{at} + P_{t_{gp}} \quad , (4)$$

The potential of fiscal burden (insurance premiums) is calculated by simply allocating insurance premiums to extra budgetary funds from labour costs with these deductions. The amount of labour costs with deductions is first divided by the rate of insurance premiums increased by one, and then multiplied by this rate (formula 5):

$$P_{is} = \frac{LC * R_{ir}}{(R_{ir}+1) * RV} * 100\% \quad , (5)$$

Table 1 shows calculations of tax and fiscal potential on the example of crop production of agricultural organizations of the Saratov region using relative indicators according to the formulas given above.

Table 1. Calculation of tax and fiscal potentials in crop production (example of the Saratov region for 2019)

№	№ subsection	Taxes and indicators	Algorithms	Sales revenue, thousand rubles.	Taxable resources			Potential tax burden	
					gross profit, thousand rubles.	remuneration with social contributions	amortization	sh. Σ(col 3,4,5)	% Col 6*100
		1		2	3	4	5	6	7
1		**Value, thousand rubles. (line 95000)**		3,236,050	6,472,696	4,360,676	309,594		
2		Share in revenue, sh..	(line 1/col 2 line 1)	1.0	0.2	0.1348	0.0096	0.344	**34.43**
3	3.1	**Income tax (rate)**			0.1	0.0	0.00		
	3.2	Share in revenue	(line 2*line 3.1)		**0.02**	0.00	0.00	0.02	**2.00**
4	4.1	**VAT (rate)**			0.2	0.2	0.2		
	4.2	Share in revenue	(line 2*line 4.1)		**0.040**	**0.0270**	**0.0019**	0.069	**6.887**
5	5.1	**Personal income tax (rate)**			0.0	0.13	0		
	5.2	Share in revenue	(line 2*line 5.1)		0.000	**0.018**	0.000	0.018	**1.752**
6		**Total tax (share)**	(col 3.2,4.2,5.2)		**0.060**	**0.044**	**0.002**	0.106	**10.639**
7	7	**Insurance premiums (rate)**			0.0	0.31	0.0		
	7	Share in revenue	(line 2*line 6.1)		0.000	**0.0418**	0.000	0.042	**4.177**
8		**Total taxes and insurance premiums (share)**	Col 7+col 6.2		**0.060**	**0.086**	**0.002**	0.148	**14.816**

Source: Own calculation.

Meanwhile, the algorithm for calculating the total tax and fiscal potential differs from the calculation of the tax potential only by an additional burden on labour due to the rate of insurance premiums. On the other hand, it is obvious that remuneration is the greatest contribution to burden formation. It is present in three private formulas (lines: 4.2; 5.2; and 7) out of four (when calculating VAT, personal income tax and insurance premiums). It is necessary to conclude how important the amount of remuneration is for tax and fiscal public authorities, and how this prevents the increase in the average wage by taxpayer employers.

The profit of agricultural organizations participates in calculations twice, and its share in the total load is small, because, taking into account the presence of preferential tax regimes, the rate is accepted at the level of 10%. Accrued depreciation has the least effect on the total burden. We have had to neglect property taxes and land taxes because they are actually very small in size and proportions, although they are agents of the most important components of productive capacity and factors of production - fixed assets and, especially, land resources, which are the main means of production in agriculture. This structural analysis of the process of building the potential of tax and fiscal burden gives rise to a serious review of the modern taxation system in the agricultural sector of the economy.

The obtained results of calculating the potentials of tax and insurance burdens are subject to assessment by indicators of tax efficiency and compliance with parity of interests of three participants of economic relations. First, the state participates in relations because it receives taxes; Secondly, the society is a participant, because agricultural producers pay insurance premiums to extra budgetary funds; and finally, taxpayers (producers) are involved, because their goal is gross profit remaining after taxes, excluding personal income tax. We can measure taxpayer efficiency as a ratio that is determined by the product of the factor of the tax burden of taxpayer to its fiscal burden and the share of the wage fund in revenue or the ratio of the fiscal burden of taxpayer to similar averages to the aggregate. In addition, we can calculate and compare the cost payback index, which measures the taxpayer's solvency to efficiency, assessing the effectiveness of taxation; and the share of the residual gross profit after tax without personal income tax, which indicates the extent to which the producer's economic interest is satisfied (Table 2).

Table 2 shows the calculations of potentials and estimates of their results in crop production of agricultural organizations according to the lines of the table of the annual report: total for crop production without fruit and berry crops; seeds of cereals and legumes; corn grain; oilseeds; including sunflower and others. Potentials indicate that the highest tax burden on revenue can be borne by the production of protected soil vegetables (15.5% of revenue) with an insurance premium burden of 8.1% of revenue - also the maximum. The fiscal potential of the Total is also the highest, but the difference between private potentials is small, so their ratio is not large (1.29). However, the tax efficiency coefficient acquires the largest value (3.75) with an efficiency index of 1.2, since the level of insurance premiums is highest (2.0), (this industry is an industry of high labour intensity). However, it should be noted that the cost recovery of agricultural producers was lower than the average (1.21 versus 1.25). As a result, the share of the balance of gross profit in its initial amount after tax without personal income tax and, of course, without insurance premiums was the lowest - less than 31%. The amount of all taxes and insurance payments was 1.35 times higher than the amount of gross profit. Of course, such a tax and fiscal burden is not effective, and therefore is unacceptable.

On the other hand, there is the production of sunflower oilseeds, which have lower tax and insurance potentials not only compared to vegetable production of protected soil, but also with the production of corn grain. There is also a low tax efficiency ratio, but the highest cost recovery (1.36) allowed it to receive the highest share of the profit balance (56.63%).

The optimal taxpayer, with some assumption, is corn grain producers. Having almost the same cost payback as sunflower oilseeds producers (1.35), they have a higher potential for both tax (13.8%) and fiscal burden (3.1%), which also, with almost the same share of gross profit in revenue (26.19%), reduces the balance of their gross income at-were up to 52.27% of the total amount or up to 13.69% of revenue.

Table 2. Results of calculation of tax and fiscal potentials and their assessment by crop production indicators in the Saratov region in 2019

Agricultural commodities	Num.	Share in revenue (%):		Revenue tax burden potential (%):		Tax efficiency:			Factors:		
		revenue	compensations	total taxes	insurance premiums	tax burden ratio	level of insurance premiums (index)	effectiveness ratio	effectiveness	profit balance	economic return
Total: (line 95100+ ….+ 95900)	95,000	20.00	13.48	12.9	4.1	3.1	1.0	3.12	1.00	1.8	1
Grain and seeds of cereals and legumes (line 95110+ …+ 95180)	95,100	12.29	17.07	12.5	5.2	2.39	1.3	3.02	0.97	1.2	0.91
corn grains	95,120	26.19	9.99	13.8	3.1	4.52	0.7	3.35	1.07	2.1	1.08
Oilseeds (line 95310+ … 95390)	95,300	26.01	9.08	12.7	2.8	4.58	0.7	3.09	0.99	2.3	1.08
sunflower seeds	95,330	26.38	8.91	12.7	2.7	4.66	0.7	3.08	0.99	2.3	1.08
Vegetables and melons, (line 95410+ …+ 95490)	95,400	16.49	20.57	13.0	6.3	2.07	1.5	3.16	1.01	1.6	0.95
including: open ground vegetables (except seeds)	95,410	13.30	9.49	9.3	2.9	3.19	0.7	2.24	0.72	1.7	0.92
vegetables of protected soil	95,420	17.48	26.37	15.5	8.1	1.92	2.0	3.75	1.20	1.5	0.96
potatoes	95,450	-2.93	10.00	5.2	3.1	1.69	0.7	1.25	0.40	-0.8	0.77
Sugar beet root crops (commercial) in physical weight	95,460	13.42	7.42	8.3	2.3	3.67	0.6	2.02	0.65	1.8	0.92
Other vegetable crops	95,490	45.19	9.99	17.0	3.1	5.56	0.7	4.13	1.32	2.9	1.45

Source: Own calculation.

As a result, the balance of interests of the three counterparties is as follows: the state - 13.8%; society (3.1%); taxpayers - 13.7% of revenue. In a word, the shares of the state (taxes) and taxpayers (balance of profits) are almost equal, and the ratio of the state's share to the share of society is noticeably higher (4.52) than in the whole crop production (3.1%). Moreover, despite the relatively low share of wages in revenue (9.99%) and, accordingly, the level of insurance premiums (0.74), the efficiency ratio is above average (3.35 versus 3.12).

In this way, we can find that balance. In this case, the balance is achieved in the production of corn grains: the state (13.8% of revenue); company (3.1% of revenue); taxpayer (13.7%). As you can see, the taxpayer remains almost as much profit as the state receives taxes. Therefore, it can be stated that tax parity between taxpayers and the state is observed. The interests of the company remain unacceptable – only 3.1% of revenue. In addition, the efficiency of taxpayers increases due to an increase in the share of taxes in revenue, and they increase due to a decrease in insurance premiums.

Consequently, there is a direct contradiction between the interests of the state and society, which requires a review of the conditions for the formation of extra budgetary insurance funds.

In the same way, we calculated and analysed the potentials of tax and fiscal burden in other sectors of agriculture and in other areas of the agro-industrial complex: fruit and berry crops; animal husbandry; primary and industrial processing of agricultural products; working and provision of services, as well as we calculated it for farms and individual entrepreneurs. The potential of the tax and fiscal burden can be calculated not only in the form of a share of revenue, but also in the calculation of 1 hectare of land area in order to optimize the structure of their use, increase the manageability and efficiency of agricultural production.

CONCLUSIONS

We completed the study, and developed a method for determining tax and fiscal potentials for agricultural producers, based on a combination of three main taxes (income tax, value added tax and personal income tax) using the maximum allowable tax rates, as well as insurance contributions to extra budgetary funds. This method shows that the modern taxation system in agriculture prevents higher wages for workers, as it leads to a very significant increase in the tax burden on commodity producers. In this regard, in order to improve taxation, we have proposed a method for assessing the effectiveness of the taxpayer, in which tax and fiscal (insurance) burdens are compared with each other, as well as determining the balance of gross profit of the taxpayer after paying all taxes (without personal income tax). We also proposed procedures for calculating tax and fiscal burden potentials not only for individual producers and production sectors, but also for individual crops (group of crops), animal species, etc., in order to optimize the production structure on this basis to increase the efficiency of agribusiness. In addition, we believe that the tax system should be developed in the direction of transferring insurance extra budgetary funds to other sources of financing, as well as increasing the role of property and land taxes.

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AN ASSESSMENT OF INDIGENOUS KNOWLEDGE SYSTEM OF PEST CONTROL AND TECHNICAL EFFICIENCY OF VEGETABLE PRODUCTION IN OSUN STATE, NIGERIA

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Abstract

Indigenous Knowledge System (IKS) of Pest Control is an eco-friendly, cost effective and culturally accepted method of controlling pests and diseases. The study assessed the Indigenous Knowledge System (IKS) of Pest Control on Technical Efficiency of Vegetable Production in Osun State, Nigeria. A structured questionnaire was used to elicit information from 240 farmers across the state. The data collected were analyzed using Descriptive Statistics, Stochastic Frontier Analysis and Ordinary Least Square Regression Analysis. Result of analysis revealed the major indigenous knowledge used for pests and diseases control by the vegetable farmers were early harvesting (71.32%), removal of affected plants (62.80%), use of ash and water mixture (60.74%) and mixture of red pepper with water (41.09%). The average technical efficiency of farms using only IKS for pest and disease control was 0.78 while farms using a combination of IKS and pesticide had the highest average technical efficiency of 0.94. The technical efficiency of vegetable production in the study area is significantly affected by farm experience, usage of IKS, level of farmer's education and access to extension agent. The study concluded that the usage of Indigenous Knowledge System for pest control in vegetable production increased the technical efficiency of the farmers in the study area. The study however, recommends that there should be increase in the sensitization of farmers by government and non-governmental agencies on the economic benefits of indigenous knowledge system on pest control in order to boost productivity and efficiency of food production.

Key words: *efficiency, education, vegetable, farmers*

INTRODUCTION

Vegetable production is a major means of sustenance to the rural poor and even the people in the urban and peri-urban areas of Nigeria especially those who are unemployed [2]; but the production has been constrained by various forms of pests and diseases that includes insect pest and pathogens resulting to crop losses. Currently, the use of pesticides for the management and control of pests and pathogens is becoming more rampant.

Conversely, challenges encountered include resistance of insect pest and pathogen to the pesticides, requirement of repeated applications, increase in the cost of chemicals have given the drive to other methods for managing insect-pests and plant diseases. The use of chemicals for pest control usually leads to food poisoning, soil, water and environmental pollution as they create environmental imbalance and let insect-pest build up resistance, also emergence of new pests that were either non-existent or present as minor pest, degradation of arable land to the extent of unfit for cultivation and overall ill effects to human health as well as declining productivity due to barren and infertile lands caused by excessive use of chemicals [4]. It is as a result of the challenges faced in the use of chemicals for controlling pests in vegetable production that indigenous knowledge system (IKS) associated with plant protection in agriculture becomes important.

Indigenous knowledge system (IKS) are the local knowledge that is exclusive to a given culture or society, it is the basis for local-level decision-making in agriculture, natural resource management, health care, food preparation and several other activities in rural communities [1, 8]. The knowledge system are generally not established in written form and is passed on from generation to generation through word of mouth and have been well employed for enhancing and conservation of natural resources [5]. It involves the use of no or little use of chemicals because of the farmer's eco-friendly attitude; it has cost effectiveness, additional advantages, results in reduced insect pest and disease occurrence in crops, and leads to long-term sustainability of soil and crop productivity [9].

Although, owing to the usage of pesticides, vegetable farmers have been able to increase their productivity to a large extent. Nevertheless, the use of chemical methods in the management of pests and diseases especially the excessive usage have led to severe dangers such as environmental pollution, adverse effects on the health of consumers and causing the death of non-target organisms. Towards reducing and prevailing over these adverse effects, the vegetable farmers are moving back to applying indigenous knowledge system to manage pests and diseases. As a result, this study seeks to assess indigenous knowledge system of pest control and technical efficiency in vegetable production in Osun State, Nigeria.

The specific objectives of the study are to:

(i) identify the socio-economic characteristics of respondents;

(ii)identify the indigenous knowledge system practiced by farmers in controlling pests and diseases;

(iii)determine the technical efficiency of vegetable production;

(iv)examine the effect of indigenous knowledge system on technical efficiency of vegetable production.

MATERIALS AND METHODS

Study Area

The study was carried out in Osun State, Nigeria. It has thirty (30) local government areas (LGA) which was further divided into three agricultural zones and the capital of the state is in Osogbo. It lies on latitude 8° and longitude 6° to the North and South respectively; also it is marked by longitude 4° to the west and longitude 5° to the east [6]. It has tropical climate with distinct wet and dry seasons; and rich soil that supports crops and livestock production. The rainy season is usually between April and October, while the dry season is between November and March. The annual average temperature ranges between 21.1 and 31.1°C and the annual rainfall is within the range of 1,000mm and 1,200mm in the derived savannah and rainforest belt respectively [7]. The major economic activities of the people is centered around crop and livestock farming, trading, and artisanship while the main crops produced are palm oil and kernels, yam, cassava, maize, vegetables, plantain, banana and kola nuts [6].

Data and Sampling procedure

Primary data which was used for the study was collected using a structured questionnaire. The population for the study was the vegetable farmers in the state. A two staged sampling technique was employed in selecting the respondents. The first stage was the random selection of four communities from each zone making a total of twelve communities from all the zones using the Agricultural Development Project (ADP) communities listing in the state. The second stage was the random selection of twenty vegetable farmers in each community selected to make a total of 240 respondents which were sampled for the study but only 232 responses were found useful for the study.

Analytical Techniques

Data collected were analyzed using descriptive statistics, stochastic production frontier and ordinary least square regression model.

Descriptive statistics

Descriptive statistics which includes frequency, percentage and tabulation, use of central tendency and dispersion was used to capture the socio-economic characteristics of the vegetable farmers and identify the indigenous knowledge system practices in controlling pests and diseases.

Stochastic production frontier

Stochastic production frontier was used to estimate the technical efficiency indices of vegetable production and was specified using Cobb-Douglas production function following the study by [10]. The model implicit form is given as:

$$TEi = Yi/Yi^* = f(Xi;\beta)\ \exp(Vi - \mu i)/f(Xi;\beta)$$
$$\exp V = \exp(-\mu i)$$

where:
Yi: Observed output;
Yi*: Frontier output;
TE: Ranges between 0 and 1
while, the explicit form is specified as:

$$\ln Y = \beta_o + \beta_I \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + (V_i - U_i)$$

where:
ln = Natural logarithms;
Y = Output of vegetable farms (kilogram);
Y = Output of vegetable farm (kilogram grain equivalent);
X_1 = farm size (hectares);
X_2 = labour (mandays);
X_3 = quantity of fertilizer (kilograms);
X_4 = quantity of pesticides (litres);
X_5 = quantity of seeds (kilograms);
X_6 = quantity of water used for irrigation ($HaCm^3$);
β_I- β_6 = Production function parameters to be estimated;
B_0 = intercept, U_i = negative random error assumed to account for errors in technical efficiency, it is assumed to be half normally distributed $U_i \sim N(0, \delta^2 u)$ and ranges between zero and one;
V_i = stochastic error term which has zero mean and accounts for measurement errors and random factors beyond the farmers control, it is assumed to be a normally distributed random variable $N \sim (0,\delta^2 v)$.
U_i and V_i are assumed to be independent of each other. The technical efficiency indices were obtained using the FRONTIER 4.1 programme.

Ordinary least square (OLS) regression model

OLS regression model was used to examine the effect of indigenous knowledge system on technical efficiency of vegetable production. It was used due to it normality assumption for error term (ei), and its estimator is said to be normally distributed, best, and unbiased linear estimator [3]. The model is specified implicitly as:

$$Y = f(X_7, X_8, X_9 \ldots\ldots\ X_{15} + ei)$$

and explicitly as:

$$Y = \alpha + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \ldots\ldots + \beta_{15} X_{15} + ei$$

where:
α = intercept;
Y = Technical efficiency of vegetable farms;
β_7-β_{15} = regression coefficient;
ei =error term designed to capture the effects of unspecified variables in the model;
X_7 = gender of farmer (binary variable: 1 = male, 0 = female);
X_8 = Age (years);
X_9 = household size (adult equivalent);
X_{10} = farm income (Naira);
X_{11} = farming experience (years);
X_{12} = educational level;
X_{13} = access to extension services (binary variable: yes = 1, no = 0);
X_{14} = access to credit (binary variable: yes =1, no = 0);
X_{15} = IKS usage (binary variable: yes = 1, no = 0).

RESULTS AND DISCUSSIONS

Socio-Economic Characteristics of Farmers

Table 1 shows that about 95 percent of the farmers were female and most (90%) of them were married.
The modal age range is 41- 49 years while the average age of the household heads was 44 years. This is an indication that majority of the farmers in the study area are in their middle age and still active.
About 70% of the farmers have no formal education. The average farming experience of the farmers in vegetable production is

12years. This shows that the farmers were well experienced in vegetable production. The average farm size of the farmers in the study area was 1.4 ha with the modal class of farm size being (<2.0) ha.

This suggests that majority of the vegetable farmers in the study area are small scale farmers with farm size less than 2ha. The table also revealed that 55.60% employed indigenous knowledge practices in the control of pests and diseases of vegetable while the remaining 44.40% do not.

Table 1. Socio-Economic Characteristics of the Farmers (n=232)

Characteristics	Frequency	Percentage
Sex		
Male	11	04.74
Female	221	95.26
Age		
< 30	19	08.19
30-39	65	28.02
40-49	101	43.54
50-59	31	13.36
>60	16	06.89
Educational Level		
No Formal	164	70.69
Primary	38	16.38
Secondary	30	12.93
Tertiary	00	00.00
Marital Status		
Single	21	9.05
Married	132	56.89
Widowed	79	34.06
Farm Size		
<2.0 hectare	196	84.48
2.0-4.0	35	15.09
>4.0	01	0.43
Farming		
Experience	38	16.38
<5	78	33.62
5-10	49	21.12
11-16	64	27.59
16-21	03	1.29
>22		
Usage of IKS		
Yes	129	55.60
No	103	44.40
Extension Visits		
Yes	56	24.14
No	176	75.86

Source: Field Survey, 2020.

Indigenous Knowledge System Practiced in Controlling Pest and Diseases in Vegetable Production

Table 2 shows that the major indigenous knowledge used for pests and diseases control by the vegetable farmers were early harvesting (71.32%), removal of affected plants (62.80%), use of ash and water mixture (60.74%), mixture of red pepper with water (41.09%) etc.

Table 2. Distribution of Vegetable Farmers according to the Indigenous Knowledge System Practices used

Indigenous Materials used for field pest	Frequency (n=129)	Percentage
Mixture of Wood Ash and water	78	60.47
Mixture of Red Pepper with water	53	41.09
Mixture of Ginger with water	50	38.76
Crop Rotation	46	35.66
Neem seed	43	30.01
Cassava Slurry	32	24.81
Early harvesting	92	71.32
Removal of affected plants	81	62.80
Locust Bean soaked in water	41	31.78

Source: Field Survey, 2020.

Technical Efficiency of Vegetable Production under Orthodox and Indigenous Knowledge System (IKS) of Pests and Diseases Control Methods

Table 3 shows the summary of technical efficiency indices of vegetable farms in the study area.

The technical efficiency of farms that solely use IKS ranged from 0.30 to 0.99 with an average technical efficiency of 0.78.

Meanwhile the technical efficiency of farms that use only pesticide for the control of pest ranged from 0.60 to 0.99 with an average of 0.88.

The technical efficiency of farms using a combination of IKS and pesticide had the highest average technical efficiency of 0.94.

Table 3. Distribution of Vegetable Farmers by Level of Technical Efficiency

Efficiency Level	IKS Sole Users		Pesticides Sole Users		Users of both IKS and Pesticide	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
0.10-0.19	00	0.00	00	0.00	01	1.49
0.20-029	00	0.00	00	0.00	00	0.00
0.30-0.39	06	9.68	00	0.00	00	0.00
0.40-0.49	01	1.61	00	0.00	00	0.00
0.50-0.59	02	4.84	00	0.00	00	0.00
0.60-0.69	07	11.29	10	9.71	00	0.00
0.70-0.79	23	37.10	06	5.83	06	8.96
0.80-0.89	08	12.90	41	39.81	13	19.40
0.90-0.99	15	24.19	46	44.66	47	70.15
Sample	62	100.00	103	100.00	67	100.00

Source: Field Survey, 2020.

Effect of Indigenous Knowledge System of Pest and Disease control on Technical Efficiency of Vegetable Production in the Study Area

The result as shown in Table 4 reveals that technical efficiency of vegetable production in the study area is significantly affected by farm experience, usage of IKS, level of farmer's education and access to extension agent.

The coefficient of farm experience was positive and significant at 1%, which implies that the higher the experience of a farmer in vegetable production the more their technical efficiency.

The coefficient of usage of IKS was also found to be positive and significant at 1% implying that farmers who use the Indigenous pest control methods have higher technical efficiency in the vegetable production.

The coefficient of the level of education of a farmer was positive and significant at 1% which implies that increasing the level of a farmer's education will improve his/her technical efficiency of vegetable production.

The coefficient of access to extension was positive and significant at 1%, implying that an increase in the number of extension visit will improve the technical efficiency of vegetable production.

The coefficient of determination (R^2) shows that the explanatory variables explain about 56.12% of the variations in the factors influencing the technical efficiency of vegetable production leaving about 43.78% unexplained.

Variables such as Gender, age, household size, farm size, access to credit and farm income were not significant in explaining the factors influencing the technical efficiency of vegetable production in the study area.

Table 4. Ordinary Least Square Regression Result for Effect of IKS on Technical Efficiency of Vegetable Production in the Study Area

Variables	**Coefficient**	**t-value**
Gender	0.541	0.916
Age	1.125	2.892
Household Size	-0.987	-0.241
Level of Education	0.981***	3.960
Usage of IKS	0.678***	2.925
Farming Experience	0.231***	2.921
Farm Size	-0.985	-0.500
Access to Extension Service	-0.421***	-2.722
Farm Income	-0.420	0.312
Access to credit	0.752	0.512
Constant	3.987***	-2.811

***Significant at 1%

Number of observation = 232; LR chi^2 (9) = 71.30; Prob> chi^2 = 0.0000;

Log likelihood = -91.21901 and Pseudo R^2 = 0.5612

Source: Field survey, 2020.

CONCLUSIONS

The study concluded that the usage of Indigenous Knowledge System for pest control in vegetable production increased the technical efficiency of the farmers in the study area.

As vegetable farms that used a combination of both systems of pest control had the highest efficiency in the vegetable production. However, the study recommends that in order to boost the efficiency of vegetable production there should be increase in the sensitization of farmers by government and non governmental agencies on the economic benefits of indigenous knowledge system on pest control in order to boost productivity and efficiency of food production.

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EFFECT OF REHABILITATION TECHNIQUES ON COCOA BEANS YIELD IN SOUTHERN NIGERIA

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Abstract

The study investigated effects of rehabilitation techniques on Cocoa bean yield in Southern Nigeria. Three hundred cocoa farmers were selected using multistage sampling procedure. Data generated were analyzed with descriptive statistics and inferential statistical tools such as chi- square and t-test were used to determine the relationship between dependent variable and independent variables. The study revealed that 84.7% of the farmers were less than 50 years of age, majority (81.3%) was male, 89.3%, while, 87.3% of the farmers participated in one social organization or the others. The mean yield of cocoa beans reduced from 334.16 kg/ha in 2004 to 303.69 kg/ha in 2006 before cocoa rehabilitation techniques; while, there was an appreciable increase from 411.13 kg/ha in 2014 to 518.95 kg/ha in 2016 after cocoa rehabilitation techniques. The result of t–test table revealed a significant difference in the yield of cocoa beans before and after rehabilitation techniques ($t=22.3$; $p<0.05$). The yield of cocoa beans decreased before rehabilitation and an increased was observed after adoption of cocoa rehabilitation techniques. Efforts should be made to encourage youth to view farming as a carrier option through provision of soft loans and transfer of techniques that are easy to implement on their farms.

Key words: *rehabilitation techniques, appreciable increase, Cocoa improvement, on-farm*

INTRODUCTION

Cocoa production under agrarian agriculture in Nigeria is very low as the production per hectare ranges between 250 and 450kg/ha; this is less than 25% of the yields obtained in an ideal situation. In spite of the fact that Nigeria, especially Southern Nigeria is naturally blessed with vast areas of soil, physical and climate features that favoured cocoa production, the yield gap is the result of many production factors, such as old age of cocoa trees old age of cocoa farmers, size of cocoa farms, poor agronomic and pest /diseases management practices [3] and inadequate fund to acquire inputs [15]. Others are problems of land management, non-availability of inputs, scarcity of labour and management, farm capital and financial constraints between the grower and industries [7]. These aforementioned predicaments made cocoa production dwindling over time and Nigeria is currently the fourth world producer which is 367,000 tonnes after Cote d'Ivoire, Ghana and Indonesia [19].

However, the situation worsened since the discovery of Crude oil in commercial exportable quantity in 1968 and Oil boom of 1974 which made oil sector virtually dominated the Nigeria economy and consequently brought neglect in agriculture and abandonment of many cocoa farms [12]. Though, the neglect has negative impact on the growth of the agricultural sector and according to the International fund for Agriculture Development (IFAD) [11], Nigeria has about 73.8% rural population of which majority (about 60%) engaged in agriculture. Federal Government in an attempt to save the industry from collapse promoted adoption of cocoa rehabilitation techniques which were developed by Cocoa Research Institute of Nigeria (CRIN) through the National Cocoa Development Committee

(NCDC) in all cocoa producing states in 1999. Obviously, the predominance of the smallholding cocoa farmers who do not rehabilitate their cocoa farms in either of the techniques contributes in no small measure to the reduction of cocoa production. This reduction in cocoa yield/tree as a result of moribund trees in many cocoa farms has reduced the productivity of farmers and this has consequently affected the cocoa production output. There was need to carry out this research to have empirical information on the effect of these techniques on the yield of cocoa. Hence, this study which addressed the effects of cocoa rehabilitation techniques on cocoa beans yield before and after adoption of cocoa rehabilitation techniques was carried out to ascertain the socio – economic characteristics of cocoa farmers and determine level of cocoa beans yield before and after rehabilitation techniques. The hypothesis tested was that there is no significant difference in the yield of cocoa bean before and after adoption of rehabilitation techniques by respondents.

MATERIALS AND METHODS

Study Area

The study was conducted in cocoa producing States of Southern Nigeria which comprises of three geo-political zones; these are South-West, South-South and South-East. In exception of North-West that the climate and soil does not support cocoa production, the cocoa growing areas of the country lies between 5.09^0 - 8.49^0 North latitude and 2.78^0 - 12.16^0 East longitude with varying vegetation between tropical rain forest in the extreme South-West and South-East to derived savannah in the North Eastern Nigeria.

Sampling procedure

The population of this study was made up of cocoa farmers in Cross-River, Ondo and Oyo States. Cross-Rivers State was selected in South- South, while, Ondo and Oyo states were selected in South- West. These farmers practiced cocoa rehabilitation techniques which was an intervention of Federal Government in 1999. A multi-stage sampling procedure was used for the selection of respondents from the 10 States producing cocoa in Southern Nigeria. Cross- Rivers and Ondo States were selected as high producing states, while Oyo State was selected as medium producing state.

Two Local Government Areas (LGAs) where there is high level of participation in cocoa rehabilitation programme in each of the three states were purposively selected; these LGAs were Idanre and Ondo East in Ondo State, Ikom and Etung in Cross-Rivers States, and Ona-Ara and Iddo in Oyo State. This was followed by purposive selection of two communities where farmer’s organizations participated in cocoa intervention programme. These communities were Owena and Alade in Idanre, Bolorunduro and Soko in Ondo East, Amosun and Alagba in Ona-Ara, Akinware and Idi-Iya in Iddo, Yaunde and Etom in Ikom, Ajassor and Akumba in Etung LGAs for Ondo, Oyo and Cross-Rivers States respectively.

Data collection

Data was collected in 12 communities where 25 small holder cocoa farmers were randomly selected using table of random numbers among the farmers that belonged to Cocoa Farmers Association of Nigeria. Thus a total of 300 respondents were selected and interviewed in this study.

Data Analysis

Descriptive statistics such as frequency count, bi-charts and percentages were used to analyze the socio- economic characteristics of the respondents, while chi-square and regression analysis were used to test relationship between dependent variable and independent variables. The independent variables are age of cocoa farmers, sex, level of education and marital status. Cocoa rehabilitation techniques practiced by the farmers were also considered as independent variables in the study.

The dependent variable of this study is cocoa bean yield, this was measured in kilogram (kg), and farmers were classified on the basis of their cocoa production in their farms. Average farmers' yield was determined by asking the farmers to give their farm yield for the past three years consecutively before and after cocoa rehabilitation. The values obtained were divided by three to determine the average yield, while each of the farmer's yearly production was divided by his/her farm size to determine his/her production per hectare. The productions of the farmers were further subjected to recommended production level of 503 kg/ha. A cocoa tree with 15pods/year in 1hectare containing 1,040 cocoa trees will give about 503 kg/year of dried cocoa beans, 11 pods/tree/year will give about 392 kg/year, while, below 11 pods/tree/year will give less than 393 kg/year [4]. Any farmer scoring 503 kg/ha and above was considered high producer; a farmer who scores between 392 kg/ha and 502 kg/ha is at medium level, while below 392 kg/ha is considered a low producer [10].

RESULTS AND DISCUSSIONS

Data presented in Figure 1 showed that 84.7% of the respondents were less than 50 years of age, and this indicated that cocoa farmers in the study area were still in their active age. The result supports the finding of [18] in a study of Edo cocoa farmers that farmers are still in their active farm age. The result of this study disagrees with the finding of [3] in a study carried out in Oyo State that cocoa farmers are not in their active farm age. This implies that young people are now coming into cocoa production.

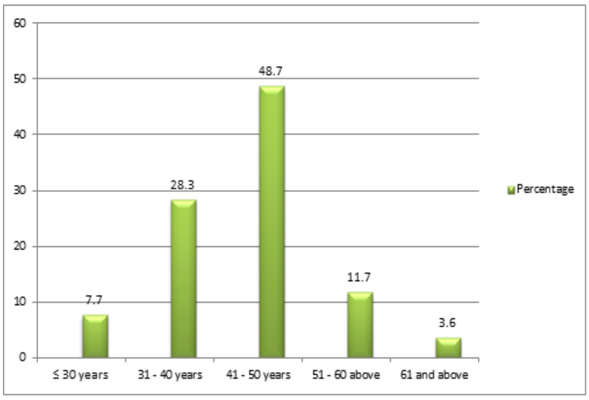

Fig. 1. Distribution of the Respondents according to their age
Source: Field Survey, 2017.

Figure 2 revealed that 81.3% of the respondents were males while 18.7 were females. This implies that there is dominance of male gender in farming activities among farmers that adopted cocoa rehabilitation techniques. This is supported by [15] that in Cross Rivers State, there were more male cocoa farmer. [9] and [5] stated that male headed households usually out-number female headed household in most communities in Nigeria. [17] supported that farming occupation in rural area was dominated by male as means of livelihood in Nigeria. This can be attributed to the fact that cocoa farming is a tedious job that requires more strength that can only be provided by male [16].

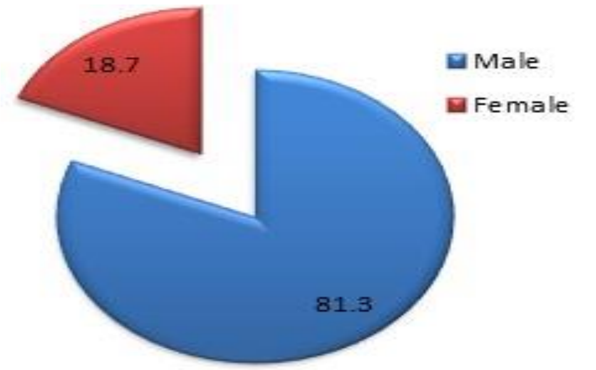

Fig. 2. Distribution of the Respondents according to their sex
Source: Field Survey, 2017.

Figure 3 showed that 89.0% of the respondents were married, 7.0% were single, and 3.3% of the respondents were widowed while 0.7% was divorced. Majority of the farmers were married (89.0%) which is an indication that marriage is highly cherished in the rural areas. This agrees with the finding of [20] who noted that most farmers in Nigeria are married. It was also an indication that most of the farmers were responsible and had a family who assisted them in their farm work. This might be the reason why they grower permanent crops like cocoa in order to have a sustainable income to feed their family and possibly invest in other small scale business. The significance of marital status can influence the household size and number of those participating in community development projects [13].

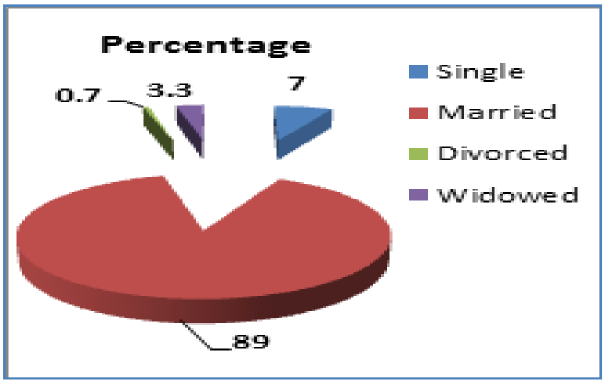

Fig. 3. Distribution of the Respondents according to their marital status
Source: Field Survey, 2017.

The presentation in Figure 4 showed that majority of the respondents 78.7% had Secondary School Education and below. Few of the respondents (10.3%) completed tertiary school while, 11.0% had no formal education. The result shows that majority of farmers can read and write which has facilitated their adoption of some cocoa rehabilitation techniques introduced to them. This is in line with [8] that ability to read and write by the respondents has greater effects on the practice of agricultural activities.

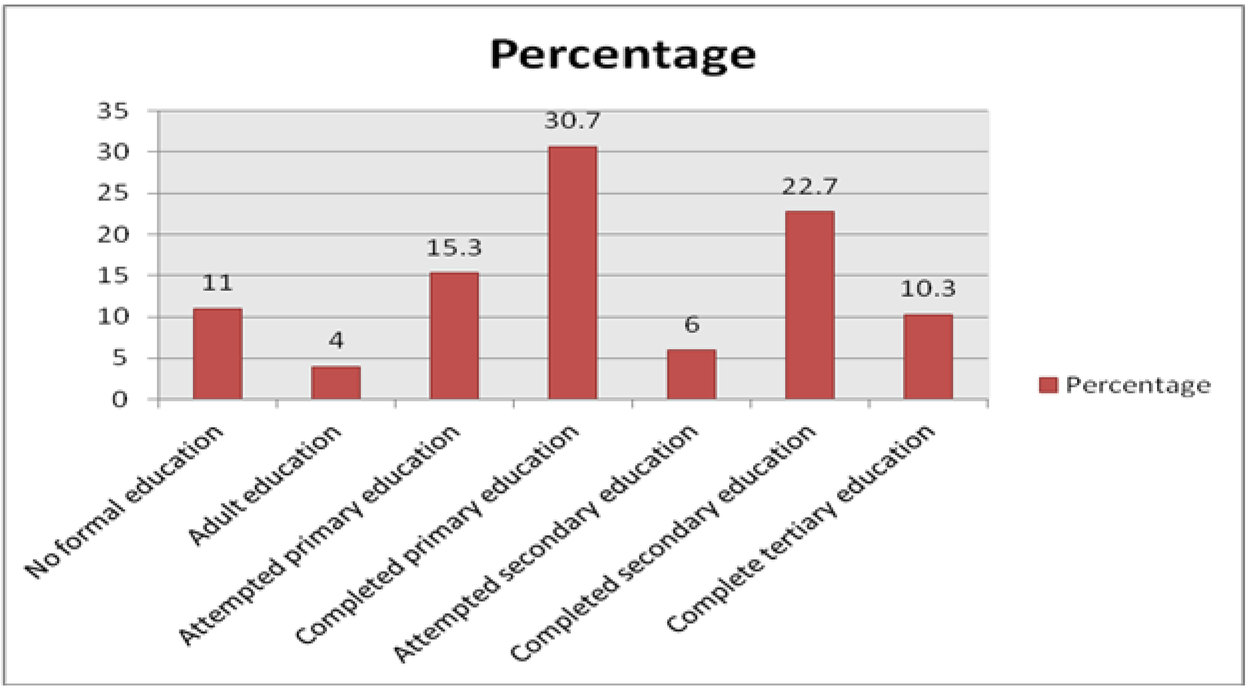

Fig. 4. Distribution of the Respondents according to their level of education
Source: Field Survey, 2017.

Table 1 shows the distribution of respondents according to their participation in social group. The finding revealed that majority of the farmers (68%) belonged to farmer organization such as Cocoa Association of Nigeria (CAN) and Cocoa Farmers Association of Nigeria (CFAN). Also, 65% of the farmers belonged to cooperative society, 28.7% of them belonged to community based organization while few (14%) belonged to religion organization. This is an indication that farmers have opportunities for skills acquisition, social and economic opportunities as a group with more responsibilities and enlightens to participate in innovation techniques. The social group also serves as a source of morale booster, linkage to source of credit, planting materials, agricultural inputs, capacity building and medium of information dissemination.

[4] In a study of farmers in adopted village observers that farmers' organization gives farmers an edge over non participated farmers. This was equally supported by [6] that group membership helps members to become better informed about the world and new technologies.

Table 1. Distribution of Respondents by farmer's participation in social group

Social group	Frequency	Percentage
Religions groups	42	14.0
Community based groups	86	28.7
Cooperative society	195	65.0
Farmers groups (CAN/CFAN)	204	68.0

Source: Field Survey, 2017.
Multiple responses

The results in Table 2 reveals that 24% of the cocoa farmers sourced their credit from cooperative society, 14% from friends and relatives while, few 4.3%, 2.7%, and 1.0% sourced their credit from commercial bank, money lender and agricultural credit institutions respectively.

The result clearly showed that very few sample respondents received loan or credit from financial institution (Commercial Banks and Government). [14] opined that collateral requirement, administration and bureaucratic process serve as strong bottle-neck to obtain loan from commercial banks.

Loan or credit from cooperative society is easily accessible because it does not require collateral or high interest rate as required in other financial institution. Also, members of cooperative society can access loan from commercial bank without collateral through Cross Guarantee for their members.

[2] supported this finding that loan from cooperative is the most accessible credit to farmers in the rural area.

Table 2. Distribution of the Respondents according to their source of credit facilities

Source of credit	Frequency	Percentages (%)
Friends &relatives	42	14.0
Money Lender	8	2.7
Agric. Credit Institutes	3	1.0
Cooperative Society	72	24.0
Commercial Bank	13	4.3
Total	300	100.0

Source: Field Survey, 2017.

The results in Table 3 showed that gapping up (84.3%) and growing young cocoa under old trees (78.7%) had the highest adoption, this was followed by complete farm replanting (59.7%) and the least practice were coppicing (27.7%) and phased farm replanting (12%). The high percentage recorded for gapping up and growing young cocoa under old trees may be attributed to the ease of implementing the techniques and the fact that many of the farmers practice it as a routine activity on their farms. Nevertheless, complete farm replanting was considered as a technique to maintain optimum population per hectare.

Table 3. Distribution according to the cocoa rehabilitation techniques practiced

Techniques	Frequency	Percentage
Planting under old free	236	78.7
Gapping up	253	84.3
Phased farm replanting	36	12.0
Complete farm replanting	179	59.7
Coppicing	83	27.7

Multiple responses
Source: Field Survey, 2017.

Table 4 showed the distribution of respondents according to their cocoa bean yield in kilogramme before and after cocoa rehabilitation techniques. The table revealed that 12.0% of the farmers had mean yield of 334.16 kg/ha in 2004 before rehabilitation and this was reduced to 8.6% with the mean yield of 303.69 kg/ha in 2006 before rehabilitation. The reduction in the output of cocoa production before rehabilitation was as a result of continuous degradation of cocoa trees due to old age. This concurs with [3], that cocoa trees in farmers' farms are old and moribund. In the same vein, 31.7% of cocoa farmers had the mean yield of 411.33 kg/ha in 2014 after cocoa rehabilitation, this yield was increased to 518.93 kg/ha in 2016 as 54.3% of the farmers adopted the techniques. The increase in output witnessed by the farmers was as a result of impact of cocoa rehabilitation techniques adopted by the farmers.

This is in consonance with [1] that cocoa rehabilitation techniques have impact on cocoa output.

Table 4. Distribution of respondents by cocoa yield (Kg) before and after rehabilitation

	Before						After					
	2004		2005		2006		2014		2015		2016	
Yield	F	%	F	%	F	%	F	%	F	%	F	%
≤ 100	16	5.3	27	9.0	45	15.0	20	6.6	9	3.0	17	5.7
101-300	112	37.4	120	40.0	86	28.7	87	29.0	42	14.0	34	11.3
301-500	136	45.3	122	40.7	143	47.7	98	32.7	136	45.4	86	28.7
≥ 501	36	12.0	31,	10.3	26	8.6	95	31.7	133	37.6	163	54.3
Mean	334.16		315.02		303.69		411.33		483.96		518.93	
S D	143.22		119.22		105.91		215.48		226.92		246.03	

F= Frequency
%= Percentage
Source: Field Survey, 2017.

Table 5 shows the difference in yield of cocoa beans before and after cocoa rehabilitation techniques in the study area. The result shows that there was a significant difference in cocoa bean yield before and after rehabilitation techniques ($t = 23.3$, $p \leq 0.05$). The implication for this is that, the yield of cocoa bean differs significantly with a mean difference of 175.7 before and after rehabilitation techniques. It could therefore be deduced that the practice of rehabilitation techniques has effect on the yield of cocoa. The result supports the findings of [4] who found out that rehabilitation through coppicing of moribund cocoa trees had positive effect on the yield of cocoa farm.

Table 5. T-test result showing significant difference in the yield of cocoa bean before and after rehabilitation technique

Variable	Mean	Mean Difference	T	Df	p-value
Yield before rehabilitation	336.2	175.7	22.3	298	0.0001
Yield after rehabilitation	511.2				

Source: Field Survey, 2017.
Significant at $P < 0.05$

CONCLUSIONS

Cocoa farmers in the study area are young and still very active in farm work. Gapping up (84.7%) and planting young cocoa under old cocoa trees (78.7%) were the techniques mostly practiced by the farmers. The yield of cocoa beans decreases over the years before rehabilitation while there was an appreciable increased in cocoa yield after adoption of rehabilitation.

The intervention of Federal Government to bring back the lost glory of cocoa production has encouraged youth to see cocoa farming a profitable venture. It is recommended that, Government should embark on the programme such as provision of soft loan mechanism and transfer of techniques that are easy to practice on their farms; this will encourage youth to engage in cocoa farming and view cocoa farming a profitable career option, which will bring an improvement to the practices of their forefathers.

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PRIVATE TOURISM ORGANISATIONS EMPLOYEES' JOB PERFORMANCE IN OSUN STATE, NIGERIA

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GROW ORGANIC – PROTECT THE ENVIRONMENT

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Abstract

Global population growth in recent decades, combined with evolving industrialization, and climate change has an immediate negative impact on the environment. Organic farming is a widespread alternative production practice having serious interrelationship with the society, economy, and ecology state worldwide. The aim of this scientific research is to prove the organic agriculture as an environmental protection approach. The paper is also an appeal to farmers, citizens, scientists, and governments for more understanding, applying, and supporting the organic farming to spare the nature. Organic farming today is close to the agriculture practiced by our ancestors. Namely, the production of agricultural products and animal husbandry in a way that protects human health and the environment.

Key words: *organic farming, sustainability, climate change, environment protection*

INTRODUCTION

Global population growth in recent decades, combined with evolving industrialization, and climate change has an immediate negative impact on the environment. The increased population requires extra food, which in turn requires the production of more and more agricultural products to feed the inhabitants.

Due to environmental problems of conventional agriculture in many countries, most agricultural policy makers are considered organic farming system as a new approach of environmental protection to achieve food security and sustainable agricultural development [17].

Sustainable development ensures a growing standard of living and protection and improvement of the environment [1].

In recent years significantly increased interest in organic agriculture, in response the increasing environmental degradation, deterioration in the quality of food and the growing threat to public health of the human population [3].

It is not only an agricultural method of providing healthy food to inhabitants, but also a certain way to protect our nature [4].

Organic farming devoid of the use of any chemical or genetically modified inputs, in which the biological potential of the soil, organic sources and underground water resources are conserved and protected adopting suitable cropping pattern including agro-forestry and methods of organic replenishment. It is environmentally enhancing agriculture: What we want is farming model that leave the environment better than it was before. We want the soil more fertile, the landscape more diverse, the forest healthier and the wildlife more prolific. Parameters of proper environmental considerations are clean air, clean water, healthy plants, and animals [6].

Organic farming is based in principle on increasing soil organic matter content by using natural fertilizers [16].

Organic agriculture is ecologically sustainable and therefore good for the environment. The fertilization of fields with organic amendments such as manures and compost provide both essential plant nutrients and a carbon source for soil microorganisms. The favourable structure created by the microbes helps improve the soil's resistance to erosion [8].

Everything in life is dependent on our soils, the sun, and water. When larger number of people are involved with the soil, food and the basics of life, the world will become a better place. In today's world, this is easy to forget, because we are a mobile society that can move away from the consequences of our actions; if the soil is poor, plow up another field. In the future, we will not have that luxury; we must improve what we have [10].

MATERIALS AND METHODS

The goal of the current scientific paper is to prove the organic agriculture as an environmental protection set of actions. The study is based on detailed peer reviewed scholarly research and secondary external data base collections. The conducted qualitative and benchmarking analysis methods consider organic farming from an ecological point of view and outline its significant benefits for the natural habitat.
We found that the organic farming is a helpful agricultural approach to environmental safety functioning and development.
Conclusions are made and future actions are being recommended.

RESULTS AND DISCUSSIONS

Agriculture is the world's largest industry. It employs more than one billion people and generates over 1.3 trillion USD worth of food annually. Pasture and cropland occupy around 50 percent of the Earth's habitable land and provide habitat and food for a multitude of species. When agricultural operations are sustainably managed, they can preserve and restore critical habitats, help protect watersheds, and improve soil health and water quality. But unsustainable practices have serious impacts on people and the environment.
The need for sustainable resource management is increasingly urgent. Demand for agricultural commodities is rising rapidly as the world's population grows. Agriculture's deep connections to the world economy, human societies and biodiversity make it one of the most important frontiers for conservation around the globe [18].
It's impact on the environment has improved, but there is still much to do. In recent years, there have been some encouraging signs that the agriculture sector of OECD countries is capable of meeting its environmental challenges. Farmers in many OECD countries have made improvements in the use and management of nutrients, pesticides, energy, and water, using less of these inputs per unit of land. Farmers have also made good progress in adopting more environmentally beneficial practices, such as conservation tillage, improved manure storage, or soil nutrient testing [11].
A major case for organic farming rests on its ability to reduce or eliminate many of the worst environmental consequences of modern production systems, including loss of wildlife and wildlife habitats, pollution of the environment and the excessive usage of non-renewable resources [9].
Benchmarking analysis has been used to compare the conventional and organic agriculture effects on the natural habitat. The results are presented in Table 1.

Table 1. Summary of the environmental impact of organic farming (compared with conventional farming)

Indicator		**Assessment of impact**	
		Per unit area	Per unit yield
Ecosystem	Biodiversity	+	+
Soil Quality	Organic matter content	+/~	+/~
	Biology	+/~	+/~
	Structure	+/~	+/~
	Erosion susceptibility	+/~	+/~
Water Quality	Nitrate leaching	+	+/~
	Phosphorus loss	~	~
	Pesticides	+	+
	Human pathogens	~	~
Air Quality	Ammonia	+	~
	Nitrous oxide	~	~
	Methane	+	-
	Carbon dioxide	+	+
Resource use	Energy efficiency	+	+
	Nutrient balance	+	+/~
	Controlled wastes	+	+
Key:			
+	Organic is better than conventional		
-	Organic is worse than conventional		
~	No difference between organic and conventional		

Source: The Department for Environment, Food and Rural Affairs (DEFRA) and Own Research.

Comparative analysis shows that organic farming has many favourable variances in favour of the biodiversity. Such as: positive effect on soil state and condition – level of nitrogen and phosphorus; ammonia control through manure production and its storage management. Regarding organic animal husbandry, the methane and carbon emissions going into the soil have relatively low levels. This is due to the typically small size of the organic holdings. Organic farming has lower energy use than the conventional. Generally, even not in once, organic agriculture can produce many environmental benefits [5].

Natural resources are depleted under the influence of weather and external conditions, as well as under the influence of strong industrialization and subsequent pollution. The use of many pesticides and herbicides in conventional agricultural production also has a strong negative effect. Organic farming has a positive effect on most natural resources - soil, water, air, chemical elements, and minerals. Therefore, it has a significant ecological role in the improvement and protection of the environment [7].

It our opinion, it is also important to mention here that climate change is the defining challenge for human development and ecological well-being in the 21st century. Agriculture is both affected by climate change but also contributes to it. organic farming systems utilize traditional skills and knowledge, manage with weather extremes, and enhance productivity and resilience. One major criticism of organic agriculture is that productivity is lower compared to intensive conventional agriculture [13].

The production approach and methods of organic farming can be considered as a closed system, from the production of fertilizers, seeds, officially authorized organic preparations, cultivation of crops and animals and the use of their residues throughout the production cycle. All this proves that organic farming is a secure production and management driver aimed at slowing down climate change and preventing possible catastrophic consequences in the future [15].

At present, climate change is one of the greatest challenges facing the globalized world. Weak populations in developing countries will be particularly affected by global warming, of which developed countries are the main drivers. According to our study, a global rise in temperature of 2°C above pre-industrial levels could irreversibly change the face of the world. The need for sustainable and climate-friendly development is clear.

We believe that environmental protection must be a priority for every country in the world and that constant measures must be taken in the production of agricultural products. Stopping the use of pesticides is one of the boldest actions to protect the environment. For example, we also found that this is exactly the step that Switzerland intends to take – likely it will be the first European country to ban their use in agriculture. Of the countries around the world, only Bhutan has completely banned the use of artificial pesticides [2].

As organic Agriculture is based on four important principles namely the principles of Health, Ecology, Fairness, and Care, according to the global organic organization IFOAM ‘These principles are the roots from which Organic Agriculture grows and develops. They express the contribution that Organic Agriculture can make to the world. Composed as inter-connected ethical principles to inspire the organic movement in its full diversity, they guide our development of positions, programs, and standards’. Ecosystems all over the world are under pressure, threatening the productive potential of the world’s natural resources and compromising the future fertility of the planet. it is clear we need to go down a new path. Organic agriculture is part of the solution [14].

We agree to IFOAM that organic farming takes a holistic approach that cares for our precious nature by producing clean and good food as well as sustaining the agri-ecosystems. In this regard, we absolutely support the United Nations’ sustainable development goals report, which is concentrated on exploring and proving the organic farming as their tool of achievement. For about a decade now, the plan aims to use organic farming to achieve half of its environment protecting goals. The main ones are reducing the negative results from conventional agriculture; increasing the positive impact on climate change; biodiversity improvement; clean soil and water resources, and their appropriate and responsible management; an enhancement in benefits for people's health and providing them with normal healthy living environment [12].

CONCLUSIONS

Based on the conducted scientific research we can conclude that our environment faces many challenges at present. Industry and conventional agriculture have a huge adverse impact on its condition and development.

As an agriculture production method organic farming can help and protect the environment. It can be achieved in reducing the harmful emissions by several production methods such as skilful soil tillage, control and care, correct selection of crop rotation and animal husbandry, fully compliant with the requirements of organic production of agricultural products.

There are established advantages and disadvantages of the organic farming, and in terms of environmental protection, its advantages are much more. Regarding the identified shortcomings, our advice is to constantly conduct scientific ecological, economic, and sociological research to analyse and assess the state and changes in organic farming and its direct impact on the environment.

The results of our research prove that organic farming is ecologically sustainable and has the full potential to apply best environmentally friendly practices optimizing the available natural, climatic and production resources; and considering the health of future generations. It can successfully and categorically attain and provide better humans and nature life.

Categorically, organic agriculture is very close to the agriculture practiced by our ancestors. Namely, the production of agricultural products and animal husbandry in a way that protects human health and the environment.

Nowadays, considering its specific features and requirements, it can be well implemented, supported, improved, and developed as a modern alternative and long-term strategy for maximizing human well-being and providing an appropriate economic, social, and natural base for future generations.

Additional complex management and production strategies, methods and guidelines need to be developed for the study, promotion, and support of organic farming worldwide.

Meanwhile, Grow Organic – Protect the Environment!

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EFFECTS OF GENOTYPE AND AGE ON FERTILITY IN TWO CHICKEN PARENT STOCKS IN SOUTH-WESTERN NIGERIA

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Abstract

This study was conducted to determine the effect of genotype and age on fertility of one chicken egg type (Hy-Line) and one broiler (Marshal) parent stocks in the derived savanna zone of South-western Nigeria. Cumulative data records from the hatchery of a reputable commercial poultry breeder farm were extracted and analysed with STATA® statistical package. Descriptive statistics and Pearson's correlation analysis were carried out. Results show that the percentage fertility in the two production types of breeders were high, indicating that the two breeder stocks can be used as egg line and broiler parent stocks in the study area. Pearson's correlation shows that age has a direct relationship with fertility in both breeds although not significant in Hy-Line but significant in Marshal ($p<0.001$). This indicates that there is a significant positive relationship between age and fertility, such that as age increases, fertility also increases to a peak and later declines as the age increases. It was concluded that, Hy-Line out-performed Marshal throughout the period of study and reached peak fertility (98.34%) earlier (30-40 weeks) than Marshal (91.11%) at between 41-50 weeks of age. Hy-Line showed higher fertility percentage than Marshal and it persisted till greater than 60 weeks of age.

Key words: *genotype, Hy-Line, Marshal, production type, fertility, chicken parent stocks*

INTRODUCTION

The reproductive performance of poultry birds is an integral component of their productivity and basic to this is the fertility. Fertility of the chicken parent stocks is vital to successful egg incubation, chick multiplication and production. It is a trait of major interest in the broiler industry due to its influence on chick output [12]. For successful operations in chick production, adequate knowledge is needed for planning and management of parent stocks. [3] noted that fertility in poultry is generally described as an independent trait, which is expressed in either male, after egg fertilization, or embryo development in the female. This author further stated that both male and female sexes contribute to fertility of the egg, and it is influenced by both genetic and non-genetic permanent environmental components. The genotype of the embryo to which both sexes had contributed is also a factor that affects fertility. [2] listed the factors affecting fertility from the male to include some sperm quality parameters which include: semen concentration, sperm motility, sperm metabolism and the percentage of dead sperm cells. [3] adds that, ability of the cock to successfully mate with the hen is another important factor. The hen effects on fertility include egg quality and the prevalence of sperm storage tubules.

[10] listed broadly several factors that can cause low fertility in chickens, and these include, wrong mating ratio, wrong time of collection, age of the breeder cocks and hen, and poor nutrition of the breeders. Others are bad management, social stress, and quality of the breeders. Many reports had indicated that breed or strain had effect on different traits in broilers, such as, carcass characteristics [5]; [8]; [9]; [6] and fertility [13]. This study was carried out to estimate the fertility from eggs set, determine the effect of genotype and age on fertility of two chicken parent stocks Hy-Line and Marshal (broiler) in the derived savanna zone of Southwestern Nigeria.

MATERIALS AND METHODS

Cumulative records, from 2013 to 2015, of incubation and hatchery records on 20,950 parent stocks, comprising 14,874 Hy-Line parent laying hens and 6,076 parent broiler hens from Marshall parents were obtained from RTO Farms in Southwestern Nigeria. The farm is located between Ede junction and Ara, in Egbedore Local Government area of Osun State on geographical coordinates: latitude 7^0 51' 0" North of the equator and longitude 4^0 23' 0" East of the Greenwich Meridian. The location enjoys two separate seasonal periods namely, rainy (April to October) and dry (November to March). The birds were housed in galvanized cages under intensive management. Feed was restricted and served twice daily and water was served *ad-libitum*. The eggs were packed six hourly and all other management practices were standards for breeder chicken rearing. The birds were artificially inseminated with undiluted freshly collected semen and fertility was estimated as percentage of incubated eggs that were fertile, and calculated as:

Fertility (%) = Total fertile eggs/Total eggs set ×100.

Statistical Analysis

Data were analysed with [11] version 15.0 analytical software for descriptive and t-test to determine significant difference in fertility of the two parent stocks. Pearson's product moment correlation coefficient model was utilized to show the relationship between age and fertility of Hy-Line and Mashal parents.

RESULTS AND DISCUSSIONS

The average percentage fertility for Hy-Line and Marshal parent stocks are shown in Table 1. At age below 30 weeks, Hy-Line showed 91.66% average fertility while 73.53% average fertility was observed in the Marshal Parent stocks. Table 1 also shows the values of the average percentage fertility for age groups (weeks) 31-40, 41-50, 51-60, and >60 of Hy-Line and Marshal, with 98.34, 98.02, 96.18, and 96.32%, and 90.15, 91.11, 90.35, and 88.39% respectively.

Average fertility for Hy-Line increased with increase in age from 30-40 weeks of age, and subsequent periods showed a decline in fertility till the end of the records at the 60^{th} week and above. Hy-Line showed the highest percentage fertility up to the 40th week while Marshal recorded its highest percentage fertility up to the 50th week. Furthermore, Table 1 consistently shows a higher absolute figures throughout the study period for Hy-Line. These results show a better performance of egg laying type over the Meat-type parent stocks. This result is in line with the findings of [1] in Saudi Arabia in Ross 308 and Cobb 500 parent stocks indicated that fertility to be affected by age of the breeder stocks. Further report from this author indicated that, eggs from breeder hens from older breeder broilers have large sizes and thus show lower fertility percentage. This might have accounted for the lower fertility shown by the broiler breeders (Marshal) when compared with the higher fertility exhibited by the egg-type breeder (Hy-Line). [7] also reported that as flock age increases fertility also decreases in South Africa. These authors further suggested that improved management should be given to ageing broiler breeder stocks in order to maintain a good level of performance.

Table 1. Fertility of Hy-Line and Marshal parent stocks

Age in weeks	Fertility	
	Hy-Line	Marshal
<30	91.66 ± 7.41	73.53 ± 17.40
31-40	98.34 ± 0.62	90.15 ± 6.73
41- 50	98.02 ± 0.60	91.11 ± 5.09
51- 60	96.18 ± 1.10	90.35 ± 5.03
>60	96.32 ± 1.44	88.39 ± 4.25

Source: Authors' results.

Figure 1 shows the trend in fertility for both Hy-Line and Marshal parent stocks. This shows more consistency in Hy-Line parent stocks than more fluctuations displayed by the Marshal. Fertility in the Marshall broiler breeders in this study was at the peak at between 41 to 50 weeks of age (91.11±5.09%) and continually decreasing from week 51 to 60 (90.35±5.03%) and at greater than 60 weeks of age (88.39±4.3). The trend in this

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report is in line with that of [4] and [2] who stated that egg fertility decreased with increasing flock age and it is as a result of reduced mating frequency. This suggests that more attention should be given to older breeder chicken flocks to increase mating in order to improve fertility in the later part of their production cycle when natural mating system is used. This is important in most developing countries where the cost of replacement of breeder stocks might be enormous and thus the need to extend their productive cycle beyond normal.

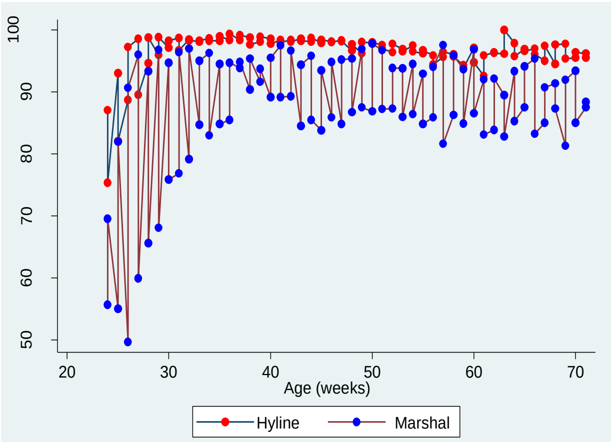

Figure 1: Fertility of Hy-Line and Marshal parent stocks with respect to age in weeks

Fig. 1. Fertility of Hy-Line and Marshal parent stocks with respect to age in weeks
Source: Authors' results.

Table 2 shows the result of the paired t-test between Hy-Line and Marshal. The Hy-Line parent stocks had a mean fertility of 96.53% while Marshal had a mean fertility of 87.91%. The mean difference in the fertility of the two parent stocks is 8.62% with a t-value of 8.3185 ($p<0.0000$) which is highly significant. This indicates a superiority in the fertility of egg line breed over the meat-type breeders. This result in this study is in line with the report of [1] in his study of Ross 308 and Cobb 500 which indicated chicken-type effect on fertility. [4] reported a negative correlation between the flock ages and fertility and early embryonic mortality. The authors reported that, as flock ages increases, the fertility decreases and early embryonic mortality increases in eggs from Ross 308 compared with Cobb 500. This indicates that, the higher the flock age, the lower the fertility and the higher the embryonic mortality. [4] also reported that egg size has effects on fertility, hatchability, embryonic mortality in broiler breeders. Higher percentage fertility was observed in small eggs (96.67%), medium (93.33%) and large (90.33%) ($p \leq 0.05$). Further reports by these authors indicated that highest embryonic mortality ($p \leq 0.05$) in eggs occurred in the large size egg group.

Table 2. Paired t-test showing the significant difference in the percentage fertility of Hy-Line and Marshal parent stocks

Genotype	Mean %	Std. Error	Std. Dev	t-statistic	P>|t|
Hy-Line	96.5264	0.3458	3.3860		
Marshal	87.9062	0.9684	9.4885		
Combined	92.2173	0.6001	8.3155		
Difference	8.6181	1.0282		8.3815	0.0000

P>|t| = 0.01
Source: Authors' results.

The result in Table 3 reveals the relationship between fertility and age (in weeks) for both Hy-Line and Marshal. Pearson's correlation coefficient (0.1317) shows that there is a positive correlation between fertility and age of Hy-line and Marshal, however, the correlation is not statistically significant for Hy-Line but for Marshal, with Pearson's correlation coefficient (0.3002) is statistically significant at 1% level of significance. The results of this study are in agreement with that of [13] that reported breed effect in fertility in chicken.

Table 3. Pearson's product moment correlation coefficient showing the relationship between age and fertility of Hy-Line and Marshal parent stocks

	Hy-Line		Marshal	
	Coefficient	P-value	Coefficient	P-value
Fertility vs age (Weeks)	0.1317	0.2010	0.3002***	0.0030

Source: Authors' results.

CONCLUSIONS

This study shows that the percentage fertility of Hy-line and Marshal is high, indicating that, both breeds can be used in the derived savanna zone in Southwestern Nigeria for egg-layers or broiler production respectively. Fertility is significantly higher in Hy-Line than in Marshal parent stocks and it persisted till greater than 60 weeks of age. Further results indicated that, there is a significant positive relationship between age and fertility, such that as age increases fertility also increases up to a point before a decline.

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ASSESSING CONSUMER PERCEPTION AND PREFERENCE FOR FRESH OR PROCESSED CITRUS FRUITS: IMPLICATIONS FOR THE SWEET ORANGE SUPPLY CHAIN IN OYO STATE NIGERIA

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Abstract

This study investigated the level of substitution of fresh fruit for processed fruit and what influences consumers' preference for purchase of fresh citrus or processed citrus in Oyo State. Well-structured questionnaires were used to collect information from 100 respondents using a two-stage sampling technique. Descriptive statistics and probit regression were used to analyze the relationship of socioeconomic factors and respondents' opinion with regards their preference for fresh or processed citrus fruits. From the result of the study, a good number of respondents prefer fresh to processed citrus fruits. The study also revealed that the opinion or perception of the respondents in relation to cost of purchase, nutritional content, negative or positive implication on health influences their preference for fresh citrus while convenience, cost of purchase and nutritional content influence preference for processed citrus fruits. Majority of the respondents indicated that processed citrus may have negative health implications.

Key words: *consumer preference, fresh citrus fruits, impact, processed citrus fruits, supply chain, Oyo State*

INTRODUCTION

The turn of events in pattern of food consumption globally has made the inclusion of staple fruits in daily dietary need very important. Fruits are vital to humans as many of the food we eat come from them. Many species of mammals, birds and insects rely on fruits for their livelihood. More importantly, fruits are known to have nutritional and commercial values. Indeed, many of the fruits we eat are not merely tasty or delicious but have the advantage of being low in calories and very high in nutrients. Fruits are also a good source of fibre, protein, vitamins and other nourishment which enhance human health and well-being. Again, many fruit trees are categorized as *medicinal plants*, that is, plants that are used for the intention of treating or preventing diseases or ailments in both humans and animals. Over 70 percent of fruits produced globally are citrus [38]. Citrus is a collective name for some allied shrubs or evergreen trees that belong to the rue family. Some common fruits they produce include lemon, grapefruit, lime, orange and citron. Perhaps the most popular type of citrus fruit is the orange fruit, which comes in different varieties such as the sweet orange (*Citrus sinensis*), sour orange, and the mandarin orange, also known as tangerine. Oranges are of high economic value, constituting about three quarters of the global citrus production which is estimated at over 105 millions tons [9]. Citrus is believed to have appeared in Southeast Asia around 4000BC and later spread to Northern African through migrants. The first worldwide trades of citrus fruit did not appear until 1800s while the sales of orange juice started in the 1940s [10]. Citrus is highly nutritious as it contains some essential nutrients such as Ascorbic Acid, folic acid, potassium, calcium, foliate, thiamine, niacin, vitamin B6, phosphorus and magnesium. The flowers, leaves and rind of the fruit are rich in volatile oil and emit sharp fragrance. Citrus is rich in essential nutrients such as proteins, vitamins, minerals, and water. These nutrients or food substances play a crucial role in maintaining human health and

survival. Nutritionists and dietitians report that citrus fruits are helpful in the treatment of such ailment's toothache, diarrhea, nasal decongestion, vomiting, and weight loss to mention a few. Generally, most fruits are rich in vitamin, which is important for vision and skin care. Vitamin A is also helpful for bone growth and in supporting the immune system. Even though is native to Southeast Asia, the citrus plant has now become a common plant all over the world. And all though China and America are regarded as the two major growers of citrus fruits, many species are also cultivated in different societies of the world. Indeed, world production of citrus fruits is on the rise all over the world.
In Tables 1 and 2, we find the various species or types of citrus fruits and the ranking of the countries with regards to their cultivation or production.

Table 1. Major producing countries of the different types of citrus fruits

Oranges
Brazil, United States, Mexico, India, Spain, China, Iran, Italy, Egypt, Indonesia
Small citrus
Nigeria, China, Syria, Guinea, Japan, Saudi Arabia, India, Sierra Leone, Angola, Tunisia
Lemons and limes
Mexico, India, Iran, Spain, Argentina, Brazil, United States, China, Italy, Turkey
Grapefruit
United States, China, South Africa, Mexico, Israel, Cuba, Argentina, India, Turkey, Tunisia

Source: UNCTAD, 2005 [34].

Table 2. Top ten total Citrus fruits producers 2007 (Metric Tons)

Country	Grapefruit	Lemon and lime	Orange	Tangerine	Others	Total
Brazil	72,000	1,060,000	18,279,309	1,271,000	-	20,682,309
China	547,000	745,000	2,865,000	14,152,000	1,308,000	19,617,000
U.S.A.	1,580,000	722,000	2,865,000	14,152,000	1,308,000	19,617,000
Mexico	390,000	1,880,000	4,160,000	355,000	66,000	6,851,000
India	178,000	2,060,000	3,900,000	-	148,000	6,266,000
Spain	35,000	880,000	2,691,400	2,080,700	16,500	5,703,600
Iran	54,000	615,000	2,300,000	702,000	68,000	3,739,000
Italy	7,000	546,584	2,293,466	702,732	30,000	3,579,782
Nigeria	-	-	-	-	3,325,000	3,325,000
Turkey	181,923	706,652	1,472,454	738,786	2,559	3,102,414
WORLD	5,061,023	13,032,388	63,906,064	26,513,986	7,137,084	155,650,545

Source: FAO of United Nations Economic and Social Department: The Statistical Division 2007 [9].

Nigeria's potential to lead in citrus fruits production is high. It was introduced into Nigeria over 5 decades ago and grew to be one of the major cash crops in the country. Nigeria ranked among the top ten citrus producers in the world [39] (Table 2), with annual production of about 930,000 tons covering 30 million hectares estimated land area. Other major producers include the United States of America and China; these countries and South Africa dominate the grapefruit and Orange export market whereas Nigeria is yet to become a major player [9].
In South West Nigeria, citrus has been reported to be one of the most widely cultivated fruit crops [3]. Citrus production takes place in the rainforest and guinea savannah belt of Nigeria which includes the state of Oyo, Ogun, Ekiti, Osun, Ondo, Kwara, Kogi, Edo, Delta, Taraba, and Benue. Orange, mandarin, grapefruit and pummelo constitute the four topmost citrus fruit varieties in international trade [36]. Orange is a common citrus fruit which is categorized into sour and sweet orange. Sour oranges are used purely for essential oil while sweet oranges are consumed fresh or juiced [37].
Citrus has gained wide acceptance in Nigeria as a nation as well as in Oyo state as it has become a part of staple food for all. Processed orange juice is one of the main drinks in homes, offices as well as celebrations. Studies show an increase in the consumption of fruit juice from 200 million litres in 2002 to about 320 million litres in 2007 [28]. Processed and packaged fruit juices are served at such occasions as burials, workshops, seminars, naming wedding ceremonies while fresh

citrus is majorly consumed at home either raw or in form of extracted fresh juice.

Citrus Supply Chain

The international citrus marketing chain is dominated by oranges and orange juice because they are the major outputs traded. In the orange chain, harvested fruit may be sold fresh or it may be processed for juice and other by-products. The chain is increasingly being driven by consumers as a result of restructuration and globalization. The fresh fruits sector is characterized by many medium-sized firms supplying the fruit, and the concentration of producers in response to buyers' consolidation. The presence of cooperative organizations in the chain keep it coordinated, enhance better prices and improve negotiating power of activities of growers [35].

There are two major markets for citrus in Oyo state; the fresh and the processed fruits - majorly orange juice (foramfera.com). The fresh citrus supply chain in Oyo state is characterized with so many challenges such as poor harvesting, inadequate and poor storage facilities, poor transportation, inadequate market infrastructure as well as unorganized supply chain among others [31]. Fresh fruits are made available without proper grading, packaging or quality control on the streets, local markets and roadside [24]. On the other hand, the juice processing firms have managed these challenges to some extent by integrating the sectors into the production cycle. They monitor the harvesting, build storage facilities and warehouses or enter into contracts with another company for warehousing and storage. Citrus fruits are processed and are well packaged in tetra parks, bottles or can using modern day equipment. Their marketing strategies involve provision of transportation for conveying the finished produce from the factory to the stores of the retailers where it is made available to the consumers.

Nigeria has a rapidly growing economy, which is gradually translating into improvement in the standard of living of her citizens, including the people of Oyo state. Change in the pattern of food consumption, westernization of our daily meal and desire for convenience in terms of food preparation, gradually finding footings. Also, health awareness has been on the increase especially in respect to food consumption; the nutritional benefits of taking fruit especially citrus as part of daily dietary requirement and the danger that consuming most of this package food may pose to our health. The result of the above on consumers' preference for citrus fruit either processed or fresh therefore pose a challenge for our citrus industries about how best to take advantage of the growing demand for citrus produce in Nigeria. Other variables such as place of origin, educational status, sex, household disposable income, convenience, price, technological advancement and level of awareness of implication of consuming citrus produce, both fresh and processed, could determine consumers' preference. Therefore, the focus of this study will be to determine the socioeconomic characteristic of respondents, what consumer preference is with respect to fresh or processed citrus fruit and the influence of some of the variables on consumers' attitude. These factors will in turn promote understanding and influence the information reaching the consumer as it is related to purchase decision. It will also help breeders to develop a better variety and also help the juice processing industry [6, 17] in producing a better, well packaged and healthier juice. This could also be a good source of information for farmers willing to go into citrus processing as the result will intimate them with the factors that influence consumers' choices.

Theoretical Framework

The underline factor for consumer preference is the consumer behaviour or utility theory [32]. Individual consumer preferences are measured in terms of the level of satisfaction derived from consuming bundle of goods. But income, and price and other factors may serve as constraints to consumer choice of goods. Consumers make decisions by allocating their scarce resources (income) among available goods or supplies as way of deriving the greatest satisfaction possible. We then say that consumer maximize their utility subject to budget constraint. Utility determinant are decided by a host of non-economic factors such as education, culture, individual taste and so on. Consumer's preferences are defined as the subjective (individual) taste, as measured by utility of various bundles of goods. They permit the consumer to rank these bundles of goods according to levels of utility they give the consumer. It studies how individuals, groups or organizations select, secure, use and dispose the product or services, to satisfy needs and the impacts they have on the consumer and the society [19]. Studies have shown that the consumers are the beginning of a value chain of agricultural products [21], their perceptions, taste and attitudes determines the success of food production [22], and their acceptance of local products develop domestic manufacturing sector of a free economy like Nigeria [27, 5]. Consumer preferences have been known to directly affect producer's decisions as goods with high demands are more likely to be produced [1]. Consumer production-marketing chain i.e. value chain studies is thus recommended to respond to consumers' changing taste that can respond to their changing tastes [11].

MATERIALS AND METHODS

Methodology

The study area was Ona Ara Local Government of Ibadan, the capital of Oyo State, located in southwestern Nigeria. Ibadan is an urban settlement and covers a total land area of 3,123 km with the main city covering 463.33 km. The 2006 National Population census estimated the population of Ibadan to be about 2,550,593, with an overall population density of about 586 persons per km. Ibadan city is the administrative and commercial headquarter of Oyo State. The city is a center of attraction for investors and potential investors. The same 2006 population census put the total population of Ona Ara at a little above 265,000, and a land area of 3,570 square kilometre. Apart from Akanran, which is the Local Government Headquarter, Ona Ara made up of other important towns and communities such as Gbedun, Olunloyo Amuloko, Olorunsogo and Araromi to mention a few. Ona Ara has a Traditional Council and many other local chiefs who are charged with maintain peace and cohesion among the citizens and the various communities. While in the past Ona Ara lacked such social amenities as good roads, electricity and potable water, presently, some of these amenities have been provided by the State Government. In Ona Ara, while the main occupation of the men is farming, the women combine farming with petty trading. Ona-Ara is gradually becoming of mixed ethnicity due to migration. Though the people are predominantly of the Yoruba ethnic group, the last decade, has witnessed tremendous vertical movement, particularly from neighboring Benin Republic. The migration route is normally through Ogun state. The migrant workers are itinerant labourers that help in farm works. Similar, there are the Igedes from the Middle-belt of Nigeria, they are also majorly farmers, and motorcycle commercial drivers, with some of their females engaged as house maids.

Ona-Ara Local Government Area is divided into 11 wards. The wards, in order of number, are: Akaran, Araro, Badeku, Gbada, Idi-Ose, Idi-Osan, Olunloyo, Ajia/Odoku, Olorunsogo, Gbedun and Ore Meji. The five urban settlements among these wards are Idi-Ose, Idi-Osan, Olunloyo, Olorunsogo and Ore-Meji. Citrus is being produced in Ona Ara local government but not on a commercial scale. Farmers cultivate this crop on less than 15 acres of land. Citrus production in this area is characterized with high incidence of pest and diseases, decaying of fruits before maturity, water deficit in soil and climate change [2]. Fresh citrus is sold in the main market by the farmers and it is made available to the consumer by the retailers, who are majorly street hawkers. Processed citrus (juice) is sold in small retail shops or local markets. Ona Ara local government was selected for this study because of its mixed population. That is, the local government is made up of peri-urban as well has rural area which is a representation of the composition of Ibadan and Oyo state at large.

Data Type and Collection

Primary data was collected from respondents using two-stage sampling. Three different wards within the local government was selected using simple random sampling. These wards are Akanran, Badeku, Gbedun. Collection of data from the respondents was done using purposive sampling method. Person-to-person interview was conducted using well-structured questionnaires administered to selected respondents to gather information on their socio-economic characteristics as well as the demographic variables. These include age, sex, educational qualification, monthly income, marital status. Data was also collected on health awareness, disposable income (especially expense on food items), and desire for convenience in preparation or consumption, location and status in the family.

Method of Data Analysis

Descriptive statistic was employed to analyze the socio-economic characteristics of respondents while frequency distribution was adopted to show the percentage of respondents who prefer fresh citrus and percentage of respondents who prefer processed citrus, based on their socioeconomic attributes. Frequency distributions are visual displays that organize and present frequency counts so that the information can be easily interpreted. It can show absolute frequencies or relative frequencies, such as proportions and percentages. Frequency tables can be shown in a table or a graph. Some common methods of showing frequency distributions include frequency tables, histogram or bar chart, pie chart and box distribution.

Regression analysis was done using a probit model to assess the relationship between the variables and consumer preference. A probit model, is used to model binary outcome variables by modelling the inverse standard normal distribution of the probability as a linear combination of the independent variables. The purpose is to estimate the probability that an observation with particular characteristics will fall into a specific binary category. Suppose Y is a response variable which is binary; that is, it has only two possible outcomes denoted as 1 and 0 [4, 7]. In this case Y represents preference for or against fresh orange juice. The outcome variable Y is assumed to be influenced by a set of independent variables or vector of regressors, X. The model is expressed as:

$$\Pr(Y = 1 \mid X) = \Phi\,(X^T \beta) \qquad \ldots \qquad (1)$$

where:

Pr = Probability

Φ = Cumulative Distribution Function of the standard normal distribution

β = Parameter to be estimated through the maximum likelihood method

The model may also be presented as a latent variable; given the expression:

$$Y^* = X^T\beta + \varepsilon \ \ldots \qquad (2)$$

where:

Y^* = Auxiliary random variable or latent variable

$X^T\beta$ = As defined above

$\varepsilon \sim N(0,1)$

Y is an indicator for whether the latent variable is positive as expressed below [7]:

$$Y = \begin{Bmatrix} 1 & Y^* > 0 \\ 0 & Otherwise \end{Bmatrix} = \begin{Bmatrix} 1 & X^T\beta + \varepsilon > 0 \\ 0 & Otherwise \end{Bmatrix} \quad \ldots\ldots.. \qquad (3)$$

The explanatory variables are a range of perception scores based on likert scale analysis. The key perception points examined are: Health benefits, nutritional benefits, social status, cost implication, convenience and absence of negative effects on the body.

RESULTS AND DISCUSSIONS

Consumers' Socio-economic Characteristics

The socio-economic characteristics of respondents considered in the study are sex, age, marital status, educational qualification, family size and monthly incomes and so on. As shown in Table 3, the frequency distribution analysis of the respondent shows that 76 out of 93 respondents prefer fresh citrus fruits; this represents 81.7 percent of the respondents, while 18.3 percent, representing 17 respondents prefer fresh citrus. 44.31 percent of those who prefer fresh citrus are male and 34.41 percent are female. 7.53 percent of those who prefer processed citrus are male while females constitute 10.75 percent. 32.4 percent of those who prefer fresh citrus are below 30 years of age, 58.8 percent are between the age of 30 and 59 years and 6.5 percent fall to the range of 60 years and above, while 53.1 percent of respondents who prefer processed citrus fruit fall below age 30 years, 47.2 within the age range 30 years and 59 years and none for 60 years and above. Also, 56.99 percent of respondents who prefer fresh citrus are married while 24.93 percent are single. Respondents who prefer processed citrus has 7.53 percent married and 10.75 percent single. 45.16 percent of those who prefer fresh citrus are in informal employment and 36.56 percent are in the informal sector. 11.83 percent of those who prefer processed citrus are in the formal sector while 6.45 percent who prefer fresh citrus are in the informal sector. 54.84 percent prefer fresh citrus, with a house size of 1 to 5 while 26.88 who prefer fresh citrus have a household size of between 6 to10. Again, 13.98 percent prefer processed citrus and have a household size of between 1 and 5 while 4.30 have a household range size of 6 to 10.

Table 3. Socio-economic Characteristics Consumers

Variable	Category	Prefer Fresh Citrus		Prefer Processed Citrus	
		Frequency	Percentage	Frequency	Percentage
Age (years)	Below 30	30	32.40	9	53.10
	30-39	21	27.40	3	17.70
	40-49	14	18.30	3	17.70
	50-59	7	13.10	2	11.80
	60 and above	5	6.5	0	0
Education (Years)	0-6	21	22.59	2	2.16
	7-12	20	21.51	5	5.38
	13-18	25	26.89	9	9.68
Marital status	Married	53	56.99	7	7.53
	Single	23	24.73	10	10.75
Household	1-5	51	54.84	13	13.98
	6-10	25	26.88	4	4.30
Monthly income (₦,000)	1-20	30	32.26	4	4.30
	21-40	38	8.60	2	2.15
	41-60	4	4.30	4	4.30
	61-80	34	36.56	7	7.53
Smoking?	Yes	8	8.60	1	1.08
	No	68	73.12	16	17.20
Gender	Male	44	47.31	7	7.53
	Female	32	34.41	10	10.75
Frequent body exercise	Yes	55	59.14	12	12.90
	No	21	22.58	5	5.38
Alcohol consumption	Yes	18	62.37	1	1.08
	No	58	19.35	16	17.20

Source: Field Survey, 2014.

32.26 percent of respondent prefer fresh citrus and earn a monthly income within ₦1,000 - ₦20,999, 8.60 percent earn ₦21,000 – ₦40,999, 4.30 percent earn ₦41,000 – ₦60,999 and 36.56 percent of the respondents who prefer fresh citrus earn between ₦61,000 and above. Respondents who prefer processed citrus who earn between ₦1,000 – ₦20,999 are 4.30 percent, 2.15 percent earn between ₦21,000 and ₦40,000, 4.30 percent earn ₦41,000 and ₦60,999 and 7.53 of those who prefer processed fruits earn ₦61,000 and above. About 54.1 percent of respondent who prefer processed citrus do not spend on fresh fruit, 18.9 percent spends between ₦100 and ₦599, 7.9 percent spend between ₦600 and ₦1,099, 10.5 percent spend between ₦1,100 and ₦1,500 and 7.8 percent spend above ₦1,500 on fresh fruits, while 11.8 percent of those who prefer processed citrus fruit spend nothing in buying processed citrus fruits, 17.7 percent spend between ₦100 and ₦599, 5.9

percent spend between ₦600 and N1,099, 35.2 percent spend between ₦1,100 and ₦1,500 and 29.4 spend above ₦1,500 on processed citrus. For respondent who prefer fresh citrus fruit, 10.5 percent do not spend on fresh citrus, 68.9 percent spend between ₦100 and ₦599, 11.8 percent spend between ₦600 and ₦1,099, 5.2 percent spend between ₦1,100 and ₦1,500 and 2.6 percent spend above ₦1,500. 11.8 percent of the respondents who prefer fresh citrus spent nothing on process citrus fruit, 58.9 percent spend between ₦100 and ₦599, 17.7 percent spend between ₦600 and ₦1,099, 5.9 percent spend between ₦1,100 and ₦1,500 and 5.9 percent of respondents who prefer fresh citrus spend above ₦1,500 on process fruits. About 8.6 percent of respondents who prefer fresh citrus engage in smoking habit, 73.12 percent do not smoke, while 1.08 percent of those who take processed citrus smoke 17.20 percent engage in smoking habit.

59.14 of respondents who indicated preference in fresh citrus engage in body exercise and 22.58 percent do not while 12.90 percent of respondent prefer processed citrus and engage in body exercise and 5,38 percent do not. 55.9% of the respondents consumed fresh citrus within the last seven days from the day which the questionnaire was administered to them while 44.1% consumed it within a week ago and above. While 29.0% of the respondents consumed processed citrus fruit within 7 days of administration and 71% consumed processed citrus fruit within a week ago and above. We can imply from above that more of the respondents consumed fresh citrus fruit more frequently than processed citrus fruit. 6.85 percent consumed grains, 7.37 percent consumed root and tuber, 7.18 percent consumed vegetables, 8.59 percent consumed fruits, 7.37 percent consumed various types of meat, 9.95 percent consumed eggs, 8.02 percent consumed fish and crayfish, 7.89 consumed pulses, 8.99 percent consumed milk and milk product, 9.18 percent consumed oil, 8.73 percent consumed sugar, 9.89 percent consumed condiments.

Consumers' Perceptions on Fresh Versus Processed Citrus Fruits

The following revealed in Table 4 are the distribution of degree of preference of the respondents. 76 respondents which represent 87.7% of the respondents prefer fresh citrus, while 17 respondents, representing 18.3% prefer processed citrus fruit. 20.4% of the respondents completely agree that fresh citrus is more nutritious, 60.2% agree, 5.4% are neutral 14% either disagree or completely disagree. 37.6% completely disagree, 49.6% disagree, 4.3 neutral and 8.5% either disagree or completely disagree with the no negative health implication question.23.7% and 59.1% respondents also indicated completely agree and agree that fresh citrus is less expensive than processed citrus, 9.7% neutral and 4.3% and 3.2% disagree and completely disagree respective. Cumulative total of 76.4% of the respondents indicate disagree and completely disagree with their socioeconomic status affecting their choice of preference of fresh citrus, while cumulative total 23.6% are either neutral, agree or completely agree. 47.3% agree, 10.8% completely disagree, 16.1% are neutral, 20.4% disagree, and 5.4% completely disagree with convenience as a determinant of preference for fresh citrus fruit. 2.0% of the respondents completely agree that processed citrus is more nutritious, 16.1% agree, 15.1% are neutral 54.8% disagree and 11.8% completely disagree. 3.2% completely disagree, 3.3% disagree, 15.1% neutral and 20.4% either disagree and 51.0% completely disagree with the no negative health implication question. 1.1% and 3.2% respondents also indicated completely agree and agree that processed citrus is less expensive than fresh citrus, 12.9% neutral and 60.2% and 22.6% disagree and completely disagree respective. Cumulative total of 20.4% of the respondents indicate disagree and completely disagree with their socioeconomic status affecting their choice of preference of processed citrus, while 43.0% are either neutral, 23.7% agree or 12.9% completely agree. 8.6% agree, 53.8% completely disagree, 16.1% are neutral, 15.1% disagree, and 6.5% completely disagree with convenience as a determinant of preference for fresh citrus fruit.

Table 4. Descriptive Analysis of Consumers' Opinion

Variables	% CA	%A	%N	% DA	% CDA
-More nutritious	20.4	60.2	5.4	10.8	3.2
-No negative health implication	37.6	49.6	4.3	6.5	2.0
-Less expensive	23.7	59.1	9.7	4.3	3.2
-Socioeconomic status	1.0	3.2	19.4	32.3	44.1
-Convenience	10.0	47.3	16.1	20.4	5.4
-More nutritious	2.0	16.1	15.1	54.8	11.8
-Negative health implication	3.2	3.3	15.1	20.4	51.0
-Less expensive	1.1	3.2	12.9	60.2	22.6
-Socioeconomic status	3.2	17.2	43.0	23.7	12.9
-Convenience	8.6	53.8	16.1	15.1	6.5

Source: Field Survey, 2014.
Note: CA: Completely Agree; A: Agree; N: Neutral; DA: Disagree; CD: Completely Disagree.

Relationship Between Consumer Perceptions and Choice of Orange

Educational status of respondents affected their preference: the higher the educational attainment of respondents, the more their preference for fresh citrus fruit. This is consistent with the position of [15], that educational attainment may influence dietary knowledge and the motivation to have a healthy diet. Previous study also showed that women with high educational attainment consumed fresh fruit and vegetables more frequently and had a higher perceived ability to control their behavior [18]. Low nutritional knowledge can affect fruit preference and purchasing behaviour (Table 5). An association was also detected between low education attainment and low intake of orange in men [15]. Also, respondents do not consider processed citrus more nutritious than fresh citrus fruit, a fact which is consistent with previous findings or studies. Fresh fruits, in particular, are good for health because they are packed with vitamins and minerals essential nutrients such as Ascorbic Acid, folic acid, potassium, calcium, foliate, thiamine, niacin, vitamin B6, phosphorus, magnesium and copper as well as anti-oxidants which help to eliminate harmful free radicals called oxidants [23]. Free radicals are believed to contribute to a host of health problems, including heart disease, diabetics and cancers. Respondents believed consuming processed citrus fruits has negative health implication. This may belief may stem from the idea that processed foods contain chemicals which are harmful to the health. According to [24] most of the commercially available fruit juices or drinks contain chemical preservatives and are more often avoided by health-conscious people.

Some of the respondents consider fresh citrus cheaper than processed citrus fruit. This cost of purchase influences their preference for fresh citrus. Whilst this is inconsistent with theory of consumer behavior, the pattern revealed is consistent with findings of [30], which showed that there were mismatches between consumer purchases and preferences. This position is consistent with findings in the literature on consumer attitude formation [16, 33]. However, respondents who prefer processed citrus will keep buying even though the price is more expensive than fresh citrus fruits. This is in agreement with theory of consumer behaviour- consumer is rational and will consume a good as long as it brings a maximum satisfaction/ utility, and supported by the result of the study on demand for fruit juice by [25]. He found out that demand for fruit juice is price inelastic; therefore, consumers are insensitive to changes in the price. Interestingly, convenience of purchase and preparation played a major role in the choice respondents who prefer either fresh or processed citrus. With improvement in the standard of living, desire for fast food (that is, western-type food) is expected. This finding agrees with the position of [39] and [29] to the effect that accessibility or handiness of food is fast becoming a major factor in consumers' preference for diet. However, consumers may sometime discover that easily accessible food may be of inferior quality. [26] corroborate this viewpoint by highlighting the effect of street or hawked foods to the nutrient intake of Nigerian adolescents.

A review of Table 6 shows that educational status and number of dependents is significant at 1 percent level of significant while others are not significant at all. Educational status has a positive relationship with preference, which implies that as respondents attain higher educational status there will be increase in their preference for fresh citrus. This is in line with the position of [15] that educational attainment may influence dietary knowledge and the motivation to have a healthy diet. Previous studies also showed that women with high educational attainment naturally choose a healthy lifestyle by eating healthy diet such as fresh fruit and vegetables. They also have a higher ability to control their behavior [19]. Low nutritional knowledge can affect fruit preference and purchasing behaviour [14]. An association was also detected between low education attainment and low intake of orange in men [15]. The number of dependents also has a positive relation with preference. This implies that members of the household influence the choice of preference of respondents. This is in line with [20], who reported that food preference may be influenced by other family members and this is reflected in family of low socioeconomic status [18].

Table 5. Relationship between Consumer Perception and Preference for Fresh or Processed Orange

Variable	Coeff.	Std. Error	Z	P|Z|value	95%
Nutrient	-1.42***	0.35	4.05	0.00	-2.10-0.73
Health	-.49*	.33	1.48	0.14	0.14-0.15
Cost	1.14**	0.49	2.35	0.01	0.19-2.08
Status	0.11	0.25	0.44	0.66	-.39-0.61
Convenience	.13	0.14	0.89	0.37	-.15-0.41
Constant	2.17*	1.25	1.74	0.08	-.28-4.62
				LR Chi2 (6)	**39.19**
				Prob.>chi2	**0.0000**
				Log likelihood	**24.636475**
				Pseudo R2	**-0.4430**

Source: Field Survey, 2014. Significance at 10%*, 5%**, 1%***

CONCLUSIONS

The study found out that a good number of respondents about 76 prefer fresh citrus to processed citrus, while 17 respondents prefer processed citrus to fresh citrus. This means that fresh citrus is consumed more in Ona Ara local government than processed citrus fruits. Majority of respondents who prefer processed citrus have either secondary or tertiary education. Also, from the result educational attainment and number of household dependents, influences consumer preference for fresh citrus fruit or processed citrus fruits. This agrees with [13, 15]. The study also revealed that respondents' opinion/ perception in relation to cost of purchase, nutritional content, negative or positive implication on health influences their preference for fresh citrus, while convenience, cost of purchase and nutritional content influence preference for process citrus. Majority of the respondents in their opinion indicates that processed citrus may have negative health implications. This may suggest why they prefer fresh to processed citrus.

The increase in dietary awareness, which has brought consumption [8, 12] of fruits to the forefront of nutritional requirement, has encouraged demand for fresh or processed citrus. In order to take advantage of this the following recommendations should be considered:

-Fresh fruit producer should cultivate improved quality citrus which is aimed at satisfying the consumers taste as well as meeting the standard requirement for exportation. Also, fresh fruit should be harvested carefully and packaged attractively in other to maintain the present consumer population. Famers should process fresh citrus fruit during glut in other to reduce loss incurred through spoilage. Since there is increasing demand for processed fruits.

-Juice processing company should fortify their product with more nutrients in other to encourage the growing population of consumers. A good hygienic and attractive packaging may also influence consumers' preference for processed citrus fruits.

-Policies should be put in place by the government to reduce or stop totally importation of citrus concentrate, in other to encourage indigenous citrus processing company. This will also reduce waste due to spoilage.

Further research should be carried out on how consumer preference affects citrus supply chain in Nigeria and citrus contribution to microeconomic development in Nigeria.

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DETERMINANTS OF PROFITABILITY OF SMALL-SCALE PLANTAIN PROCESSING ENTREPRENEURS IN OSUN STATE, NIGERIA

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Abstract

The study empirically evaluates the profitability of small-scale plantain processing entrepreneurs in Osun State, Nigeria. Cross-sectional data were employed for the study, while a multi-stage sampling procedure was used to randomly select 120 respondents. Descriptive statistics, gross margin, and Ordinary Least Square (OLS) were used for the analysis of the data. The results showed that the enterprise was dominated by female households (70.8%) with an average age of 30 years. Majority (80%) of them were married with an average processing experience of 8 years, while many (50.8%) purchased their raw plantain from the local farmers. It was revealed that roasted plantain (67.5%) and flour (26.7%) were the main processed plantain products available in the area. The average values of gross margin (N23,592.50) and profit (N21,777.80) showed that the enterprise is profitable. The value of return on investment (1.73) implies that the processors are capable to realize N1.73k for every one naira invested. The results of OLS indicated that cost of bowl, plantain price, transport cost, and labour cost were the significant factors influencing profit accrued in the area. However, high cost of labour, lack of storage facility, and high cost of transportation were the most serious constraints faced by the processors in the area. Therefore, it can be recommended that a proactive policy that would address storage facility, good road networks and as well create enabling market environment should be put in place.

Key words: *gross margin, market, Osun State, plantain, processors, profit, regression*

INTRODUCTION

Nigeria is a major producer and consumer of plantains in Africa, and is among the top 20 plantain-producing countries in the world, according to the Food and Agriculture Organization [15]. Plantains are the world's fourth most important food crop, after rice, wheat, and maize, according to the International Institute for Tropical Agriculture [19]. It is a vital staple food crop for both rural and urban areas, and it is strategically positioned for rapid food production in Nigeria. Nigeria is one of the main producers of plantain in West Africa, according to [16], with an annual production of about 2.74 million metric tons.

The plantain (*Musa paradiciaca*) is a member of the Musaseae family that originated in Southeast Asia. The plantain is a tall (3-10 m) plant with a conical false trunk created by the leaf sheaths of its spirally arranged 1.5 to 3 m long and 0.5 m wide leaves. Plantain is one of the main sources of carbohydrates in humid tropical Africa, according to the International Institute of Tropical Agriculture [18], as it comprises around 35 percent starch, 0.2 to 0.5 percent fats, 1.2 percent protein, and 0.8 percent ash. It is high in minerals, especially iron, and contains many vitamins, including A, B, and C. It is low in protein and fat, but high in minerals, particularly iron. It's also cholesterol-free, high in fiber, and low in sodium. Plantain is useful in the treatment of a variety of diseases, according to [30], including cardio-vascular and kidney disorders, dehydration in infants and diabetic patients, arthritis, and gastrointestinal ulcers. Again, its economic importance cannot be over-emphasized in terms of food security, job creation along its value chain, and source of livelihoods to many rural households. Many people have developed commercial processes of plantain fruits to provide a wide variety of products, such as puree, flour, jam, jelly, chips, crisps, flakes, vinegar, and wine, according to [13]. The author went on to say that while the plantain fruit is the main economic commodity, other parts of the crop plant can be used as food, feed, or raw materials for acid manufacturing industries, and the leaves can also be used to wrap food. Plantain flour can be combined with wheat flour to make bread, cake, and biscuits, according to [23]. More so, plantain products, such as fruits and peels, are used as animal feed in agriculture; farmers use the peels as organic manure. Plantain's dead leaves and pseudo-stems are mulched or allowed to decompose into organic manure. Plantain consumption has increased dramatically in Nigeria in recent years, owing to increased urbanization and high demand for comfortable and convenient foods among the non-farming population [6, 5]. The growing industry of plantain flour and plantain chips, the two most popular products made from processed plantain, is thought to be the cause of the country's current high demand for plantain [19]. It is important to note that these goods are in demand not only within Nigeria but also outside its borders. As a result, sales of plantain-processed goods may be a potential source of revenue for Nigeria [27]. According to [13], previous research works have shown that the plantain sub-sector faces several constraints such as high post-harvest losses, diseases, poor pricing, bad road networks, and inadequate transportation to convey produce amongst others. Plantains, like other crops, are perishable, necessitating their preservation. Fresh bananas and plantains have a limited shelf life, according to [10], and rough handling, unprotected storage conditions, and poor transportation result in post-production losses of 30-40%. Postharvest losses have been a constraining factor in plantain output, but increases in yield brought about by technological advancements through research have had little effect on small-scale farmers' economy [21]. Presently, the processing of plantain has become a big business, both in major cities and small towns in the Southern part of Nigeria with prevalent production in the study area [5], which necessitate an in-depth study of this kind.

Therefore, the study will specifically ascertain the socio-economic characteristic of the respondent; identify the main processed plantain products in the study area; estimate the profitability of plantain processors; determine factors affecting the profitability of the processor; and identify the constraints faced by the processors in the area. The significance of this study at the period Nigeria is deviating from a mono-economy of crude oil to accommodate other opportunities in other sectors including agriculture. Again, due to lack of functioning storage facilities which has aided post-harvest loss in agricultural products including plantain, makes processing a necessity. As a result, plantains and plantain products can improve national food security while also eradicating rural poverty [1]. It would be an eye-opener to the policy-makers on how to commercialize the products and as well help in building functioning organized market in plantain products. More so, the findings of this study will not only depict the determinants of profitability and other marketable potentials of plantain processing, but it will also be a guide for policymakers to effectively plan for the growth and development of the industry through formulating effective processing and marketing policies. Again, this will help the processors to readjust their resources to generate sustainable income for their families and as well improve the quality of their lives as also reported by [5].

Literature Review: Entrepreneurship is an idea or vision which one can explore and optimize for profit in business [12]. This would also help in creating new jobs and economic empowerment among people. The entrepreneurial knowledge applies to plantain processors as it is found in other products. [24] stated that every day in the rural community's food crops is processed for sale as convenient ready-to-eat foods. The industry which accomplishes this daily food processing task is characterized by its small scale, simple technology, and orientation towards its consumers. In most cases, the final product is produced from raw materials by only one person. No formal standard of quality or quantity is observed by the producers. There is gainful employment for thousands of rural people, primarily women, and a substantial amount of locally generated income, resulting from the functioning of this processing industry [17]. Plantain production is currently becoming a significant source of income for both large-scale and small-holder farmers in Nigeria, and it is one of the primary commodities for investment across the southern part of the country, where it occupies a strategic position for rapid food production [7]. Nigeria is expected to remain one of the world's largest producers of plantain due to the potential for industrial processing, which has recently been adopted, and the increased interest in development by small and large-scale farms in the region [7]. Several studies have been carried out on plantain in terms of production and marketing but only a few of them focused on the processing component of the chain. For instance, [8] researched the conceptual design of a process plant for plantain flour production from green plantain pulp, while the area of product differentiations and the performance evaluation were not covered by the study. [11] focused their research on characterizing the plantain cropping systems, genetic diversity, and production constraints as a baseline to the full utilization of this resource in crop improvement and to identify the potential production and agronomic qualities. [22] worked on the potential of plantain residues for the Ghanaian bioeconomy and found out that there is a substantial interest of private enterprises for high-quality fibers and confirmed the availability of the rich plantain pseudo-stems as fibers. Again, [3] examined the role of plantain processing and appropriate storage technologies in ensuring food security and food availability in Africa. The study dwelled on the post-harvest handling and storage of the product for improved food distribution, while [24] looked at the constraints and survival approaches of small-scale processors using Ordinary Least Square regression. The study of [5] evaluated the organization, cost, and return on plantain trade. The study employed the Gini coefficient, gross margin, and regression analysis to examine the inequality among the plantain marketers and the factors affecting the sales in the area. Therefore, this study contributes to the knowledge in the sense that not many studies in the literature have examined the factors that determine the profitability of the plantain processors in Nigeria, and very scarce in recent time most especially in Osun State. Most studies stopped at examining their profitability but failed to do in-depth analysis as does by this study.

MATERIALS AND METHODS

The research was conducted in Osun State, Nigeria. The State covers an area of approximately 14,875 square km and lies within the geographical coordinates 7°30′N and 4°30′E. The State experiences a mean daily temperature of 33°C, wind speed of 3km/h, and a humidity of 57% [2, 8, 25].
The data for the study were collected by administering on the processors through a well-structured questionnaire and interview scheduled. For this analysis, a multi-stage sampling technique was used. The first stage involved a purposive sampling technique of two (2) Local Government Areas that are well known for plantain cultivation and processing. The second stage involved using a simple random sampling method to select three (3) communities from each LGAs, making six (6) communities in total. Therefore, a simple random sampling procedure was used in stage three to select twenty (20) processors, making a total of one hundred and twenty (120) respondents. Descriptive statistics, Gross Margin, and multiple regression were used for the objectives of the study. Descriptive statistics such as mean, standard deviation, frequency tables, and percentages were used to analyze the socio-economic characteristics, identify products processed from plantains, and constraints faced by the processors. Gross Margin Analysis and Return to investment (ROI) were used to analyze costs and returns from the processed products of plantains.
The Gross Margin formula is represented as:
G.M = TR - TVC
where: G.M=Gross margin

TR =Total revenue
TVC=Total variable cost
The profitability also represented symbolically by
π =TR - TC
where: π = profit
TR = Total revenue/gross income
TC = Total cost [Total fixed cost (TFC) + Total variable cost (TVC)]
Ordinary Least Square (OLS) was used to analyze the determinants of profitability in the area. The explicit linear functional form is stated as:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + U_i$$

Where:
Yi = Profit accrued from the enterprise (₦)
X_1 = Cost of transportation (₦)
X_2 = Cost of purchasing plantain (₦)
X_3 = Cost of bowl (₦)
X_4 = Cost of Sack (₦)
X_5 = Cost of knives (₦)
X_6 = Cost of Labour (₦)
U_i = error term.

RESULTS AND DISCUSSIONS

Socio-economic Characteristics of Plantain Processors

The result in Table 1 reveals that most (46.6%) of the plantain processors fell in the age bracket of 26 - 35 years old with the mean age of 30 years old. This indicates that most of the processors were still in their youthful and economic age in the area. This is in support of [4, 26] who reported that most of the people involved in marketing activities were young persons who are vibrant and energetic with a significant market influence. The plantain processors were dominated by the female household with about 71%. It was also shown that most of the respondents (55.0%) have a family size between 4 and 6 persons per house with a mean of 4 people per household. This is an advantage because labour optimization can be attributed to the large household size which can also raise their earnings and profitability. This finding supports the result of [14] who reported that large households complement labour to enhance production and reduce the cost of hired labour. Again, about 55.0% of the respondents had processing experience of 6-10 years, with an average mean of 8 years while 22.5% had an experience of 11-15 year. This tallies with the finding of [29] that experience in agribusiness enhances output performance. The Table showed that the majority (80%) of the respondents were married. This explains why they tend to respond favorably to risk in terms of economies of scale, as the couple may combine their resources to increase output which in turn increases their income. The result agrees with the findings of [20] who reported that married individual had greater involvement in agricultural production could be as a result of high labour requirement in which they use members of their family as labour force. Also, about 50.8% of the processors purchased directly from local farmers, 45.0% purchased from plantain depot in the market, and 4.2% purchased from the bulk market.

Table 1. Distribution of the Respondents by Their Socioeconomic Characteristics

Variable	Frequency
Age (years)	
Less than 25	11
26 - 35	56
36 - 45	35
46 - 55	13
> 55	5
Sex	
Male	35
Female	85
Household size	
1 - 3	21
4 - 6	66
7 - 10	33
Experience in plantain processing (years)	
1 - 5	27
6 - 10	66
11 - 15	27
Marital Status	
Single	5
Married	96
Divorced	14
Widowed	5
Purchasing point	
Direct from local farmers	61
From plantain bulk market	5
Plantain depot in the market	54
Total	120

Source: Field Survey, 2019.

Available Plantain Processed Products in the Area

The result from Table 2 presented the availability of plantain products available in the study area. The majority (67.5%) of the respondents attested that roasted plantain was the most available product in the area, followed by flour (26.7%) and then chips (5.8%). It could be deduced that many processors engaged in roasted plantain business because of the less technology involved in processing it. Likewise, it is highly demanded for among the transporters as a fast and read-to-eat food [24].

Table 2. Distribution of the Plantain Products available in the Study Area

Plantain products	Frequency
Chips	7
Flour	32
Roasted	81

Source: Field Survey, 2019.

Costs and Returns of Respondents in the Study Area

The result reveals that on average, the total cost incurred on plantains was N29,559.7 per month. The total return and net return were N51,337.5 and N21,777.8 respectively (Table 3).

Table 3. Average Costs and Returns of Plantain Processors

Item	Mean Value in dozen
Raw plantain	23,008.33
Labour	3,917.09
Transportation	552.46
Storage	2,666.67
Total variable cost (TVC)	**27,744.60**
Depreciation cost on the knife	701.17
Depreciation cost on the bowl	525.00
Depreciation cost on the sack	588.90
Total Fixed Cost (TFC)	**1,815.10**
Total Cost (TC)	**29,559.70**
Total Revenue (TR)	51,337.50
Gross margin	23,592.90
Profit	21,777.80
Return on investment (ROI)	1.73

Source: Field Survey, 2019.

This result implies that plantain processing in the study area is profitable, and this should encourage more entrants into the business of plantain processing and marketing. This justifies one of the needs of this study as plantain offers many socioeconomic benefits including income provision. It can be deduced from the above result that plantain marketing is a profitable venture. The result of the return on investment (ROI) further reiterated the profitability of plantain processing in the area. The ROI value of 1.73 implies that for every one naira expended on processed plantain ₦1.73k is realized. It means that the processor makes a gain of 73 kobo for each naira they invest in the business. This conforms with the findings of [4, 26].

Factors Affecting Profitability of the Plantain Processors

The linear functional form of multiple regression was used in the model and presented in Table 4. The co-efficient of multiple regressions (R^2) was given as 0.62, this implies that about 62% of the variation in profit (Y) was explained by the explanatory variables captured in the regression model. The regression results showed that four (4) out of the six (6) explanatory variables had a significant effect on the profit from processed plantain. These variables were bowl cost, plantain cost, transportation cost, and cost of labour. The coefficient of bowl cost was statistically significant at a 1% probability level and had a negative relationship. This implies that an increase in the cost of the bowl will bring about a corresponding decrease in the profit of the plantain processors. The plantain cost's coefficient was statistically significant at a 1% level, implying that the cost of plantain is a critical factor in the plantain processors' profit. An increase in the cost of plantain will bring about an increase in profit. This result means that if the plantain processors increase the price of the plantain products more than the respective increase in the cost of plantain, it will thereby; bring about more increase in the profit. The coefficient for transportation cost was statistically significant at a 1% probability level. This also implies that an increase in transportation cost will bring about an increase in their profit, *ceteris paribus*, but contrary to the *apriori expectation*. The probable reason was that an increase in transportation cost makes the plantain processors increase the price more than the respective increase in the transportation cost, thereby bringing more profit. The coefficient of cost of labour was statistically significant at a 1% probability level but had a negative influence on the profit accrued. An increase in labour cost will bring a decrease in the plantain processors profit.

Table 4. Result of OLS on the Factors that Affect the Profitability of the Processors

Variables	Coefficients	Standard error	t
Constant	16,816.440	7,961.810	2.11
knife cost	.108	.549	0.19
bowl cost	-13.468	2.133	-3.3
sack cost	-1.880	1.609	-1.1
Plantain price	1.164	0.166	6.9
Transportation cost	7.190	2.099	3.4
Labour cost	-4.330	1.286	-3.3.
R^2	0.602		
F-value	28.20*		
*significant at 1 percent **significant at 5 percent Dependent variable: Profit accrued in naira			

Source: Field Survey, 2019.

Constraints Faced by the Plantain Processors in the Area

From Table 5, the mean score of each statement was used to rank the response of the processors on the constraints faced in the area. The Table revealed that the high cost of labour (mean = 4.60) was ranked as first main problem faced in the area. The respondents claimed that the labour cost incurred on conveying the raw plantain to the processing point with the cost of peeling and washing is high due to shortage of labour.

The second on the list was lack of storage facilities (mean = 3.94). Plantain is a perishable good and sometimes processors might need to purchase them in bulk to reduce cost but because of the lack of storage and preservative facilities, they could one buy what they can process at once. High cost of transportation (mean = 3.12) was ranked third. Hike in fuel price cum the poor road networks contributed immensely to the high cost of transporting the raw plantain from either the market or farm-gate to the processing point. Similar result was also reported by [28] on the study on transportation system and output market participation in Ondo State, Nigeria. Lack of credit (mean = 1.67) was noted as fourth serious problem in the area. Most of the processors claimed that funds were not made available for the expansion of the business and the available ones were unaffordable because of the high interest rate. The fifth ranked problem was price instability (mean = 1.65). This is peculiar to most markets in the area as the price fluctuates because of many factors such as fuel price, supplier cost and future expectation. Likewise, unorganized market was ranked sixth while high cost of processing equipment and scarcity of plantain were not seen as a constraint in the area. It can be deduced that the processors had enough plantain for processing with cheap processing equipment.

Table 5. Distribution of the Respondents based on the constraint faced

Constraint faced	**SA (%)**	**A (%)**	**U (%)**
Cost of labour	86.7	0.8	0
Lack of storage facilities	10.0	82.5	1.7
High cost of transportation	3..3	63.3	4.2
Lack of access to credit	80.0	13.3	0
Price instability	5.0	60.5	0.8
Un-organized market	4.2	11.7	3.3
High cost of processing equipment	0	10.0	2.5
Scarcity of plantain	0	8.3	2.5

Note: SA = Strongly agreed; A = Agreed; U = Undecided; D = Disagreed; SD = Strongly disagreed
Source: Field Survey, 2019.

CONCLUSIONS

This research study was able to determine the profitability of processed plantain in Osun State Nigeria. The prospects of plantain processing are high. It is therefore a good business opportunity for creating employment for many Nigerians to become actors in the plantain value chain (as inputs dealers, farmers, marketers, transporters, and processors). It was concluded that roasted plantain is the most available plantain product in the area. Factors like plantain price, transportation cost, and labour cost are significant in determining the profitability of plantain processors in the area. The high cost of labour, lack of storage facilities, high cost of transportation, and lack of access to credit were the main challenges that need urgent attention in the area. Based on the findings of this research study, the following recommendations are made:

(i)The various levels of governments should give serious attention to the challenges posed by the processors. The government should construct and repair roads network to link farm-gates in the rural areas to market locations in the urban centers. This will reduce the hike in the cost of transportation.

(ii)Federal and State Ministries of Agriculture should promote plantain production by encouraging farmers to produce more to meet the increasing market demand for local consumption, plantain processing industries, and export markets. This will encourage more participants in the enterprise and as well reduce high cost of labour.

(iii)The Ministry of Trade and Investment should encourage value addition to plantain produce to avoid the challenge posed by its high rate of perishability due to the lack of storage facilities.

(iv)The government should put up favourable credit policies that would encourage plantain processors to take loans for their business expansion.

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ASSESSMENT OF PULL MECHANISM AT ENHANCING MAIZE FARMERS' UTILISATION OF AFLASAFE BIO-CONTROL MEASURES IN OYO STATE, NIGERIA

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Abstract

There is the need to rethink how technology is being disseminated to end users in order to ensure adoption and utilisation. This study assessed how pull mechanism is enhancing the utilisation of Aflasafe bio-control measures among maize farmers in Oyo State, Nigeria. Multi-stage sampling procedure was used to select 91 maize farmers for the study. Data was collected from maize farmers through interview schedule and analysed using descriptive statistics (means, frequencies and percentages) and inferential statistics (Pearson Product Moment Correlation and Regression analysis). The result showed that 89% of the farmers indicated Implementers as the outlet for the purchase of Aflasafe. Also, premium payment and provision of technical assistance were the highly ranked incentives to utilisation of Aflasafe among the farmers. The study also revealed low access to credit as major constraint to the utilisation of Aflasafe bi-control measures. Meanwhile, 54% of the farmers had full utilisation of Aflasafe in maize production. Significant correlation was found between incentives and utilisation of Aflasafe (r-value = 0.274; p≤ 0.01). The study therefore recommends that governments and non-governmental organisations should ensure availability of Aflasafe bio-control to the maize farmers either through loan provision or price subsidy.

Key words: *Aflasafe bio-control, maize production, production incentives, pull mechanism*

INTRODUCTION

Feeding the estimated world population that is projected at 8.5 billion in 2030 would be a mirage without intensive utilisation of research outputs by smallholder farmers. According to [3], the number of people suffering from chronic hunger and undernourishment in the world has increased from 804 million in 2016 to 821 million in 2017. The situation is precarious in most regions of South America and Africa. Thus, without concerted efforts, the sustainable development goal of eradicating hunger in the world by 2030 may become an illusion. Ironically, a good number of improved technologies have been generated to tackle hunger and malnutrition. Nonetheless the modus operandi of conception, design and implementation of these innovations has prevented them from achieving their intended objectives. It is either they are developed without adequate consideration of the end users (often the smallholder farmers) or the methods of delivery are in defiant with social norms and values. Thus, despite the huge potentials, the adoption of agricultural innovation to transform agricultural landscape in sub-Saharan African by smallholder farmers seems to be slow [7]. The challenge now lies not in existence of innovation but in scaling them up in ways that are inclusive while overcoming the challenges in their uptake [10].

The innovation in pull mechanism according to [5] was to eliminate the constraints in demand and supply of agricultural technologies. Limited awareness about the technology, cost of the technology and risk of the technology may lead to low demand. Whereas, the costs and risks of investment in developing appropriate products or services, low demand by smallholder farmers, poor infrastructure may serve as constraints on the supply side. In order to overcome these challenges, pull mechanisms deviate from donor dependent-market designed specifically to meet the specification of the donors who usually contribute majorly to the development of the product through push mechanisms [4]. In this regard both the donor and innovator are stakeholders that jointly share the risks in product development. Pull mechanisms in this context are seen as a possible complement or even alternative to traditional donor-funded development approaches that seek to "push" promising technologies to beneficiaries through grants or contracts that pay in advance for recipients' efforts.

Maize is the most widely-grown staple food crop in sub-Saharan Africa (SSA) occupying more than 33 million hectares each year [6]. The crop covers nearly 17% of the estimated 200 million hectares of cultivated land in SSA, and it is produced in diverse production environments and consumed by people with varying food preferences and socioeconomic backgrounds. More than 300 million people in SSA depend on maize as a source of food and livelihood. The top 20 countries, namely South Africa, Nigeria, Ethiopia, Tanzania, Malawi, Kenya, Zambia, Uganda, Ghana, Mozambique, Cameroon, Mali, Burkina Faso, Benin, Democratic Republic of Congo, Angola, Zimbabwe, Togo, and Cote d'Ivoire account for 96% of the total maize production in SSA [6].

Aflatoxin is among the most carcinogenic substances known in nature and produced by the ubiquitous fungus, Aspergillus flavus. It is highly toxic and is capable of colonizing and contaminating major staples like maize and groundnut at the pre-harvest, harvest and post-harvest stages of the crops rendering them unsafe for consumption. Aflatoxin contamination is a global problem affecting 4.5 billon people in developing countries. In Nigeria where smallholder farmers produce over 70 percent of the nation's maize crops, about 60% of maize production may be aflatoxin contaminated [5]. This therefore posts a great danger for smallholder farmers who derive their livelihood from maize production. In order to combat this toxic infection, Aflasafe biocontrol measure was developed. Aflasafe is an innovative aflatoxin solution developed by International Institute of Tropical Agriculture (IITA) in collaboration with the Agricultural Research Service of the United States Department of Agriculture (USDA-ARS), University of Bonn, Germany and University of Ibadan, Nigeria. While deviating from the traditional push method of technology dissemination, pull mechanism incentivise adoption of the bio-control through premium per-unit payment for maize verified to contain a high prevalence of Aflasafe at designated maize aggregation centers.

The elements of pull mechanisms in Aflasafe bio-control begin with developmental problem that requires technological solutions. In this study, aflatoxin contamination in maize is the developmental problem that needs solutions to ensure food safety and sustainable livelihood to maize farmers. Next is technological solution with potential to have a significant impact if adopted on a large scale. The technological solution in this case is Aflasafe bio-control. The developmental problem and technological solution will interest the solvers (private sector actors) to take the advantage of market opportunity. The incentives structure is the targeted outcome and parameters in the pull mechanisms that will motivate the solvers to invest in the design, development and drive the adoption of the technological solution. Being an innovative approach that was piloted in Nigeria in 2013 and currently at various levels of adoption and commercialization in the country, this study then assessed the utilisation of Aflasafe bio-control among maize farmers in Oyo State, Nigeria. The specific objectives of the study were to: determine farmers' awareness of Aflasafe bio-control; identify sources of purchase of Aflasafe, examine incentives at utilisation of Aflasafe bio-control; ascertain the extent of utilisation of Aflasafe bio-control; determine constraints faced by farmer in utilising Aflasafe bio-control and factors influencing the utilisation of the bio-control measures. The study hypothesised that there was no significant relationship between incentives and utilisation of Aflasafe bio-control.

MATERIALS AND METHODS

Study Area

The study was carried out in Oyo state, Nigeria. The state is an in-land state. The climate is equatorial, notably with dry and wet seasons with relatively high humidity. The dry season lasts from November to March while the wet season starts from April and ends in October. Average daily temperature ranges between 25^0C and 35^0C almost throughout the year. The tropical nature of the climate favours the growth of variety of food crops such as; yam, maize, cassava, millet, plantain, banana, rice and fishing. Population of the study comprised of maize farmers in the state.

Data and sampling technique

Multi-stage sampling procedure was used in the selection of the respondents. The first stage involved purposive sampling of two Local Government Areas (LGAs) in Oyo state based on expert recommendation and these were Iseyin and Akinyele LGAs. The second stage involved random sampling of five farming communities from each local government area. The selection of these communities was based on the quantum of maize production in the ten communities. Then, using systematic random sampling, 10 maize farmers were selected from each community to give a sample size of one hundred. Interview schedule was used to obtain information from the maize farmers. Meanwhile, only 91 questionnaires were found suitable for data analysis. Data was analysed using SPSS version 15.

Farmers' awareness was measured using Yes (1) and No (0) to awareness statements on Aflasafe bio-control technologies. In measuring incentives to Aflasafe bio-control, farmers' responded to a list of available incentives on Yes (1) and No (0). Utilisation in this study is the final stage of adoption process. This is the stage at which farmers have already adopted the technology and use it consistently. Utilisation of Aflasafe bio-control was measured based on recommended rate of 10kg/ha [9]. The level of utilisation was then computed as the ratio of quantity of Aflasafe (kg) and farm size (ha). This then gave a range of 0.0 – 1.0 where 0.0 – 0.3 = poor utilisation, 0.4 - 0.9 = moderate utilisation and 1.0 = full utilisation. Constraints to utilisation of the bio-control was measured by farmers indicating appropriately on various constraints statement on a 4-point rating scale of "to a very great extent", "to a great extent", "to some extent" and "to no extent". The values of the response categories were 0, 1, 2 and 3 respectively.

Data Analysis

Data was analysed using descriptive statistics (means, frequencies and percentages) and regression analysis.

The regression analysis is explicitly represented below:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \ldots\ldots\ldots. + b_8X_8$$

where:
Y = Aflasafe utilisation (0-1)
X_1= Farmers' age (years)
X_2= Household size (number of persons)
X_3= Years in formal education (years)
X_4 = Farm size (hectares)
X_5= Farming experience (years)
X_6 = Output of maize (kilograms)
X_7 = Price of Aflasafe (naira)
X_8 = Years of using Aflasafe bio-control

RESULTS AND DISCUSSIONS

Farmers' awareness of Aflasafe bio-control

Pre-harvest operations with high level of awareness were: sourcing for maize seeds from reliable agro dealers ($\bar{x}$ =1.0) and planting of improved maize variety ($\bar{x}$=0.98) (Table 1). This means that the farmers are already conscious that good yield start from right selection of good seeds. Similarly, the table also indicates that plucking maize cobs directly into bags ($\bar{x}$=0.94) and determining properly dried maize through cracking the kernel between the teeth (x=0.93) are the most post-harvest activities that the farmer were aware of. The grand mean indicates that the maize farmers had high awareness of pre-harvest activities ($\bar{x}$ = 9.29) than post-harvest activities ($\bar{x}$ = 8.93). It is therefore expected that the high awareness of Aflasafe bio-control practices will translate into high utilisation. This agrees with [8] that found significant relationship between farmers' awareness of improved plantain technologies and its adoption.

Table 1. Distribution of farmers' on awareness of Aflasafe bio-control

Agronomic Activities	Aware		Not Aware		Mean	Rank
	Frequency	Percentage	Frequency	Percentage		
Pre-harvest activities						
Right source of maize	91	100.0			1.00*	1st
Planting improved varieties	90	98.1	1	1.1	0.98*	2nd
Broadcasting method	89	97.8	2	2.2	0.97*	3rd
Application on wet soil	87	95.6	4	4.4	0.95*	4th
Delay planting	86	94.5	5	5.5	0.94*	5th
Proper timing for weeding	86	94.5	5	5.5	0.94*	6th
Apply 10kg/ha	80	87.9	11	12.1	0.87*	7th
Apply at first flag leaf/flowering	84	92.3	7	7.7	0.92*	8th
Do not apply when flowering is full	80	87.9	11	12.1	0.87*	9th
Do not bury Aflasafe into the soil	73	80.2	18	19.8	0.80*	10th
Post-harvest activities						
Plucking maize cobs into bags	86	94.5	5	5.5	0.94*	1st
Properly dry maize before storage	85	93.4	6	6.6	0.93*	2nd
Store old and new stock maize separately	85	93.4	6	6.6	0.93*	3rd
Harvest while plant still standing	85	93.4	6	6.6	0.93*	4th
Sun-dry on a raised platform	84	92.3	7	7.7	0.92*	5th
Do not thresh by beating with sticks	83	91.2	8	8.8	0.91*	6th
Heap together to form a cone	81	89.0	10	11.0	0.89*	7th
Damaged cobs should be separated	77	84.6	14	15.4	0.84*	8th
Transport using leak proof vehicle	74	81.3	17	18.7	0.81*	9th
Store threshed maize on pallets	73	80.2	18	19.8	0.80*	10th

Grand Mean
Pre-harvest activities = 9.29
Post-harvest activities = 8.93
Source: Field survey, 2018.

Farmers' sources of purchase of Aflasafe bio-control

Results in Table 2 show that, most (89%) of the maize farmers sourced for Aflasafe from Implementers. This could be because they are the anchors used by IITA to integrate producers in the chain. Also, 4.4% sourced from IITA, 3.3% from Agro-dealer, and 3.3% from other farmers. The business drive of this private actor (Implementers) whose gain is dependent on the quantum of aflatoxin free maize aggregated will definitely lead to high utilisation by the farmers. This supports the findings of [1] that identified implementers as the main promoter of Aflasafe bio-control measures in Nigeria.

Table 2. Distribution of farmers' sources of purchase of Aflasafe

Sources of purchase	Frequency	Percentage
Implementers	81	89.0
Agro-dealers	3	3.3
IITA	4	4.4
Other farmers	3	3.3

Source: Field survey, 2018.

Incentives to utilisation of Aflasafe bio-control in maize production

Results in Table 3 reveal that, most (97.8%) of the maize farmers indicated premium payment for Aflatoxin-free maize as an incentive to its utilisation. Also, 94.5% indicated provision of technical assistance and improved health from consuming Aflatoxin-free maize. This shows that the presence of tangible incentives has motivated the farmers to utilise Aflasafe in maize production. This supports the finding of [2] that posits that incentivizing disseminating farmers through material rewards aided diffusion of pit and composting technologies among farmers in Malawi. Almost half (49.5%) of the maize farmers indicated guaranteed market for Aflatoxin-free maize as an incentive. This means that the farmers do not recognise this as an incentive as there is no better market outlet than selling to aggregating vendors to enjoy premium payment. The results further show that 33.0% of the respondents indicated discount on other inputs e.g. fertilizer for purchasing Aflasafe. This result may akin to the fact that just a few got discounted on the purchase of other inputs along with Aflasafe bio-control.

Table 3. Distribution of maize farmers' incentives for utilising Aflasafe bio-control

Incentives	**Yes**		**No**		**Mean**	**Rank**
	Frequency	%	Frequency	%		
Premium payment for Aflatoxin-free maize	89	97.8	2	2.2	0.98*	1st
Provision of technical assistance	86	94.5	5	5.5	0.94*	2nd
Improved health from consuming Aflatoxin-free maize	86	94.5	5	5.5	0.94*	3rd
Effective public health awareness against Aflatoxin contamination	85	93.4	6	6.6	0.93*	4th
Expected increase in maize yield	85	93.4	6	6.6	0.93*	5th
Enforcement of Aflatoxin regulation	84	92.3	7	7.7	0.92*	6th
Enhanced access to input distribution system	81	89.0	10	11.0	0.89*	7th
Subsidy on the cost of Aflasafe	71	78.0	20	22.0	0.78*	8th
Discount on other inputs e.g. fertilizer for purchasing Aflasafe	30	33.0	61	67.0	0.33	10th
Guaranteed market for Aflatoxin-free maize	45	49.5	46	50.5	0.49	9th

Source: Field survey, 2018.

Level of Utilisation of Aflasafe

Result in Table 4 show that 54% of the maize farmers were fully utilising Aflasafe bio-control as recommended. Also, from the results, 12% and 34% had moderate and poor utilisation of the product respectively. Meanwhile, the mean of 0.7 indicates a fairly good utilisation of Aflasafe bio-control measures. With this level of utiliation, maize produced is expected to be aflatoxin free with high Aflasafe content to attract premium prices.

Table 4. Distribution of farmers according to level of utilisation of Aflasafe bio-control

Level of Utilisation	**Frequency**	**Percentage**	**Mean**
Poor utilisation (0.1-0.3)	31	34.0	0.7
Moderate utilisation (0.4-0.9)	11	12.0	
Full utilisation (1.0)	49	54.0	

Source: Field survey, 2018.

Constraints to the Utilisation of Aflasafe

Results in Table 5 show that low access to credit facilities ($\bar{x}$=2.5), inadequate sources of purchase ($\bar{x}$=2.4) of the bio-control and lack of storage facilities ($\bar{x}$=2.3) were rated as the highest constraints toward its utilisation. This means that as the farmers may be willing to utilise Aflasafe, lack of credit may limit the extent of utilisation as this determines the volume they would be able to purchase with their limited finance. Similarly, inadequate storage facilities may as well serve as a discouraging factor for the farmers to expand maize production.

Table 5. Constraints to utilisation of Aflasafe bio-control

Constraints	Severe constraints		Mild constraints		Not a constraint		Mean	Rank
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage		
Low access to credit facility	58	63.7	19	20.9	14	15.4	2.5*	1st
Inadequate sources of purchase	59	64.8	13	14.3	19	20.9	2.4*	2nd
Lack of storage facilities	48	52.7	18	19.8	25	27.5	2.3*	3rd
Lack of prerequisite skills	47	51.6	19	20.9	25	27.5	2.2*	4th
High cost of technology	40	44.4	32	35.2	19	20.9	2.2*	5th
Lack of access to other essential inputs	35	38.5	38	41.8	18	19.8	2.2*	6th
Weak interaction	38	41.8	22	24.2	31	34.1	2.1*	7th
Lack of labour	35	38.5	25	27.5	31	34.1	2.0*	8th

Source: Field survey, 2018.

Factors influencing farmers' utilisation of Aflasafe bio-control measures

Kolmogorov-Smirnov was used to perform diagnostic tests on the data to ascertain the suitability of the regression model. The tests showed that the error term is normally distributed (p value = 0.100) and there were no problems of multicollinearity, autocorrelation and heteroscedasticity. Results in Table 6 indicates that six independent variables, namely: farmers' age (X_1), household size (X_2), educational level (X_3), farm size (X_4), maize production experience (X_5), and years of using Aflasafe (X_8) were found significant as factors influencing farmers utilisation of Aflasafe bio-control measures. The estimates of the model coefficients reveals that keeping other factors constant, a unit increase in household size, years of formal education, maize production experience and maize output will increase Aflasafe utilisation by 0.391, 0.404, 0.572 and 0.531 respectively.

Meanwhile, negative coefficients observed in farmers' age and years of using Aflasafe indicate that keeping other factors constant, a unit increase in these variables will reduce Aflasafe utilisation by -0.384, and -0.408 respectively.

This implies that as the farmers aged and also acquires more experience they may tend to be complacent in the utilisation of Aflasase bio-control.

Furthermore, Table 6 shows the value of R (that is correlation coefficients between all of the predictor variables and utilisation). In the model, the value is 0.736, which indicates that there is high variance between the independent variables and utilisation of Aflasafe bio-control.

Meanwhile, the R^2 of 0.541 indicates that 54.1% of the variance in utilisation of Aflasafe bio-control is explained by the independent predictor variables in the model.

Table 6. Result of linear regression model for factors influencing maize farmers utilisation of Aflasafe bio-control

Variables	Unstandardized coefficient		Standardized coefficient	T	Sig.
n = 91	B	Std. Error	Beta		
Constant	241.312	58.110		4.153	0.000
Farmers' age	-0.011	0.003	-0.384	-3.121	0.002*
Household size	0.036	0.012	0.391	3.010	0.003*
Education	0.029	0.007	0.404	3.994	0.001*
Farm size	-0.050	0.016	-0.723	-3.115	0.003*
Maize production experience	0.016	0.005	0.572	3.330	0.001*
Output	0.001	0.000	0.531	2.254	0.027*
Cost of Aflasafe	2.972	0.001	0.077	0.790	0.432
Years of using Aflasafe	-0.120	0.029	-0.408	-4.141	0.001*

$R = 0.736$ $R^2 = 0.541$ Adjusted $R^2 = 0.497$ *Significant at $p \leq 0.05$
Source: Field survey, 2018.

Relationship between incentives and utilisation of Aflasafe bio-control

The result of Pearson Product Moment Correlation in table 7 shows that there was significant relationship between incentives and utilisation of Aflasafe bio-control. The PPMC coefficient of 0.274 indicates a weak correlation between the two variables. This implies that farmers' utilisation of Aflasafe increases with increase in incentives. It is therefore a worthwhile endeavour to invest more in the incentives to utilisation which appears weak from the result in order to enhance full utilisation of the product.

Table 7. Significant relationship between incentives and farmers' utilisation

	Mean	r-value	p-value	Decision
Incentives	8.15	0.274	0.001	Significant
Utilisation	0.71			

*Significant at $p \leq 0.01$
Source: Field survey, 2018.

CONCLUSIONS

The incentives measures at both demand and supply sides of pull mechanism have proven innovative toward scaling the uptake of agricultural technology. The low uptake of agricultural technologies among the end users (particularly farmers) could be addressed by attaching tangible rewards as compensation for utilising the innovation. Meanwhile, farmers also need to be motivated prior the tangible reward with *ex ante* factors such as credit and storage facilities provisions. This will further activate the desire to utilise the product with the ultimate incentives in view. Thus, as food safety is a global phenomenon, it is imperative for governments and nongovernmental organisations to make loans available for purchase of Aflasafe or subsidised its cost to make it affordable for the farmers. Also, ministries and agencies of governments should create awareness of the incentives to Aflasafe through radio or television broadcast. This will further sensitise the public and the maize farmers on the health benefits of consuming and growing Aflatoxin-free maize respectively. Efforts should also be geared in selecting experienced maize farmers and those with high level of formal education in the upscale of the technology.

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INDIGENOUS MEAT AND MILK GROSS PRODUCTION INDEXES AND THE DYNAMIC MACROECONOMIC FUNDAMENTALS IN NIGERIA: ARDL MODEL APPROACH

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Abstract

The study established the empirical relationship between some key macroeconomic variables and meat as well as the milk gross production indices in Nigeria. Data were source from the World Bank, Food and Agricultural Organization and the Central Bank of Nigeria and it covers the period from 1961 to 2020. The properties of the series were tested with the Augmented Dickey-Fuller unit root test and ADF-GLS unit root test. The Autoregressive Distributed Lag Model (ARDL) was used to establish the existence of the cointegration among the specified series. The empirical results revealed that, real GDP per capita, nominal exchange rate, land density are the determinants of meat gross production gross index in the long run, whereas, per capita income, credit to the economy and land density are the short run determinants. Also, the per capita income, nominal exchange rate, export and inflation rate influence the milk gross production index in the long run; while the per capita income, land density, credit to the economy, value of export and nominal exchange rate had short run impact. Based on the findings, it is recommended that, specific policy to focus on the improvement of the per capita income, foreign trade control policy and reduction and or stabilization of inflation rate in the country are inevitable.

Key words: *agriculture, production, macroeconomic, crop, Nigeria*

INTRODUCTION

Meat and milk are popular animal derivatives and among the major sources of animal based protein and calorie available to man [33, 39, 2]. In Nigeria, the meat from cattle, goat, sheep, pig and poultry constitute the main sources of daily per capita consumption of animal protein; whereas, the cattle are the primary source of milk, providing more than 90% of the total animal domestic milk output [41, 22, 18]. The bulk of the cow milk produced in the country is derived from the nomadic pastoralists [20]. The dairy sub sector is characterized by small scale production and low average yields/cow/year of 213 litres which is less than one tenth of the World average production [29]. FAO, [19] reported a cattle population of 20.7 million heads, including 2.2 million dairy animals, goat population of 80.1 heads, pig population of 8.0 heads and 46.8 heads for sheep for the year 2019. In 2018, the total production of milk, meat and eggs amounted to 0.5 billion litres, 1.4 and 0.6 million tonnes per year, respectively [19]. The consumption of adequate quantity of animal protein is essential in reducing malnutrition and increasing household food security.

In the last three decades, the demand for meat and milk based products have increased in the Sub Saharan Africa and Nigeria in particular [19]. The upsurge in the demand for meat and milk based products is stemming from several causation factors, including increasing urbanization, educational status, rising personal income and socialization among others. Following the report of FAO, [21, 23], about 40 percent of households in Nigeria are responsible for producing the bulk of the meat and local milk consumed, with the exception of the poultry meat.

With the population growth rate of 2.57% per annum and an estimated population of around 400 million in 2050; the Nigerian government has a serious challenge in meeting the protein requirement of its citizen now and in the future. Cities are expanding, rural areas are turning into semi-urban areas, culminating in an unprecedented increase in overall demand for meat and milk products. The majority of the population is rapidly adopting the consumption model that has greatly enhanced diets rich in meat and milk additives. Following the reports of Popkin, [36] and de Halen *et al.,* [14], urbanization has induced a dietary shift towards more processed foods, partially in response to longer working hours. The increase consumers' preference for meat and milk based products have upshot demand and created short and long run incentives for livestock farmers to increase production. Hence, the livestock sub sector has potentials for job creation, reducing poverty, increase the socio-economic benefits of farmers, and guaranteed availability of affordable priced animal source foods now and in the future.

The recent statistics have shown that, Nigeria's per capita meat and milk consumption are approximately 9.0kg and 8 litres per person per year respectively [20, 22, 19]. This is far less than the continental averages that are 44 litres and 19kg respectively and World Health Organization (WHO) stipulated minimum standard of 0.83g/kg per day consumption of protein for an adult [22]. To address the issue of protein deficiency among Nigerians, the government has implemented several agricultural promotion policies and the national livestock transformation plan programs aimed at increasing output of animal based protein sources as well as guiding the anticipated transformation of the livestock sub sector till 2027. Looking at the retrospective performances of the cow milk, beef and chicken (meat) production with an annual growth rate of 2.11%, 1.18% and 3.42% respectively, there is an overwhelming need for a holistic policy intervention to upshot production. Figures 1 and 2 show the production trend in cow milk and beef in Nigeria. The production performances have been unpredictable and inconsistence across the various policy regimes in the country. Given the current level of poverty among resource poor and vulnerable groups in the country [10, 8, 13, 12], malnutrition could be aggravated if proactive actions are undertaken both in the short and long run periods to upsurge animal protein production.

Observing the trend and given the annual growth rate of individual commodity and the population growth rate of 2.57%, it is obvious that livestock farmers in the country, despite the huge market potentials have not been able to drive production of animal protein adequately. The untapped market opportunities have induced food imports amounted up to 3-5 billion USD per year, out of which milk accounts for 1.3 billion USD [32].

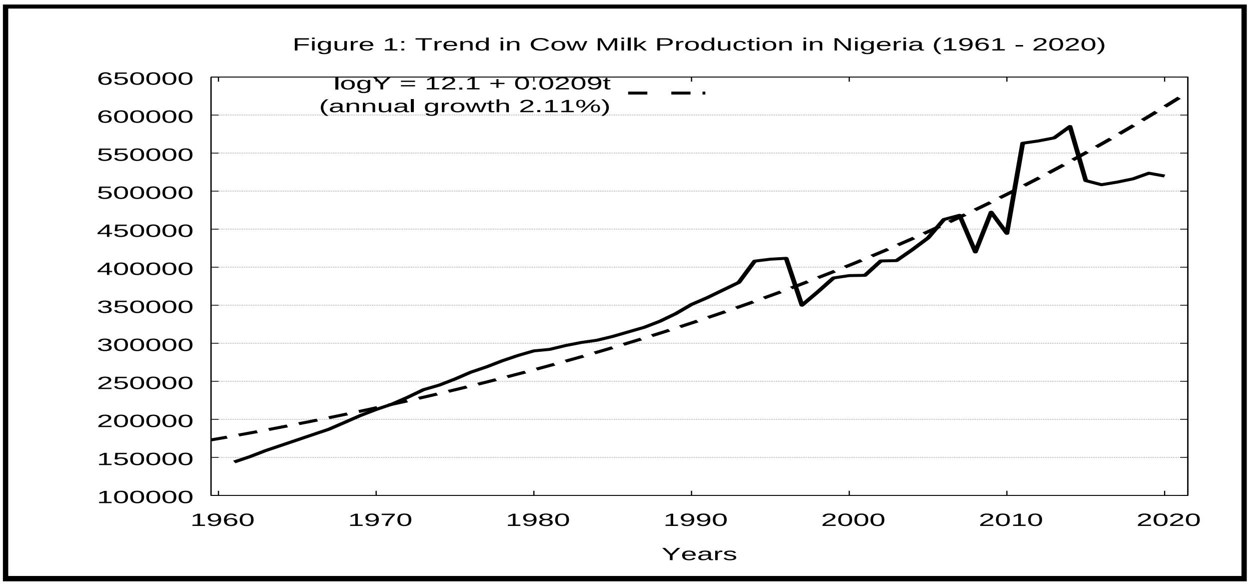

Fig. 1. Trend in Cow Milk Production in Nigeria (1961-2020)
Source: Plotted by authors using gretl, and time series data from the FAO.

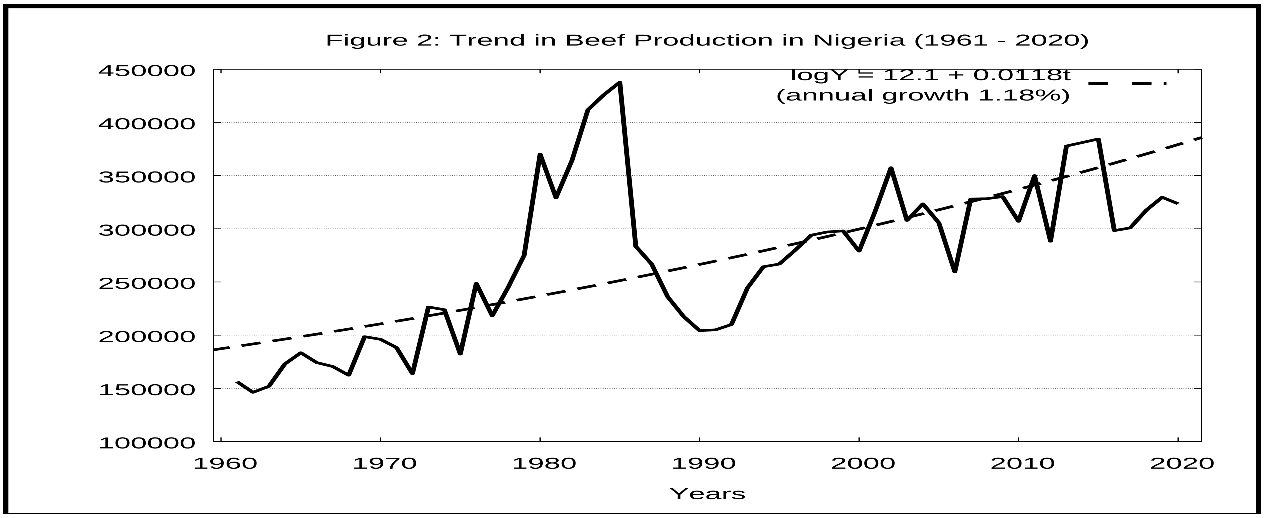

Fig. 2. Trend in Beef Production in Nigeria (1961-2020)
Source: Plotted by authors using gretl, and time series data from the FAO.

Hence, Nigeria is a net importer of dairy products and cereals: currently, the country imports about 60 percent of dairy products consumed to satisfy excessive demands of about 1.3 billion tonnes of milk annually [20, 22, 5]. However, the expected transformation of the agricultural sector especially the livestock sub-sector through the adequate supply of meat and milk and its by-products depends, among other things, on the efficiency of the macroeconomic environment [7, 4, 11, 40]. As noted by FAO, [22, 18, 23], the increase in the real per capita GDP is considered as a major driver of demand for meat and milk in Nigeria. Moreover, as observed by Akpan *et al.,* [3], the surge in inflation and persistent poverty among the majority of Nigerians are factors that hamper optimal protein consumption in the country. Likewise, Simo-Kengne *et al.,* [38] opined that price of meat, inflation, GDP, exports, import and urbanization are the major factors that influence meat consumption. Still on the related literature, Saleh *et al.,* [37] identified GDP, exchange rate and country's land area as the significant factors affecting the Chinese pork export flows. According to Akpan *et al.,* [11], the per capita real GDP, real total exports, external reserves, inflation rate and external debt influence agricultural production negatively in the short and long run periods; whereas industry's capacity utilization rate and nominal exchange rate relate positively in both long and short run periods. Also, Akpan *et al.,* [9] examined the relationship between the agricultural intensification and some macroeconomic variables in Nigeria. The findings identified the rate of inflation, external reserves, industrial production, per capita income and energy consumption as long-term negative factors in agricultural intensification. On the other hand, the crude oil prices, foreign capital in agriculture, lending rate of Bank and non-oil import were identified as the positive long run drivers. Also, the finding revealed that the inflation, external reserves and industrial output, reduce agricultural intensification in the short run period. Besides lending rate of commercial Banks and crude oil price were identified as stimulants of agricultural intensification in the short run. Also, Muftaudeen and Hussainatu [30], investigated the impact of macroeconomic policies on crop production in Nigeria. They found that in the long run, agricultural production reacted to changes in government spending, farm credit, inflation rate, interest rate and the exchange rate. Besides, Akpan and Patrick [6] modelled palm oil, palm kernel and rubber annual output equations from 1962 to 2013 in Nigeria. The results identified the per capita GDP, lending interest rate, industrial capacity utilization and kilowatts per capita of electricity consumed as significant factors that affect the outputs of palm oil, palm kernel and rubber; whereas, the per capita GDP was identified as significant variable in the short run period. As well, Adekunle and Ndukwe [1] using data set from 1981 to 2016 showed that, there was no significant long-run relationship between the real exchange rate and agricultural output in Nigeria. Their findings however, revealed significant drivers of agricultural output in Nigeria to include; industrial capacity utilization rate and government expenditure on agriculture. In a related research, Ewubare and Iyabode [17], established a positive relationship between agricultural output and agricultural credit as well as exchange rate in Nigeria. In Ghana, Enu & Attah-Obeng, [16] found real exchange rate, labour force and real GDP per capita as significant determinants of agricultural production. In Malaysia, Kadir and Tunggal [27] employed the Autoregressive-Distributed Lag (ARDL) approach to investigate the impact of macroeconomic variables on agricultural productivity from the period 1980 to 2014. The empirical findings revealed that, in the long run the nominal exchange rate had a significant negative relationship with agricultural productivity. In the short run, the country's net export and government expenditure showed negative correlations with agricultural productivity while interest rate responded positively. From the available literature, it is observed that none has focused specifically on meat and milk production despite the important roles the duo played in the daily dietary requirement of man. Hence, the meat and milk sub sectors need specific policy recommendations given the current consumption deficiency gap in the country. Also, for the last two decades a lot has happened in the Nigeria's macroeconomic environment, therefore there is need to update the available information on its impact on agricultural production.

The study therefore, sought to establish the empirical relationship between macroeconomic variables and meat gross production index as well as milk gross production index in Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Nigeria located in the sub-Saharan Africa. It lies between 4^0 and 14^0 north of the equator and between longitude 3^0 and 15^0 east of the Greenwich. Nigeria has a total land area of about 98.3 million hectares or 923,769km^2 with an extended 853km of coastline and an estimated population of 200 million [31]. The country is gifted with significant agricultural, mineral, marine and forest resources. Its multiple vegetation zones, plentiful rain, surface water and underground water resources and moderate climatic extremes, allow for production of diverse food, tree and cash crops. Recent records have provided evidence of over 60 per cent of the population actively engaged in agricultural activities [24].

Data source

Secondary data were used in the study. These data were sourced from the World Bank and Food and Agricultural Organization (FAO) as well as the Central Bank of Nigeria. Data covered the period from 1961 to 2020. The choice of the period was based on the availability of data.

Analytical Technique

The macroeconomic variables and land specific variable were factored as explanatory variables in the indigenous meat and milk gross production indexes equation in Nigeria. The explanatory variables were selected based on the related works in the literature and availability of trusted data sources. The indigenous meat gross production index equation adopted assumes the following implicit Cobb-Douglas form:

$$MET_t = f(PCI_t, EXC_t, EXP_t, CRE_t, LAS_t, CPI_t) \ldots\ldots (1)$$

where:

MET_t = Indigenous gross meat production index (%) 2014 – 2016 = 100

PCI_t = Gross domestic product per capita (Naira/person) to capture demand shock

EXC_t = Nominal exchange rate (%) to capture the effect of external World

EXP_t = Value of total export of goods and services as a % of GDP

CRE_t = Domestic credit to private sector (% of GDP) as a proxy of credit availability

LAS_t = Land density measures as size of arable land per rural dweller (ha/person)

CPI_t = Consumer price index (%) (2010 = 100) to capture effect of price variability.

Likewise, the milk gross production index equation was specified implicitly in the Cobb-Douglas form as thus:

$$QLSK_t = f(PCI_t, EXC_t, EXP_t, CRE_t, LAS_t, INF_t) \dots (2)$$

where:

MIK_t = Milk gross production index (%) 2014 – 2016 = 100

INF_t = Inflation rate (%) proxy of input price changes

Testing for the short and long runs relationships among series in equation 1 and 2

The Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran and Shin [34] and Pesaran *et al.* [35] was used to investigate the long and the short run relationships among variables specified. The ARDL bound model has three advantages when compared with the Engle and Granger [15] two step method and Johansen and Juselius [26] cointegration method. The ARDL method is applied to deal with series having mixed stationary issues (i.e. mixture of 1(0) and 1(1)). Hence, it relaxes the assumption that all series must be integrated of the same order. The second merit associated with ARDL model is that of being relatively more efficient in the cases involving small and finite sample data sizes. The method produced unbiased estimates of the long-run model [25]. The ARDL model for equation (1) and 2 is expressed as follows:

$$\Delta MET_t = \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta MET_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta PCI_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta EXC_{t-i} + \beta_4 \sum_{i=1}^{n_4} \Delta EXP_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta CRE_{t-i} + \beta_6 \sum_{i=1}^{n_6} \Delta LAS_{t-i} + \beta_7 \sum_{i=1}^{n_7} \Delta CPI_{t-i} + \delta_1 MET_{t-i} + \delta_2 PCI_{t-i} + \delta_3 EXC_{t-i} + \delta_4 EXP_{t-i} + \delta_5 CRE_{t-i} + \delta_6 LAS_{t-i} + \delta_7 CPI_{t-i} + U_t \dots\dots\dots\dots..\dots..(3)$$

For equation 2

$$\Delta MIK_t = \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta MIK_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta PCI_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta EXC_{t-i} + \beta_4 \sum_{i=1}^{n_4} \Delta EXP_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta CRE_{t-i} + \beta_6 \sum_{i=1}^{n_6} \Delta LAS_{t-i} + \beta_7 \sum_{i=1}^{n_7} \Delta INF_{t-i} + \delta_1 MIK_{t-i} + \delta_2 PCI_{t-i} + \delta_3 EXC_{t-i} + \delta_4 EXP_{t-i} + \delta_5 CRE_{t-i} + \delta_6 LAS_{t-i} + \delta_7 INF_{t-i} + U_t \dots\dots\dots\dots..\dots..(4)$$

The specification of the ARDL model was also done for the rest of the variables in equation (1) and (2). The coefficients from β_1 to β_8 represent the short-run coefficients whereas the coefficients from δ_1 to δ_8 represent the long-run coefficients of the ARDL model. Also, β_0 is the drift component, "n" is the maximum lag length while U_t is the stochastic error term. The bounded F-statistic test was used to check the existence of a stable long-run relationship among the variables in the models. For instance, if the calculated F-statistic in equation (3) and (4) are greater than the upper bound critical values, the null hypotheses are rejected implying the existence of co-integration relationship. But if the value of the F-statistic is below the lower bound, the null cannot be rejected, indicating the absence of co-integration. Besides, if the F-statistic value lies within the lower and upper bounds, the results is considered inconclusive [35]. If the bound test shows evidence of co-integration among variables specified, the long and short run (an error correction model (ECM)) equations of the ARDL model are specified as follows;

The ARDL long run model for equation 3:

$$\mathrm{MET_t} = \delta_0 + +\delta_1 \mathrm{MET_{t-i}} + \delta_2 \mathrm{PCI_{t-i}} + \delta_3 \mathrm{EXC_{t-i}} + \delta_4 \mathrm{EXP_{t-i}} + \delta_5 \mathrm{CRE_{t-i}} + \delta_6 \mathrm{LAS_{t-i}} + \delta_7 \mathrm{CPI_{t-i}} + \mathrm{U_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Then the ARDL short run model (ECM model) for equation 3 is stated as thus:

$$\Delta MET_t = \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta MET_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta PCI_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta EXC_{t-i} + \beta_4 \sum_{i=1}^{n_4} \Delta EXP_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta CRE_{t-i} + \beta_6 \sum_{i=1}^{n_6} \Delta LAS_{t-i} + \beta_7 \sum_{i=1}^{n_7} \Delta CPI_{t-i} + +\emptyset ECM_{t-1} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where: Ø is the error correction term and its measures the speed of adjustment towards the long-run equilibrium, and the remaining coefficients provide the short-run dynamics. To access the performance of the estimated model, RESET test, Serial correlation and normality of the residuals tests were conducted, whereas the cumulative sum squared (CUSUM) test was conducted to verify the stability nature of the model.

RESULTS AND DISCUSSIONS

Descriptive Statistics

The summary of the descriptive statistics of the variables used in the study are presented in Table 1. The coefficient of variability and skewness in the indigenous meat gross production index and milk gross production index are 51% and 35% respectively. This means that, there was more fluctuations in annual meat production compared to annual milk production in the country. Both variables showed positive insignificant skewness and marginal exponential growth rates in the specified period.

The average land density per rural dweller stood at 0.46ha with a 26.00% coefficient of variability and exponential growth rate of 0.93% per annum. The finding revealed that agricultural land expansion grew at a rate below unity per annum. This means that the continuous increase of the rural population will restricts agricultural land expansion in the future. The descriptive statistics for the nominal exchange rate (EXC), per capita income (PCI) and consumer price index (CPI) showed explosive coefficients of variability and exponential growth rates respectively.

Table 1. Descriptive Statistics of Variables Used in the Estimated Models

Varia bles	Mean	Std. deviation	CV	Skewn ess	Exponentia l growth rate (%)
MET	58.34	29.72	0.51	0.079	0.11
MIK	65.18	22.72	0.35	0.152	0.06
PCI	1.3+05	2.1+05	1.63	1.554	18.46
EXC	66.54	92.21	1.39	1.316	13.51
EXP	17.60	7.85	0.45	0.246	1.25
CRE	8.53	3.26	0.38	1.353	1.35
LAS	0.46	0.12	0.26	0.944	0.93
CPI	44.22	70.93	1.60	1.779	16.67
INF	16.16	15.10	0.93	2.078	1.51

Source: Computed by authors, data from the FAO and World Bank, 2020.

This means that, these variables were so unstable during the period specified in the study. The inflation rate also showed a high degree of variability, but grew exponentially at the rate of 1.51% per annum. The value of export (EXP) skewed to the right hand side and has a variability rate of about 45% and the annual exponential growth rate of 1.25%.

Unit root test

The study employed ADF and ADF-GLS unit root tests to confirm the unit root of the specified variables. The results are presented in Table 2. The results revealed that, inflation rate (INF) and domestic credit (CRE) were stationary at levels; while the rest of the variables were stationary at the first difference. Since we have a mixture of variables that are 1(0) and 1(1), it implies that the ARDL model is most appropriate to test the co-integration in the specified models. Before estimating the ARDL model, the optimal lag lengths for the series were determined by using the Akaike Information Criterion (AIC), Schwarz and Bayesian Criterion (SBC). The F-statistics computed for the selected equations are presented at the upper portion of Table 3.

Table 2. ADF and ADF-GLS unit root tests on variables used in the specified equations

Variable	ADF (constant and trend)			ADF-GLS (constant and trend)		
	Level	**1st Diff.**	**Decision**	**Level**	**1st Diff.**	**Decision**
MET	-1.478	-9.524***	1(1)	-1.631	-9.524***	1(1)
MIK	-2.785	-9.924***	1(1)	-1.892	-9.027***	1(1)
PCI	-2.041	-6.271***	1(1)	-1.588	-6.299***	1(1)
EXC	-1.883	-5.950***	1(1)	-1.248	-6.039***	1(1)
EXP	-3.014	-9.269***	1(1)	-2.412	-9.099***	1(1)
CRE	-3.431*	-	1(0)	-1.432	-4.544***	1(1)
LAS	-1.636	-7.770***	1(1)	-1.653	-7.850***	1(1)
CPI	-1.976	-3.541**	1(1)	-1.084	-3.551**	1(1)
INF	-4.261***	-	1(0)	-4.333***	-	1(0)
	Critical values					
1%	-4.124	-4.127		-3.58	-3.739	
5%	-3.489	-3.490		-3.03	-3.164	
10%	-3.173	-3.174		-2.74	-2.866	

Source: computed by authors. Note: ***, ** and * indicate 1%, 5% and 1% significance levels respectively. Note, the variables are stated in natural logarithm form.

The Results of the F-statistics for equation 3 and 4 revealed that cointegration exist among the variables specified. The F-statistics calculated for these equations were greater than the tabulate upper bound critical value at 10% and 5% levels of significance. The findings imply that, the long run equilibrium equations exist for equations 3 and 4 and the short run models can be generated from these equations.

Table 3. ARDL Bound Test

Equations	F-Statistic		Decision
F_{MET}(MET │PCI, EXC, EXP, CRE, LAS, CPI)	9.4819		Co-integration
F_{MIK}(MIK │PCI, EXC, EXP, CRE, LAS, INF)	4.2457		Co-integration
Critical Values Bound (at K = 6 and n = 60)			
	Lower	Upper	
10%	2.114	3.153	
5%	2.456	3.598	
1%	3.293	4.615	

Source: computed by authors using Eviews 10 and data as described in equation 1 and 2. Critical values are derived from Narayan, (2005). Note, variables are stated in natural logarithm form.

Following the establishment of the co-integration for the specified equations, Table 4 presents the long run coefficients for the ARDL model for equation 3 (indigenous meat gross production Index equation).

The Long- run Coefficients of ARDL for Indigenous meat gross production Index equation

The results revealed that, the per capita income (PCI) has a positive and significant (at 1%) impact on the indigenous meat gross production index. This means that, one percent increase in the per capita income will lead to 0.236 percent increase in the indigenous meat gross production index. The result satisfies *a priori* expectation, because increase in the PCI increases the purchasing power of the citizen thereby stimulating aggregate demand. When demand increases, farmers would have incentives to produce more meat resulting in the increased in the total meat production. The result is similar to the reports submitted by Akpan *et al.,* [11], Enu & Attah-Obeng, [16], Akpan *et al.,* [9], Akpan and Patrick [6], and recently by FAO, [22, 18, 23].

The coefficient of land density is negative and has a significant (at 10%) effect on the indigenous meat gross production index in the country. A unit increase in the land density would lead to about 0.245 increase in the indigenous meat gross production index in the long run. The result may be partly due to the opportunity cost of land. Farmers may decide to go for alternative land use following the magnitude of returns from competing enterprises. Also, meat production requires special facilities and not really relied on large land size.

Table 4. The Long- run Coefficients for Indigenous meat gross production Index equation

Var.	Coeff.	Std. error	t-value	Prob.
Const.	1.797	0.539	3.33**	0.001
PCI	0.236	0.069	3.38***	0.001
EXC	−0.091	0.045	−2.01**	0.049
EXP	0.032	0.036	0.88	0.385
CRE	−0.042	0.059	−0.69	0.491
LAS	−0.245	0.141	−1.74*	0.087
CPI	0.003	0.086	0.04	0.971

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are specified in natural logarithm form.

The slope coefficient of the nominal exchange rate shows a significant negative effect (at the 5% level of significance) on the indigenous meat gross production index in the long run. This means that, an increase in the nominal exchange rate decreases the indigenous meat gross production index by 0.0907 units in the country. It is a fact that a good proportion of goats, sheep and cattle consumed in Nigeria are imported from the neighbouring countries of Niger, Sudan and Chad. Hence, the international trade on livestock depends on the strength of our local currency. It implies that, the stronger the international currency, the smaller the volume of trade across the boarder and this would have a negative impact on the overall meat production volume in the country. The finding corroborates Muftaudeen and Hussainatu [30] and Saleh *et al.,* [37], but is contrary to Ewubare and Iyabode [17].

The Error Correction Model of the ARDL for Indigenous meat gross production Index equation

The result in Table 5 contains the error correction representation of the ARDL model for equation 3. The coefficient of the error correction term is negative and statistically significant at 1% level, which implies the existence of a stable long run relationship among the variables included in the ARDL model for the indigenous meat gross production index. It indicates that about 20.37% of the short-run disequilibrium is adjusted towards its long-run equilibrium annually. The diagnostic test for the ECM model revealed R^2 value of 0.4913 which means that the specified explanatory time series explained about 49.13% of the adjusted total variations in the indigenous meat gross production index.

Table 5. The short - run coefficients for indigenous meat gross production Index equation

Variable	Coeff.	Std. error	t-value	Prob.
Const.	0.024	0.016	1.567	0.124
ΔMETt -1	−0.061	0.152	−0.401	0.691
ΔPCIt-1	0.174	0.052	3.33***	0.002
ΔEXCt	−0.034	0.035	−0.97	0.339
ΔEXPt-1	0.021	0.021	1.00	0.322
ΔCREt-1	0.169	0.051	3.33***	0.002
ΔCREt-2	0.056	0.029	1.86*	0.070
ΔLASt	0.489	0.130	3.76***	0.001
ΔLASt-2	−0.362	0.124	−2.92***	0.006
ΔCPIt-2	−0.094	0.073	−1.28	0.209
ECMt-1	−0.204	0.064	−3.18***	0.003
Diagnostic Test				
R-Squared	**0.49**	Durbin-Watson		**2.1546**
F(9, 46)	**9.22*** **	Normality of residual		**10.0*** **
RESET test	**3.73***	CUSUM test for parameter stability		**-10.5*** **
Breusch-Pagan test	**17. 8*** **	LM test for autocorrelation (1)		**0.93**

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are stated in natural logarithm form.

The F-statistic of 9.2156 is significant at 1% probability level, indicating that the R^2 is significant and this implies that the equation has goodness of fit. The Durbin-Watson value of 2.154 indicate a mild serial correlation. According to Laurenceson and Chai, [28], it is shown that the presence of autocorrelation does not negatively affected the ECM estimates. Therefore, the presence of autocorrelation does not affect the estimates. Also, the RESET test is significant which confirms the structural rigidity of the estimated model. The residual is normally distributed and this justified the used of OLS estimation method. The CUSUM test is significant, indicating that, the estimated model is stable. As shown in Figure 3, the CUSUM of recursive residuals remains within the 5 per cent critical bounds, which indicate that the model is stable. The Breusch-Pagan test shows no evidence of heteroscedasticity.

The empirical result revealed that, the current value of the per capita income has a significant positive relationship with the indigenous meat agricultural gross production index in the short run period. It means that, a unit increase in the PCI would lead to about 0.1738 units increase in the indigenous meat gross production index in the country. The finding suggests the importance of consumers' income in the aggregate volume of meat produce in the country. The result agrees with Akpan *et al.,* [11], Enu & Attah-Obeng, [16], Akpan *et al.,* [9], Akpan and Patrick [6], FAO, [22, 18, 23].

The short run coefficients of the current and the last two-year value of land density of farmers has a positive and negative significant effect on the indigenous meat gross production index at 1% level respectively. As previously noticed, the result could be linked to the opportunity cost of farmers' land in the short run.

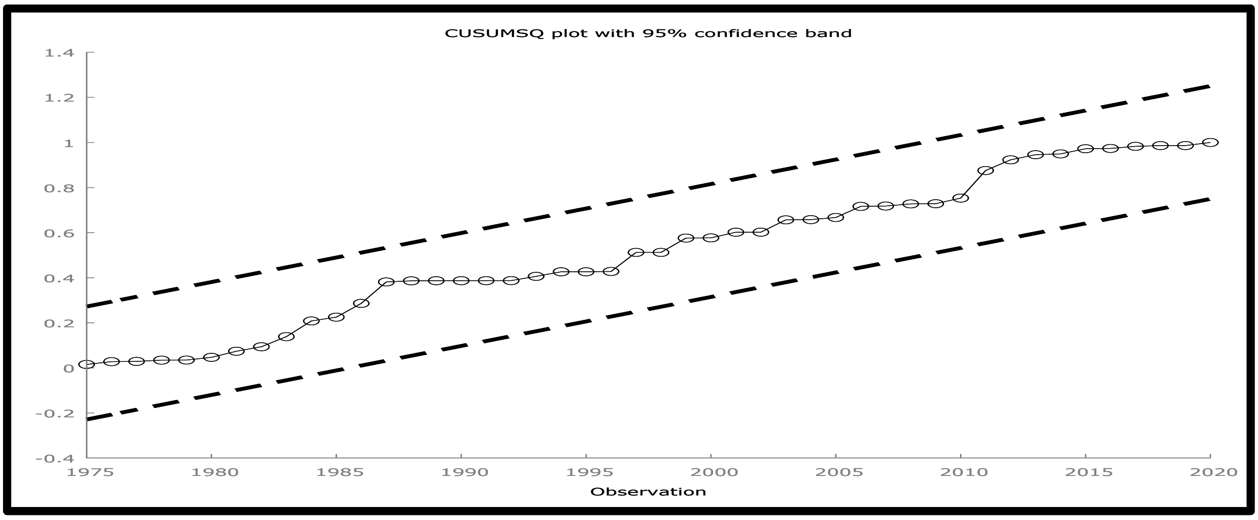

Fig. 3. The Cumulative sum of recursive residuals plot
Source: Plotted by authors using gretl, and data from the result of analysis.

The coefficients of the previous year's credit exhibited significant positive relationships with the indigenous meat gross production index in the country. For instance, about 0.1697 and 0.0555 units' increase would occur in the indigenous meat gross production index for a unit increase in the previous one year and two years' values of credit disbursed to the economy respectively. The finding indicates the importance of credit to the meat processing industry in Nigeria. Credit is always seen a stimulant to production by facilitating the acquisition of other factors of production. The finding upholds the reports of Ewubare and Iyabode [17].

The Long and short runs estimate of ARDL for milk gross production Index equation

The long run model for milk gross production index equation is presented in Table 6. The result revealed that the per capita income (PCI), the volume of exports (EXP) and inflation rate (INF) have positive and significant long run relationship with the milk gross production in the country. A unit increase in (PCI), (EXP) and (INF) would lead to 0.1593 units, 0.0523 units and 0.0294 units increase in the milk gross production index respectively.

The increase in the per capita income implies increase in the purchasing power per capita and the corresponding increase in the market demand of milk. The sustained increase in demand for milk would probably stimulate production, increase farm income and increase the overall well-being of the country's milk producers. The finding is in line with the report of Enu & Attah-Obeng, [17], FAO, [22, 18, 23].

Similarly, increase in export will create alternative opportunities for milk farmers to earn more revenue through stimulation of production. Farmers are rational and will therefore respond to alternative opportunities that yield higher income, such as export market by increasing production.

Table 6. The Long-run Coefficients for milk gross production index equation

Var.	Coeff.	Std. error	t-value	Prob.
Const.	2.602	0.133	19.61***	0.000
PCI	0.159	0.024	6.67***	0.000
EXC	−0.073	0.027	−2.71***	0.009
EXP	0.052	0.026	2.03**	0.047
CRE	0.009	0.043	0.23	0.819
LAS	−0.018	0.098	−0.19	0.853
INF	0.029	0.014	2.07**	0.043

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The result with respect to the inflation rate could be explained by the fact that, increase in inflation rate is always associated with the increase in prices of goods in the country. Premised on this fact, milk farmers will utilize the opportunity of any price increase to boost meat production in order to increase farm income. The finding verifies the submissions of Akpan *et al.,* [3] and Simo-Kengne *et al.,* [38].

On the other hand, a 10% increase in the nominal exchange rate would lead to 0.729 units decrease in the milk gross production index. The literature as previously stated has provided evidence that about 60% of the milk consumed in the country is imported. Hence the increase in the nominal exchange rate (devaluation of Naira) would constrain importation of dairy cows from the neighbouring countries thereby reducing aggregate milk production in the country. The finding is supported by the empirical results of Muftaudeen and Hussainatu [30], Kadir and Tunggal [27]) and Saleh *et al.,* [37].

The results of the ECM estimates for the milk gross production index are presented in Table 7. The diagnostic statistics revealed that the estimates were best, efficient and adequate. The F-test, Breusch-Pagan test, RESET test and normality test as well as CUSUM test showed that the ECM has goodness of fit, no heteroscedasticity, have structural rigidity, justified the used of the OLS estimation method and is stable within the time horizon of the data set. The coefficient of the error correction term is negative and statistically significant. It indicates that 23.86 per cent of the short-run disequilibrium is adjusted towards its long-run equilibrium annually.

The short run model revealed that the current value of PCI has a significant positive relationship with the milk gross production index in the country. That is, a unit increase in the PCI will result at 0.0381 units increase in the milk gross production index. The reasons are similar to that of the meat gross production index. Enu & Attah-Obeng, [16], FAO, [22, 18, 23], have reported similar result.

The slope coefficient of the exchange rate shows a significant positive effect (at the 10% level of significance) on the milk gross production index in the short run. The likely reason for the result could be that the increase in the nominal exchange rate (N/$) would constrain importation by depreciating the domestic currency (N) against appreciating US dollar. The reduced importation would likely decrease unhealthy competition in the domestic market and instead creates incentives for milk farmers to increase production. The result is supported by the finding of Enu & Attah-Obeng, [16], however it contradicts the report of Ewubare and Iyabode [17].

Credit to the economy has a negative impact on the growth of milk gross production at 10% level of significance in the short run. This means that, credit has not played a significant role in the development of the milk sub sector. The result seems reasonable because the bulk of the domestic milk production is carried out by the nomadic pastoralists who have little or no need for credit and produced mostly in subsistence level using traditional tools. Also, credit to the agricultural sector from the conventional banks has always been a serious issue due to risk inherent in the sector.

The last two-year coefficient of land intensity is negative and significant at 10% probability level. This implies that, as the milk farmers' land holding increase, less output of milk will be produced. We suggest the opportunity cost of land as the major factor inducing this relationship. With increase in land holding, milk farmers may diversify occupation to high yielding ventures.

Table 7. The Short-run Coefficients for milk gross production index equation

Variable	Coeff	Std. error	t-value	Prob.
Constant	0.015	0.011	1.416	0.164
ΔMIKt-1	−0.166	0.137	−1.217	0.229
ΔPCIt	0.038	0.018	2.165**	0.040
ΔEXCt	0.039	0.021	1.845*	0.071
ΔEXPt-1	0.033	0.017	2.022**	0.049
ΔCREt-1	−0.069	0.037	−1.895*	0.064
ΔLANt	0.071	0.049	1.424	0.161
ΔLANt-2	−0.187	0.099	−1.881*	0.066
ΔINFt	0.013	0.010	1.280	0.207
ΔINFt-2	0.011	0.005	1.963*	0.056
ECMt-1	−0.239	0.103	−2.328**	0.024
Diagnostic Test				
R-Squared	0.58	Durbin-Watson		1.86
F(9, 46)	6.02***	Normality of residual		11.19***
RESET test	5.56***	CUSUM test for parameter stability		-10.62***
Breusch-Pagan test	17.04***	LM test for autocorrelation (1)		1.06

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The short run coefficient of the previous export is positive and significant at 5% significance level. This implies that, as total value of export increases by a unit in a short run, the milk gross production index increases by 0.033 units.

The result satisfies *a priori* expectation, because increase in activities in the export market would induce domestic competition that will lead to increase in production. The finding corroborates Kadir and Tunggal [27] and Simo-Kengne *et al.*, [38].

The result also revealed that the inflation rate has a positive significant relationship with the milk gross production index. A unit increase in the INF would lead to a 0.0106 units increase in the milk gross production index. Akpan *et al.*, [3] and Simo-Kengne *et al.*, [38] have submitted similar results.

CONCLUSIONS

The study has established the relationship between some key macroeconomic variables and meat as well as the milk gross production indicators from the period 1961 to 2020 in Nigeria. The time series data properties were analysed using the Augmented Dickey-Fuller unit root test and improved ADF-GLS unit root test. The result indicated that the specified series have mixed stationarity issue (i.e. I (0) and 1(1)). Grounded on the behaviour of the series, the ARDL model was used to establish the cointegration among series. The existence of cointegrations among series was established and the long and short runs coefficients of the specified meat and milk production indicator equations were generated. The error terms from the short run models have appropriate signs and were statistically significant at the conventional probability levels. This entails that, some key macroeconomic fundamentals in Nigeria's economy interact in each period to re-establish the long-run equilibrium in meat and milk gross production indices equations following the short-run random disturbances.

The empirical findings revealed that real GDP per capita, nominal exchange rate and land density are significant determinants of the long-term gross meat production index. Besides, the per capita income, credit to the economy and land density were identified as the short run determinants of meat gross production index in the country. Also, the per capita income, nominal exchange rate, export and inflation rate influence the milk gross production index in the long run; whereas the per capita income, land density, credit to the economy, the value of export and nominal exchange rate had a short run impact.

The study established the fact that, variations in some key macroeconomic fundamentals transmit mixed effects to the meat and milk sub sector production indicators in the short and long run periods. It is also established that, the per capita income is the most important factor that influence the production of meat and milk in Nigeria. The findings further suggest that, the country needs specific policy intervention in order to help boost meat and milk production in the country. Such policy should target improvement of the per capita income of Nigerians, regulation of trade policy that will favour export driven market or reduction in the excessive importation of foods in order to protect domestic agro-enterprises. Appropriate measures to reduce or stabilize the rate of inflation in the country are inevitable and adequate credit to agriculture is strongly recommended.

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AGRICULTURAL PRODUCTION INDICATORS AND THE DYNAMIC MACROECONOMIC VARIABLES IN NIGERIA: ARDL MODEL APPROACH

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Abstract

The study established the empirical relationship between agricultural production indicators and some key macroeconomic fundamentals in Nigeria. Data (time series from 1961 to 2020) were collected from the World Bank, Food and Agricultural Organization and the Central Bank of Nigeria. The properties of the series were tested with the Augmented Dickey-Fuller unit root test and improved ADF-GLS unit root test. The Autoregressive Distributed Lag Model (ARDL) was used to establish the existence of the cointegration among the specified series. The empirical results revealed that, the per capita real GDP, land density and consumer price index are the determinants of crop production gross index in the long run, whereas, per capita income, lending rate, land density and total import are the short run determinants. Also, the per capita income, land density, consumer price index and the nominal exchange rate influence the agricultural gross production index in the long run; while the per capita income and land density were the short run determinants. Moreover, land density, per capita income and balance of trade were found to determine the livestock gross production index in the long run; while the lending rate, land density and inflation rate were the short run determinants. Based on the findings, it is recommended that, specific policy to focus on the improvement of the per capita income, restricted trade policy and reduction and or stabilization of inflation rate in the country are inevitable. The lending interest rate should be regulated to provide more credit to the agricultural sector.

***Key words**: agriculture, production, macroeconomic, crop, Nigeria*

INTRODUCTION

Agricultural sector in Nigeria is still developing and is being dominated by the small scale producers. The sector has benefitted from a myriad of government policies, incentives and programs all geared towards improving the efficiency of the sector [24]. Before the advent of crude oil exploitation in Nigeria, the agricultural sector played pivotal roles in the economy in terms of contributing a lion share to the country’s GDP, employment generation and stimulation of primary agricultural product exports [13]. The sector is likewise known to draw a considerable volume of imports, thereby making up as a catalyst for international trade [7]. With regard to poverty alleviation, the sector has played an essential role in reducing rural and urban poverty, especially in developing economies [15, 31]. These attributes of the agricultural sector were major features of the country's economy during the 1960s and into the early 1970s. For instance, the country was one of the world's largest producers of some agricultural products, including palm oil, cocoa, rubber and groundnuts among others. During this period, the sector was the main source of foreign currency exchange and played a key role in the development of the country's infrastructures. However, after this era, the agricultural sector has constantly struggled to perform its traditional roles efficiently in the economy. In recent years, Nigeria has been the largest rice importer in sub-Saharan Africa and a major rice importer in the world [45].
The agricultural sector no longer showed its prowess in terms of performing its traditional responsibilities in the economy. Following this deteriorating trend in the performance of the sector, many scholars have delved into the

archives in attempts to uncover the causes of the poor performances of the agricultural sector in Nigeria. Many researchers have identified corrupt governance regimes that have eroded the country's resources for years [27, 36, 20, 34]; some mentioned unsustain farm factor productivity [5, 4, 8, 6]; while others linked the perturbed performances of the sector to negligence and prioritizing the crude oil as the main source of revenue in the country [2, 37]. Still, the contemporary scholars have argued that, instability and unsustainable growth in the key macroeconomic fundamentals are among the major factors causing declines in the performance of the real sectors of the economy [13, 11, 12, 29, 44, 3, 38]. Accordingly, the key macroeconomic fundamentals consist of the fiscal, monetary, exchange rate regimes and trade policies. Several scholars, [13, 32, 7, 35], have through empirical investigations adjudged that the macroeconomic variables to a greater extent, determined production outcomes in the real sectors including agricultural sector and non-real sectors of the economy. Everett *et al.,* [21] and Chirwa and Odhiambo, [14] also maintained that the stability and sustainable growth in the macroeconomic fundamentals depend on the nature of the economic and political environments they exist. From this assertion, it implies that, the stability of the macroeconomic fundamentals or policies are the results of the interplay of all components of economic, political and cultural environments among others. Thus, it can be inferred that, macroeconomic fundamentals combined with other factors to influence variability in the real sector of the economy including the agricultural sector. Premised on the aforementioned fact and for the agricultural sector to play its primary responsibilities in a sustainable way, the economy must be rooted in a sound and stable macroeconomic environment among others [14].

Over the last three decades, outputs from the agriculture sector and other macro-economic variables in the country have been unpredictable. For instance, the agricultural sector outputs have been inconsistent across various economic policy regimes in the country. Growth rates, for major agricultural products between 1962 and 2019, as shown in Table 1, did not follow a regular trend. Each crop component showed wide variation in trend with conspicuous peaks and troughs. As noted by Okuneye and Ayinde [33] Akpan *et al.,* [9] and Akpan *et al.,* [13], the peaks and troughs in the trends of growth rates of crop outputs in the country followed various policy interventions by the federal government which is mostly hinged on the buoyancy of the macroeconomic environment. Similar trends in growth rates for certain key macroeconomic variables were observed in the country, as shown in Table 2.

As noted by Chirwa and Odhiambo [14], Akpan *et al.,* [13] and Akpan *et al.,* [10] agricultural production correlates with macroeconomic variables. In order to empirically establish the true relationship between the agricultural sector's output and some important macroeconomic variables, several researchers have employed varieties of econometric methods at different time horizons to explore the relationships. For instance, Akpan *et al.,* [13] investigated the impact of some macroeconomic variables on the value of agricultural GDP from 1970 to 2010 in Nigeria. The empirical results revealed that in the short and long run periods, the real total exports, external reserves, the inflation rate and external debt had negative influence on agricultural productivity; whereas industry's capacity utilization rate and nominal exchange rate have positive associations. However, the per capita real GDP had a positive influence on the agricultural productivity in the ECM model.

Also, Muftaudeen and Hussainatu [29] investigated the impact of macroeconomic policies on agricultural output specifically on crop production from 1978-2011 in Nigeria. They found that in the long run, agricultural production reacted to changes in government spending, farm credit, inflation rate, interest rate and the exchange rate.

Table 1. Linear growth rates/fluctuations in selected Agricultural Products in Nigeria

Agricultural product	Policy periods and linear growth rates in (%)						Average linear growth rate (%) from 1970 to 2019
	1962 - 1971	**1972 - 1981**	**1982 - 1991**	**1992 – 2001**	**2002-2011**	**2012 - 2019**	
Maize	2.16	5.37	25.92	-1.59	7.04	3.05	7.12
Rice	16.89	18.94	11.98	-0.94	6.42	8.42	10.35
Wheat	2.55	3.35	30.38	2.19	15.50	-9.79	7.96
Millet	2.75	1.59	5.04	3.21	-6.48	8.56	2.24
Yam	11.63	-5.11	15.33	4.58	3.22	5.75	5.90
Cassava	2.33	1.95	9.69	2.18	4.12	3.46	3.97

Source: Computed by authors, data from the FAO and World Bank, 2020.

Furthermore, Akpan and Patrick [7] modelled palm oil, palm kernel and rubber annual output equations from 1962 to 2013 in Nigeria. The empirical results revealed that, per capita GDP, industrial capacity utilization, lending interest rate and kilowatts per capita of electricity influenced the output of palm oil, palm kernel and rubber in the long run; whereas, per capita GDP was significant variable in the short run.

Table 2. Linear growth rates/fluctuations in selected Macroeconomic variables in Nigeria

Macroeconomic variable	**Policy periods**						**Average linear growth rate from 1970 to 2019**
	1962 - 1971	1972 - 1981	1982 - 1991	1992 – 2001	2002-2011	2012 - 2019	
Inflation rate	-219.13	30.58	49.80	32.82	2.634	4.47	-17.19
Exchange rate	-0.02	-1.24	37.19	44.27	3.67	9.57	15.78
Per capita income	12.59	32.04	12.96	28.40	19.79	8.16	19.37
GDP (naira)	15.09	35.72	15.92	31.65	22.96	11.05	22.44
Value of import	11.86	27.80	27.73	46.80	26.03	12.41	25.89

Source: Computed by authors, data from the FAO and World Bank, 2020.

As well, Adekunle and Ndukwe [1] using data set from 1981 to 2016 showed that, there was no significant long-run relationship between the real exchange rate and agricultural output in Nigeria. The finding, however, revealed significant drivers of agricultural output in Nigeria to include; industrial capacity utilization rate and government expenditure on agriculture. In a related research, Osuji *et al.,* [38], examined the effect of macro-economic variables on the national food security proxy by the expenditure on food production in Nigeria. Using the ARDL, the finding revealed that in the long run, interest and inflation rates had a negative effect on food security, while government expenditure and money supply responded positively. The result further revealed, that in the short run, interest and inflation rates reacted negatively to food security while net export, government expenditure and money supply showed positive impact. In addition, Ewubare and Iyabode [22] established a positive relationship between agricultural output and agricultural credit as well as exchange rate in Nigeria.

Elsewhere in Ghana, Enu & Attah-Obeng [19] found the real exchange rate, labor force and real GDP per capita as significant determinants of agricultural production. Also, in Malaysia, Kadir and Tunggal [26] employed the Autoregressive-Distributed Lag (ARDL) approach to investigate the impact of macroeconomic variables on agricultural productivity from the period 1980 to 2014. The empirical findings revealed that, in the long run the nominal exchange rate had a significant negative relationship with agricultural productivity. In the short run, the country's net export and government expenditure showed negative correlations with agricultural productivity while interest rate responded positively. Besides, Muraya [30] in Kenya identified the macroeconomic variables that determined agricultural productivity from 1980 to 2013 period. Using the Johansen-Granger cointegration procedures, the result showed that, in the long run, the exchange rate and inflation had negative correlations with the agricultural productivity, while labor force, rainfall, and government expenditure had positive impacts. In the short run, labour, rainfall, and government expenditure were the major determinants of agricultural productivity in the country. Similarly, Shita *et al.,* [41] determined factors affecting agricultural productivity in Ethiopia for the period of 1990–2016 by using autoregressive distributed lag (ARDL) model. The results revealed that cereal productivity was positively influenced by the use of fertilizers and real gross domestic product (GDP) both in the long run and in the short run. While the size of arable land influences productivity positively in the long run; its short-run effect was found to be negative. Later, Shita *et al.,* [42] investigated the impact of technology adoption on agricultural productivity by using Autoregressive Distributed Lag (ARDL) approach for the period of 1990-2016. The result revealed that, technology adoption (captured as fertilizer consumption) and real GDP affects agricultural productivity positively and significantly both in the long-run and short-run. Also, area of arable land affected agricultural productivity positively in the long run but negatively in the short-run.

From the literature reviewed, it is observed that most researchers used aggregated measure of productivity to proxy agricultural sector production. The agricultural sector consists of sub- sectors that need specific policy interventions. Hence, there is an overwhelming need to disaggregate sectoral productivity indices to sub-sectoral indices in order to derive specific policy recommendations. Also, for the last two decades a lot has happened in the Nigeria's macroeconomic environment and the country is swallowed deeper in the scourge of poverty and urgently need proactive policy interventions based on the current realities. Therefore, there is need to update the available information on this topical issue. The study, therefore, sought to establish the empirical relationship between agricultural production indicators and some key macroeconomic fundamentals in Nigeria.

Materials and methods

Study Area

The study was conducted in Nigeria. The country is situated on the Gulf of Guinea in the sub-Saharan Africa. It lies between 4^0 and 14^0 north of the equator and between longitude 3^0 and 15^0 east of the Greenwich. The country has a total land area of about 923,769km^2 (or about 98.3 million hectares) with 853km of coastline along the northern edge of the Gulf of Guinea and a population of around two hundred (200) million [43]. The country is gifted with significant agricultural, mineral, marine and forest resources. Its multiple vegetation zones, abundant rainfall, surface and groundwater, and moderate climate extremes enable the production of a variety of food, tree and commercial crops. Over 60 per cent of the population is involved in the production of the food crops such as cassava, maize, rice, yams, various beans and legumes, soya, sorghum, ginger, onions, tomatoes, melons and vegetable. Also, fishery, aquaculture and livestock production such as poultry, goat, sheep, pigs and cattle flourished very well in all regions of the country. The main cash crops are cocoa, cotton, groundnuts, palm oil and rubber.

Data Source

Secondary data were used to conduct the study**.** These data were sourced from the World Bank and Food and Agricultural Organization (FAO) as well as the Central Bank of Nigeria. Data covered the period from 1961 to 2019. The choice of the period was based on the availability of data.

Analytical Technique

To identify the nature of the relationship between agricultural productivity indicators and some macroeconomic variables and other relevant variables in Nigeria, three agricultural productivity equations were specified in implicit forms. The explanatory variables were selected based on the related works in the literature and availability of trusted data sources. The agricultural productivity function adopted assumes the following implicit form expressed in the Cobb-Douglas form as thus:

$$\mathbf{AGP_t} = f(RGP_t, PCI_t, LAS_t, INF_t, EXC_t) \ldots\ldots (1)$$

where:

$\mathbf{AGP_t}$ = Agricultural gross production index in time t (2014 – 2016 = 100) in (%)

$\mathbf{RGP_t}$ = Real gross domestic product in naira (at current market prices) to represent economy growth in time t
$\mathbf{PCI_t}$ = Gross domestic product per capita (Naira/person) to capture demand shock
$\mathbf{LAS_t}$ = Land density measures as size of arable land per rural dweller (ha/person)
$\mathbf{INF_t}$ = Inflation rate (%) proxy of input price changes
$\mathbf{EXC_t}$ = Nominal exchange rate (%) to capture the effect of external World

To further investigate the effect of the macroeconomic variables and other related variables on the sub-sector productivity, the following equations were implicitly specified in Cobb-Douglas form and estimated:

$$\mathbf{CRP_t} = \mathrm{f}(\mathrm{PCI_t}, \mathrm{LEN_t}, \mathrm{LAS_t}, \mathrm{CPI_t}, \mathrm{IMP_t}) \ldots\ldots (2)$$

where:
$\mathbf{CRP_t}$ = Crop gross productivity index 2014 – 2016 = 100 in (%),
$\mathbf{LEN_t}$ = Lending rate (%) to capture credit availability to the economy
$\mathbf{PCI_t}$ = Gross domestic product per capita (Naira/person) to capture demand shock
$\mathbf{IMP_t}$ = Value of total import of goods and services as a % of GDP
$\mathbf{CPI_t}$ = Consumer price index (%) (2010 = 100)

Also, the livestock gross production index was specified as thus:

$$\mathbf{LSK_t} = \mathrm{f}(\mathrm{LEN_t}, \mathrm{LAS_t}, \mathrm{PCI_t}, \mathrm{INF_t}, \mathrm{BOT_t}) \ldots (3)$$

Where,
$\mathbf{LSK_t}$ = Livestock gross productivity index 2014 – 2016 = 100 in (%),
$\mathbf{BOT_t}$ = Annual balance of trade, the ratio of the total value of exports to imports in time t.

Testing the short and long runs relationship between Agricultural production indicator and Macroeconomic variables

The Autoregressive Distributed Lag (ARDL) bound test approach developed by Pesaran and Shin [39] and Pesaran *et al.,* [40] was used to investigate the long and the short run relationship between agricultural productivity indicators and the explanatory variables. The ARDL bound model has three advantages when compared with the Engle and Granger [18] two step method and Johansen and Juselius [25] cointegration method. The ARDL method is applied to deal with series having mixed stationary issues (i.e. mixture of 1(0) and 1(1)). Hence, it relaxes the assumption that all series must be integrated of the same order. The next advantage is that the ARDL test is relatively more efficient in the case of small and finite sample data sizes. The method produced unbiased estimates of the long-run model [23].

The ARDL model for equation (1) in logarithm form is expressed as follows:

$$\begin{aligned}\Delta \boldsymbol{AGP_t} = {} & \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta AGP_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta RGP_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta PCI_{t-i} \\ & + \beta_4 \sum_{i=1}^{n_4} \Delta LAS_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta INF_{t-i} \\ & + \beta_6 \sum_{i=1}^{n_6} \Delta EXC_{t-i} + \delta_1 AGP_{t-i} + \delta_2 RGP_{t-i} \\ & + \delta_3 PCI_{t-i} + \delta_4 LAS_{t-i} + \delta_5 INF_{t-i} \\ & + \delta_6 EXC_{t-i} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)\end{aligned}$$

$$\begin{aligned}\Delta \boldsymbol{RGP_t} = {} & \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta RGP_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta AGP_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta PCI_{t-i} \\ & + \beta_4 \sum_{i=1}^{n_4} \Delta LAS_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta INF_{t-i} \\ & + \beta_6 \sum_{i=1}^{n_6} \Delta EXC_{t-i} + \delta_1 RGP_{t-i} + \delta_2 AGP_{t-i} \\ & + \delta_3 PCI_{t-i} + \delta_4 LAS_{t-i} + \delta_5 INF_{t-i} \\ & + \delta_6 EXC_{t-i} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)\end{aligned}$$

The specification of the ARDL model was also applied to the rest of the variables in equation (1), equation (2) and equation (3). The variables are as defined in equation (1), (2) and (3). The coefficients from β_1 to β_6 represent the short-run coefficients whereas the coefficients from δ_1 to δ_6 represent the long-run coefficients of the ARDL model. Also, β_0 is the drift component, "n" is the maximum lag length while U_t is the stochastic error term. The bounded F-statistic test was used to check the existence of a stable long-run relationship among the variables in the models. For instance, if the calculated F-statistic in equation (4) is greater than the appropriate upper bound critical values, the null hypothesis is rejected implying the existence of co-integration relationship. But if the value of the F-statistic is below the lower bound, the null cannot be rejected, indicating the absence of co-integration. Besides, if the F-statistic value lies within the lower and upper bounds, the results is considered inconclusive [40].

If the bound test shows evidence of co-integration among variables specified for example as in equation 4, the long and the short run (an error correction model (ECM)) are specified as follows; The long run model:

$$AGP_t = \delta_0 + \delta_1 \sum_{i=1}^{q_1} RGP_{t-i} + \delta_2 \sum_{i=1}^{q_2} PCI_{t-i} + + \delta_3 \sum_{i=1}^{q_3} LAS_{t-i} + \delta_4 \sum_{i=1}^{q_4} INF_{t-i} + + \delta_5 \sum_{i=1}^{q_5} EXC_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The short run model (ECM model):

$$\Delta AGP_t = \beta_0 + \beta_1 \sum_{i=1}^{n_1} \Delta AGP_{t-1} + \beta_2 \sum_{i=1}^{n_2} \Delta RGP_{t-i} + \beta_3 \sum_{i=1}^{n_3} \Delta PCI_{t-i} + \beta_4 \sum_{i=1}^{n_4} \Delta LAS_{t-i} + \beta_5 \sum_{i=1}^{n_5} \Delta\Delta INF_{t-i} + \beta_6 \sum_{i=1}^{n_6} \Delta EXC_{t-i} + \emptyset ECM_{t-1} + U_t \ldots\ldots\ldots\ldots (7)$$

where: Ø is the error correction term and its measures the speed of adjustment towards the long-run equilibrium, and the remaining coefficients provide the short-run dynamics. To access the performance of the estimated model, RESET test, Serial correlation and normality of the residuals tests were conducted, whereas the cumulative sum (CUSUM) test was conducted to verify the stability nature of the model.

RESULTS AND DISCUSSIONS

The descriptive Statistics

The descriptive statistics of the variables used in the study are presented in Table 3. The coefficient of variability and skewness in the agricultural gross production index, crop gross production index and livestock gross production index revolved around the 50 % mark respectively. This implies that, these variables had average fluctuations over the specified period and concentrated more on the right-hand side of the normal distribution curve. Moreover, the exponential growth rates of these variables are around 3.0% per year, which means that all specified indicators have steadily increased at nearly the same annual growth rate.

Table 3**.** Descriptive Statistics of Variables Used in the Estimated Models

Variables	Minimum value	Maximum	Mean	Std. deviation	Coefficient of Variation	Skewness	Exponential growth rate (%)
AGP	19.73	103.19	51.28	28.74	0.56	0.45	3.27
CRP	18.76	103.77	49.69	29.01	0.58	0.49	3.36
LSK	15.85	101.36	58.21	29.47	0.51	0.09	3.40
RGP	4.56e+12	6.18e+13	2.58e+13	1.82e+13	0.69	0.71	4.37
LAS	0.28	0.77	0.46	0.12	0.26	0.03	0.93
INF	0.48	72.84	16.24	15.22	0.94	2.05	1.59
EXC	0.55	306.90	62.47	87.40	1.39	1.35	13.51
PCI	69.27	7.25e+5	1.20e+5	2.0e+5	1.66	1.63	18.46
IMP	3.03	23.92	14.41	5.21	0.36	-0.19	0.17
CPI	0.07	267.51	40.66	65.94	1.62	1.86	16.67
LEN	6.00	31.65	14.07	6.42	0.46	0.34	2.27
BOT	0.56	2.83	1.30	0.56	0.43	0.77	11.55

Source: Computed by authors, data from the FAO and World Bank, 2020.

The real GDP showed coefficient of variability of 69% and an exponential growth rate of 4.37% per annum. The skewness of 0.71 in RGDP implies a continuous increase in its annual value over the specified period of time. The average land density per rural dweller stood at 0.46ha with a 26.00% coefficient of variability and exponential growth rate of 0.93% per annum. The finding revealed that agricultural land expansion grew at a rate below unity per annum. This means that the continuous increase of the rural population restricts land expansion. The statistics for the nominal exchange rate (EXC), per capita income (PCI) and consumer price index (CPI) showed explosive coefficients of variability and exponential growth rates respectively. This means that, these variables were so unstable during the period specified in the study. The inflation rate also showed a high degree of variability, but grew exponentially at the rate of 1.59% per annum. The value of imports (IMP) skewed to the left hand side and has a variability rate of about 36% and the annual exponential growth rate of 0.17%.

Unit root test

The study used the ADF test developed by Dickey and Fuller in [16] and ADF-GLS unit root test developed by Elliott, Rothenberg and Stock [17] which is an improvement of the original ADF test to confirm the unit root of the specified variables. The results for both ADF and ADF-GLS unit root tests are presented in Table 4. The results revealed that, inflation rate (INF) and balance of payment (BOT) were stationary at levels; while the rest of the variables were stationary at the first difference. The test equations contain both constant and trend. Since we have a mixture of variables that are 1(0) and 1(1), it implies that the ARDL model can be used to test the co-integration in the specified models. Before estimating the ARDL model, the optimal lag lengths for the series were determined by using the Akaike Information Criterion (AIC), Schwarz and Bayesian Criterion (SBC). The various lag lengths are shown in Table 5. The F-statistics computed for the three selected equations are presented at the upper portion of Table 5. Note, each of the variable in equation 1, 2 and 3 were tested, but the results of equations of our interest are presented for discussion. The Results of the F-statistics for equation 1, 2 and 3 revealed that cointegration exist among the variables specified.

Table 4. ADF and ADF-GLS unit root tests on variables used in the specified equations

Variable	ADF (constant and trend)			ADF-GLS (constant and trend)		
	Level	1st Diff.	Decision	Level	1st Diff.	Decision
AGP	-1.539	-7.961***	1(1)	-1.407	-7.999***	1(1)
CRP	-1.487	-7.894***	1(1)	-1.355	-7.745***	1(1)
LSK	-1.164	-9.627***	1(1)	-1.357	-7.012***	1(1)
RGP	-2.241	-7.007***	1(1)	-2.213	-7.125***	1(1)
LAS	-1.636	-7.770***	1(1)	-1.653	-7.850***	1(1)
INF	-4.261***	-	1(0)	-4.333***	-	1(0)
EXC	-1.883	-5.950***	1(1)	-1.248	-6.039***	1(1)
PCI	-2.041	-6.271***	1(1)	-1.588	-6.299***	1(1)
IMP	-2.229	-7.712***	1(1)	-2.232	-7.639***	1(1)
CPI	-1.976	-3.541**	1(1)	-1.084	-3.551**	1(1)
LEN	-1.157	-7.345***	1(1)	-1.330	-7.425***	1(1)
BOT	-3.304*	-	1(0)	-3.200**	-	1(0)
	Critical values					
1%	-4.124	-4.127		-3.739	-3.58	
5%	-3.489	-3.490		-3.164	-3.03	
10%	-3.173	-3.174		-2.866	-2.74	

Source: computed by authors. Note: ***, ** and * indicate 1%, 5% and 1% significance levels respectively. Note, variables are expressed in natural logarithm.

Table 5. ARDL Bound Test (unrestricted intercept and no trend

Equations	Lag	F-Stat.	Decision
F_{AGP}(AGP │ RGP, PCI, LAS, INF, EXC)	(1,1,1,1,1)	6.89	Co-integration
F_{CRP}(CRP │ PCI, LEN, LAS, CPI, IMP)	(1,1,1,1,1)	7.07	Co-integration
F_{LSK}(LSK │ LEN, LAS, PCI, INF, BOT)	(2,2,2,2,2)	4.44	Co-integration
Critical Values Bound (at K = 5 and n = 59)			
	Lower	Upper	
10%	2.204	3.210	
5%	2.589	3.683	
1%	3.451	4.764	

Source: computed authors using Eviews 10 and data as described in equation 1, 2, and 3. Critical values are derived from Narayan, (2005). Note, variables are expressed in natural logarithm.

The F-statistics calculated for these equations were greater than the tabulate upper bound critical value at 1% level of significance. The findings imply that, the long run equilibrium or stable equations exist for equation 1, 2 and 3 and the short run or the ECM models can be generated from the equations to capture the dynamics in the agricultural production index equations in the short-run and identified the speed of adjustment as a response to departure from the long-run equilibrium. Following the establishment of the co-integration for all the specified equations, Table 6 presents the long run coefficients for the ARDL model for equation 1 (agricultural gross production Index equation).

The Long- run Coefficients of ARDL for Agricultural gross production Index equation

The results revealed that, the per capita income (PCI) has a positive and significant (at 1%) impact on agricultural gross production index. This means that, one percent increase in the per capita income will lead to 0.169 percent increase in the agricultural gross production index. The result satisfies *a priori* expectation, because increase in the PCI increases the purchasing power of the citizen thereby stimulating aggregate demand. When demand increases, farmers would have incentives to produce more resulting in increased in total production. The finding corroborates Akpan and Patrick [7] and Enu & Attah-Obeng, [19].

Table 6. The Long- run Coefficients for Agricultural gross production Index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	4.0805	1.1474	3.556***	0.0008
Real GDP	−0.0521	0.0418	−1.246	0.2181
Per capita income	0.1688	0.0232	7.281***	<0.0001
Land density	0.4013	0.0713	5.628***	<0.0001
Inflation rate	0.0023	0.0079	0.292	0.7715
Nominal exchange rate	0.0551	0.0205	2.691**	0.0095

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The coefficient of land density is positive and has a significant (at 1%) effect on the agricultural gross production index in the country. A unit increase in the land density would lead to about 0.401 increase in the agricultural gross production index in the long run. The result is as expected following the concept of economies of scale. Larger farm size would likely produce higher output compared to the smaller farms. The result is however substantiated by [41, 42] in Ethiopia.

The slope coefficient of the nominal exchange rate shows a significant positive effect (at the 5% level of significance) on agricultural gross production index in the long run. This means that increase in the nominal exchange rate increases the agricultural gross production index in the country. The plausible reason for the result could be connected to the fact that the increase in the nominal exchange rate (N/$) would constrain importation by depreciating the domestic currency (N) against appreciating US dollar. The reduced importation would likely decrease unhealthy competition in the domestic market and instead creates incentives for farmers to increase production. Similar result has been reported by Akpan *et al.,* [13], Muftaudeen and Hussainatu [29] Ewubare and Iyabode [22], but the finding however contradicts the submissions of Kadir and Tunggal [26] in Malaysia, Muraya [30] in Kenya and Adekunle and Ndukwe [1] in Nigeria.

The Error Correction Model of the ARDL for Agricultural gross production Index equation

The result in Table 7 contains the error correction representation of the ARDL model for equation 1. The coefficient of the error correction term is negative and statistically significant at 1% level, which implies the existence of co-integration among the variables included in the ARDL model for agricultural gross production index. It indicates that about 53% of the short-run disequilibrium is adjusted towards its long-run equilibrium annually. The diagnostic test for the ECM model revealed R^2 value of 0.5222 which means that the specified explanatory time series explained about 52.22% of the adjusted total variations in the agricultural gross production index. The F-statistic of 8.341 is significant at 1% probability level, indicating that the R^2 is significant and this implies that the equation has goodness of fit. The Durbin-Watson value of 2.042 indicate almost zero serial correlation. The ECM model has been shown to be robust against residual autocorrelation. Therefore, the presence of autocorrelation does not affect the estimates [28]. Also, the RESET test is significant which confirms the structural rigidity of the estimated model. The residual is normally distributed and this justified the used of OLS estimation method. The CUSUM test is significant, indicating that, the estimated model is stable. The empirical result revealed that, the current level of the per capita income has a significant positive relationship with the agricultural gross production index in the short run period. It means that, a unit increase in the PCI would lead to about 0.143 units increase in the agricultural gross production index in the country. The finding is in line with a *priori* expectation as an increase in demand will stimulate supply or production. The result is similar with the findings of Akpan *et al.,* [13]; Akpan and Patrick [7] and Enu & Attah-Obeng, [19].

Table 7. The Short - run Coefficients for Agricultural gross production Index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	0.01891	0.00957	1.976*	0.0542
ΔAGP_{t-1}	−0.02169	0.16149	−0.134	0.8938
ΔRGP_{t-1}	−0.01689	0.03989	−0.424	0.6738
ΔPCI_{t}	0.14269	0.04268	3.343***	0.0017
ΔPCI_{t-1}	−0.01884	0.03929	−0.479	0.6340
ΔPCI_{t-2}	−0.03729	0.03037	−1.228	0.2256
ΔLAS_{t}	0.37534	0.07286	5.152***	<0.0001
ΔINF_{t-1}	−0.00136	0.00703	−0.193	0.8479
ΔEXC_{t}	0.01280	0.02164	0.592	0.5569
ECM_{t-1}	−0.52555	0.12044	−4.364***	<0.0001
Diagnostic Test				
R-Squared	0.52216	Durbin-Watson		2.04289
F(9, 46)	8.340705***	Normality of residual		8.3236***
RESET test	2.68123*	CUSUM test for parameter stability		10.5132***

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The short run coefficient of the land density of farmers is positive and is significant at 1% level. This means that, increase by one unit of the farmers' land density would result in 0.375 units increase in the agricultural gross production index in the country. Land being one of the major factors of production is critical for agro - business enterprises such as crop and livestock productions. The result is strongly supported by Shita *et al.,* [40] and Shita *et al.,* [41].

The Long and short runs Coefficients of ARDL for Crop gross production Index equation

The long run model for crop gross production index equation is presented in Table 8. The result revealed that per capita income (PCI), land density (LAS) and consumer price index (CPI) have positive and significant coefficients in the estimated long run equation. A unit increase in (PCI), (LAS) and (CPI) would lead to 0.102 units, 0.655 units and 0.120 units increase in crop gross production index respectively. The increase in per capita income and land density are strongly linked to the demand power and economic of scale in production respectively. The result of the consumer price index could be explained by the fact that, increase in CPI is always associated with the increase in prices of goods in the country. Premised on this fact, crop farmers would likely utilize the opportunity of any price increase or hike to boost crop production in order to increase farm income. The results of the ECM estimates for crop gross production index are presented in Table 9. The diagnostic statistics revealed the relevance of the estimates. The values of the F-test, RESET test and normality tests as well as CUSUM test showed that the ECM has goodness of fit, structural rigidity, justified the used of the OLS estimation method and is stable within the time horizon of the data set. The coefficient of the error correction term is negative and statistically significant, which implies the existence of co-integration among the variables used in the model. It indicates that 41.97 per cent of the short-run disequilibrium is adjusted towards its long-run equilibrium annually.

Table 8. The Long run Coefficients for Crop gross production index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	3.0754	0.4636	6.634***	<0.0001
Per capita income	0.1019	0.0483	2.110**	0.0396
Lending rate	0.0295	0.0525	0.5617	0.5767
Land density	0.6548	0.0501	13.07***	<0.0001
Consumer price index	0.1204	0.0569	2.116**	0.0391
Total import	0.0259	0.0305	0.8474	0.4006

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The short run model revealed that the current value of PCI has a significant positive relationship with the crop gross production index in the country. However, the previous year value of PCI impacted negatively on the crop gross production index. That is, a unit change in the previous year value of PCI_{t-1} resulted in the reduction in the crop gross production index. Many factors could be linked to this result; among them is the changing pattern of the GDP, consumer preference and mounting rate of inflation in the country. The finding confirms the earlier reports of Akpan *et al.,* [13], Akpan and Patrick [7] and Enu & Attah-Obeng [19]. The coefficient of the previous year lending rate is positive and significant at the 5% level in the short run. This means that, as the previous year lending rate increases, the current crop gross production index increases too. Credit to the agricultural sector from the conventional banks has always been a serious issue due to risk inherent in the sector. The subsistence nature of agriculture and the biological risks involved in crop production make farmers scramble for few loan opportunities irrespective of the lending rate. However, the finding controverts the assertion of Akpan and Patrick [7]. The result with respect to the land intensity satisfies a *priori* expectation as many scholars have attributed output increase in Nigeria to land expansion instead of productivity. Hence, as the land density increases, farmers have more access to land resource and economic of scale set in, thereby resulting in an upsurge in output. The result is in consonance with the submissions of [40] and Shita *et al.,* [41]. The short run coefficient of import is negative and is significantly related to the crop gross production index in the country. This implies that, as total value of import increases by a unit in a short run, the crop gross production index decreases by 0.041 units. The result satisfies a *priori* expectation, because the increase in import reduces the domestic competition through induce dumping in the domestic economy thereby dampening local production.

Table 9. The Short run Coefficients for Crop gross production index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	0.01575	0.01026	1.535	0.1316
ΔCRP_{t-1}	−0.00856	0.12065	−0.071	0.9437
ΔPCI_t	0.09838	0.04512	2.181**	0.0344
ΔPCI_{t-1}	−0.07168	0.03425	−2.093**	0.0419
ΔLEN_{t-1}	0.10505	0.04886	2.150**	0.0369
ΔLAS_t	0.44357	0.06855	6.471***	<0.0001
ΔCPI_t	0.08202	0.03893	2.107**	0.0406
ΔIMP_t	−0.04052	0.01739	−2.329**	0.0243
ΔIMP_{t-1}	0.02636	0.02030	1.299	0.2006
ECM_{t-1}	−0.41973	0.092199	−4.553***	<0.0001
Diagnostic Test				
R-Squared	0.57046	Adjusted R-squared		0.486413
F(9, 46)	11.610***	Normality of residual		20.19153***
RESET test	9.57614**	CUSUM test for parameter stability		12. 3863***

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The result also revealed that the current consumer price index (CPI) has a positive significant relationship with the crop gross production index. A unit increase in the CPI would lead to a 0.082 units increase in the crop gross production index.

The Long and short runs Coefficients of ARDL for Livestock gross production Index equation

The estimated long run equation for the livestock sub sector is presented in Table 10, the finding revealed that, land density has a significant negative relationship with the livestock gross production index. The finding showed that as the land density increases by a unit, the livestock gross production index decreases by 0.382 units. Some of the possible reasons for this result could be linked to the land use preference of farmers, the nature of investment in terms of the size or capacity of livestock farms and the opportunity cost of land. Nevertheless, the finding is contrary to the reports submitted by Shita *et al.,* [40] and Shita *et al.,* [41].

The coefficient of the per capita income has been consistent across all indicators used in the study. The positive significant relationship between livestock gross production index and the PCI is in line with a *priori* expectations. The effective demand would always stimulate production and ensured increase in farm income. The finding is supported by Akpan *et al.,* [13] and Akpan and Patrick [7], and Enu & Attah-Obeng [19].

The coefficient of balance of trade (BOT) showed a positive significant correlation with the livestock gross production index in the country. A unit increase in the BOT would result in 0.15608 units increase in livestock gross production index in the long run. This implies that, increase in the volume of export would promote increase in production of livestock in the country. The finding also revealed that, activities at the international market significantly influence the domestic production of agricultural commodities.

Table 10. The Long run Coefficients for Livestock gross production index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	2.17487	0.12043	18.06***	<0.0001
Lending rate	0.01157	0.05903	0.1960	0.8453
Land density	−0.38175	0.06992	−5.460***	<0.0001
Per capita income	0.15246	0.00833	18.30***	<0.0001
Inflation rate	0.00689	0.01478	0.4658	0.6432
Balance of trade	0.15608	0.05256	2.970***	0.0045

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The short run coefficients for the livestock gross production index equation are presented in Table 11. The coefficient of the error correction term is negative and statistically significant at 1% level. It shows that, about 27.22% of the short-run disequilibrium is adjusted towards its long-run equilibrium annually. The R-squared explained about 38.72% of the total variations in the livestock gross production index. This however, implies that many factors that influence livestock production were not captured in the model. However, the F-statistic is significant showing that, the estimated R^2 is significant. The RESET test, normality of residual and the CUSUM test all indicate satisfactory results.

The short run model shows that; the last two-year lending interest rate has a negative significant relationship with the current value of the livestock gross production index in the country. The finding revealed the ineffectiveness of the credit system in the country towards the development of the livestock sub sector in Nigeria. Many commercial banks and other financial outfits are reductant at lending to the agricultural sector due to the inherent risks and the predominant small-scale and low-yielding businesses that dominate the sector.

The short run slope coefficient of land density in the current year period and the last two-year periods exhibited positive and negative impacts on the livestock gross production index respectively.

Table 11. The Short run Coefficients for Livestock gross production index equation

Variable	Coefficient	Standard error	t-value	Probability
Constant	0.03266	0.01018	3.208***	0.0024
ΔLSK_{t-1}	−0.05236	0.11566	−0.453	0.6529
ΔLENt-2	−0.09377	0.04815	−1.947*	0.0576
ΔLAS_t	0.27101	0.08737	3.102***	0.0033
ΔLAS_{t-2}	−0.30977	0.08939	−3.465***	0.0012
ΔPCI_t	0.02857	0.03931	0.727	0.4710
$\Delta INFL_t$	0.016201	0.00681	2.379**	0.0216
ΔBOT_t	−0.00114	0.02872	−0.039	0.9684
ΔBOT_{t-1}	−0.00486	0.02365	−0.206	0.8379
ECM_{t-1}	−0.27223	0.07583	−3.590***	0.0008
Diagnostic Test				
R-Squared	0.387177	Adjusted R-squared		0.267277
F(9, 46)	7.6526***	Normality of residual		10.1609***
RESET test	11.0239***	CUSUM test for parameter stability		-2.16683**

Source: computed by authors. Note: ***, and ** indicate 1% and 5% significance level respectively. Note, variables are expressed in natural logarithm.

The result indicates that, the current year land density in the short run has an accelerating influence on the livestock gross production index while the last two previous year relates negatively to the production of livestock in the country. Regarding livestock production in the country (especially cattle), there has been conflicts between the nomadic herdsmen and the landlords (farmers), making it difficult for the parties to have a sustainable land holding agreement. Hence, most communities based on their previous experiences with livestock owners will be reluctant to relinquish their land resources for livestock rearing.

The coefficient of the inflation rate is positive and significant implying that increase in inflation rate would cause marginal increase in livestock production. The plausible reason for this relationship could be explained by the adaptive nature of livestock farmers in the country. That is farmers would likely invest more on livestock production during surging of inflation with the hope of realizing higher income due to high product prices cause by the inflation.

CONCLUSIONS

The study has established the relationship between agricultural sector's production indicators and some key macroeconomic fundamentals from the period 1961 to 2019 in Nigeria. The time series data properties were analysed using the Augmented Dickey-Fuller unit root test and improved ADF-GLS unit root test. The result indicated that the series had mixed stationarity issue (i.e. I (0) and 1(1)). Based on the behaviour of the series, the ARDL model was employed to establish the cointegration among series. The existence of cointegrations among series was established and the long and short runs coefficients of the specified agricultural production indicator equations were generated. The error term from the short run models had appropriate signs and were statistically significant at the conventional probability levels. This implies that, some key macroeconomic fundamentals in Nigeria's economy interact in each period to re-establish the long-run equilibrium in the agricultural production indicator equations following the short-run random disturbances.

The empirical results revealed that, per capita real GDP, land density and consumer price index are the determinants of crop production gross index in the long run, whereas, per capita income, lending rate, land density and total import are the short run determinants. Also, the study identified per capita income, land density, consumer price index and the nominal exchange rate as the long run determinants of agricultural gross production index. The estimated model further revealed per capita income and land density as the short run determinants of agricultural gross production index in the country. Moreover, land density, per capita income and balance of trade were found to determine the livestock gross production index in the long run. Besides, the lending rate, land density and inflation rate determined the livestock gross production index in a short run.

The study established the fact that, fluctuations in some key macroeconomic variables transmit mixed effects to the agricultural sector's production indicators in the short and long run periods. The findings call for the formulation of specific policies to focus on the improvement of the per capita income of the citizenry. Also, the country's trade policy should be developed to curtail the excessive importation while promoting exports in order to protect domestic agro-enterprises. Appropriate policy package to reduce or stabilize inflation rate in the country is inevitable. The lending interest rate should be regulated to favour agricultural sector in line with its peculiar characteristics. The land use act should be reassessed to make land more available to farmers and encourage economies of scale. Finally, the study supports the present deregulation or market determined nominal exchange rate system as this will reduce excessive importation.

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DETERMINANTS OF LABOUR PRODUCTIVITY IN SMALL SCALE WATERLEAF PRODUCTION IN AKWA IBOM STATE, SOUTH-SOUTH REGION OF NIGERIA

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Abstract

The study modelled the labour productivity equation for waterleaf farmers in the Uyo agricultural zone of Akwa Ibom State, south-south region of Nigeria. Four hundred and twenty (420) waterleaf farmers were randomly selected for the study. A structured questionnaire was used to collect data, and a multiple linear regression model based on Ordinary Least Squares estimation technique was specified and estimated. The explanatory variables used were derived from an in-depth reviewed of related literature and observed characteristics of the respondents. The empirical results revealed that; farmers' marital status, education, household size, farming experience, access to extension services, quantity of waterleaf stems planted and the amount of credit collected as loans were positive determinants of labour productivity in the waterleaf production enterprise. On the contrary, farm size, quantity of manure used and non-farm income were identified as negative determinants of labour productivity in waterleaf production in the zone. Based on the results, it is recommended that, improved education of waterleaf farmers, provision of fertilizer subsidy and provision of quality planting materials should be considered when developing any policy framework for labour productivity of vegetable farmers in the State.

Key words*: *waterleaf, farmers, labour, productivity, Akwa Ibom State

INTRODUCTION

Waterleaf (*Talinum fruticosum* or *Talinum triangulare*) is one of the popular vegetables grown in the south-south region of Nigeria [14, 1, 2, 4]. The crop is the most preferable softener in most of the fibrous vegetable delegacies in the Southern region of Nigeria. The popularity of waterleaf in the region is also associated with its affordability, the low cost per unit of resource utilization in production, short gestation period and quick returns on invested capital compared to other vegetable and arable crop enterprises [7, 8, 33].
Currently, waterleaf is an important part of urban agriculture, and its production has become one of the most highly preferred livelihood activities among unemployed women in the peri-urban areas, urban and rural areas of the south-south region of Nigeria [32, 33, 23, 6, 34].
Sustained production of waterleaf in the southern region of Nigeria can only be achieved if farm inputs are readily available and utilized in an efficient manner. In this regards, rational farm resource allocation and utilization are prerequisites for attaining higher productivity in the vegetable production in the southern region of Nigeria. Productivity measures the quantity of outputs of a production process relative to the level of inputs. The more output resulting from a given level of input, the more productive the process and the farm factor(s) in consideration [10, 5, 4].
According to Udoh and Akpan [33], vegetables are among the staple food components in the world, and their production has continued to increase due to the increasing awareness of the nutritional value derivable from its consumption. Vegetables are good sources of protein, mineral salts, sugars, vitamins, and essential oils that increase man's resistance to disease [11]. Francisca *et al.,* [16] asserted that the increase in vegetable production, improved food security and have increased employment opportunities to many rural women in Nigeria. According to Kebede and Gan [21], one of the main sources of farm

income for small and limited resource based farmers are basically arable crop production consisting of vegetable and non-vegetable crops.

Observing the increasing demand to sustain vegetable production and farm factor productivity, Hussian and Perera [20] noted that the agricultural productivity change is explained by such factors as climatic, agronomic and socioeconomic as well as farm management factors. Likewise, the need to increase food crop production and make food sufficient to the populace is one of the major challenges faced by the Nigerian government. Farmers in Nigeria are not getting maximum yields from resources devoted to their farm enterprises [26, 29, 3]. Factor productivity is crucial for the real income growth, and for improving economic well-being and quality of life, or at least its material aspects [22].

Ogbalubi and Wokocha [25] observed that the availability of labour which is one of the major farm resources has become a serious challenge to small scale farmers in the country. Deotti and Estuch [13] further stressed that the phenomenon is due to the fact that rural-urban migration has continued to prevail despite the presence of disguised unemployment in the urban areas. As noted by Gocowski and Oduwole [17], labour is a major constraint to peasant agricultural production in Nigeria especially during the periods of planting, weeding and harvesting. Following the persistent imbalance in the agricultural labour market, the majority of small scale farmers have resorted to family labours as the main source of farm labour [35]. With the changing needs of the farm families over time, relying on family labour for farm operations might not yield sustainable production. As reckoned by Omotesho *et al.* [28], the need for an alternative source of rarely efficient family labour is overwhelmingly necessary in order to meet the food security requirements of the country in the short and long-run periods. Hired labour, the alternative for family labour, has its own particular issues. For instance, the wage rate for hire labour is rising in some rural communities following increasing rural-urban migration and improvement in educational facilities [13]. The wage is gradually metamorphosing from a general prevailing rate to a more competitive bargaining rate in some rural farming communities in the region following inelastic demand for labour. Currently, labour availability and productivity are critical in sustaining waterleaf production in the southern region of Nigeria.

There are few empirical literature that focused on farm-specific labour productivity in arable crop production enterprises in developing countries. Available literature includes a cross country study conducted by Reardon *et al.,* [30] on the differences in patterns and determinants of farm productivity over agro-climatic zones in Burkina Faso, Rwanda, Senegal, and Zimbabwe. The findings showed that rates of growth in yields and returns per labour-day were low in the four countries studied. They also identified productivity determinants in the four countries to include fertilizers, improved seeds, animal traction, organic inputs and conservation investments. Other determinants were farm size and land tenure, non-cropping income and functioning input and output markets. In Nigeria, Okoye *et al.* [27] carried out a study to determine factors that affect farm-level labour productivity in smallholder cocoyam farms in Anambra State. The empirical results showed that the coefficients of fertilizer, cocoyam setts, capital and farmer's experience were positively and significantly related to labour productivity at 5% probability level each. Contrary to the above results, farm size and household size had negative relationships with labour productivity in cocoyam farms. Similarly, Anyaegbunam *et al.,* [9] examined labour productivity among smallholder cassava farmers in the Southeast agro-ecological zone, Nigeria. The study found gender, household size and age of cassava farmers as the negative determinants of labour productivity. On the other hand, the quantity of fertilizer, the number of hired labour and land ownership were positive determinants. Omotesho *et al.,* [28] examined the relationship between hired labour use and food security among rural farming households in Kwara State, Nigeria. The results revealed that, the dependency ratio, age and educational qualification of the household head, total household size, and household income significantly influenced hired labour use among farming households. Also, Obike *et al.* [24] examined labour productivity and resource use efficiency amongst smallholder cocoa farmers in Abia State, Nigeria. The results showed that education, farming experience, and capital had positive influences on labour productivity while farm size related negatively.

It is noticed that some of the literature reviewed are old and needed to be updated to reflect the current realities. Also, vegetable crops have not been given fair concentration on the issue of labour productivity determinants in the country. Since the agronomical practices and requirements are not exactly the same for all crops, issues of labour productivity should be crop-specific. Furthermore, none of the studies were conducted in the south-south region of Nigeria. The region has peculiar characteristics such as increasing rural-urban migration, the presence of multinational companies that provide a juicy alternative to farm labours, increasing oil pollution or spillage, and water as well as soil erosion. Hence, special attention should be given to farm labour productivity to ensure sustained vegetable/arable crop production in the region.

Therefore, given the importance of vegetables in job creation, ensuring food self-sufficiency, and as food complements, this study specifically aimed at identifying non-wage factors that influence labour productivity in waterleaf enterprises in Akwa Ibom State, southern region of Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried in Uyo agricultural zone in Akwa Ibom State, Nigeria. The State has six agricultural zones namely: Eket, Ikot Ekpene, Etinan, Uyo, Oron and Abak. Uyo Agricultural zone covers extension activities in Uyo, Ibesikpo Asutan, Itu, Uruan and Ibiono Ibom Local Government Areas. The region is basically agrarian in nature, and crops such as waterleaf, cassava, fluted pumpkin and garden egg are common. Others include cocoyam, maize, water yam, pepper, plantain, and cucumber. Some households grow cash crops such as oil palm, rubber, and cocoa.

Sources of Data, and Instrument for Data Collection

Primary data were used in the study. A structured questionnaire was designed in line with the objectives of the study, and was administered to the respondents, and complemented by personal interviews to ensure the consistency and accuracy of information collected.

Sample Size Selection

From Cochran [12], a representative sample size from a large population of waterleaf farmers in the study area was obtained using the equation (1) specified as thus:

$$S_n = \frac{z^2\rho(1-\rho)}{D^2} \dots\dots\dots\dots\dots\dots\dots.(1)$$

where:

S_n is the required sample size;

Z is the 95% confidence interval (1.96);

P is the expected proportion of waterleaf farmers in total farmers' population in the study area (about 85%);

D is the absolute error or precision at 5% type 1 error.

The sample size is derived as shown in equation 2.

$$S_n = \frac{(1.96)^2 0.85(1-\ 0.85)}{(0.05)^2} = 196 \dots\dots\dots\dots\dots.(2)$$

In order to have sufficient data for the specified regression model, the sample size was scaled up to five hundred.

Sampling Procedure and Sample Size

The multi-stage sampling technique was adopted in selecting respondents for the study. The first stage was the purposive selection of all the five local government areas in Uyo agricultural zone. The second stage was the random selection of five villages from each of the local government known for intensive waterleaf production. A total of twenty-five (25) villages from Uyo agricultural zone were used in the study. The third stage involved a random selection of twenty (20) waterleaf farmers from each of the villages selected, giving a total of five hundred (500) waterleaf farmers used in the study. However, after thorough screening of copies of the questionnaire returned, only four hundred and twenty (420) of them were found suitable to be used in the study.

Measuring the Labour Productivity of Vegetable farms

Partial factor productivity (PFP) in production economics is measured by the ratio of the total quantity of output to the total quantity of specific farm factor. That is:

$$PFP = \frac{total\ output\ of\ waterleaf\ (kg)}{total\ labour\ used\ (mandays)} \ldots .(3)$$

To correct for the variations in the number of hours worked by labour (household and hired labour) in each farm firm, the study conceptualized labour productivity (LPP) in monetary terms as:

$$LPP = \frac{Value\ of\ total\ output\ of\ waterleaf\ produced\ by\ a\ farmer}{Cost\ of\ labour\ used\ (total\ wage\ rate)} = \frac{\sum_{n=1}^{n} P_s Y_s}{\sum_{n=1}^{n} W_r L_t} \ldots \ldots \quad (4)$$

where: P_s is a market price of waterleaf, and Y_s is the total quantity of waterleaf produced and willingly offered to the market by a farmer, while W_r is the wage rate prevalence in the study area, and L_t is the total number of labour used by a farmer for a production cycle. (Note, the labour used consists of family labour and hired labour). Also, the farm labour was categorized into; adult male, adult female and child labour. The wage rate for each of the categories of labour at each stage of farm activities was taken into consideration in computing the denominator in equation 4.

Analytical Framework/Techniques

Following the work of Robinson *et al.*, [31] and Gunter [18], farm labour supply (LS) is a function of human capital (HC), farm income (Y), wage rate (W) and exogenous determinants (V). That is:

$$LS = \int (HC, Y, W, V) \ldots \ldots \ldots \ldots .(5)$$

The study assumes that the supply of farm labours is directly proportional to its productivity since farmers are being considered rational in decision making. Also, a perfect competitive market situation is hypothesized for the labour market with respect to waterleaf production in the study area. For this reason, it is assumed that a single wage rate exists in the market. Also, since waterleaf production is labour intensive, household farming income would relate directly to labour demand and thus its productivity. Hence, equation (5) can be re-specified as thus:

$$LPP = \int (HC, V) \ldots \ldots \ldots \ldots \ldots \ldots .(6)$$

Therefore, based on the definition of labour productivity in equation 4, including farm income and wage rate as determinants of labour productivity function will cause endogeneity issue that may lead to econometric problem of simultaneous equation bias. Hence, equation 5 was simplified to eliminate these anticipating econometric problems in the estimation process. Expanding equation 6 implicitly, a multivariate regression model was specified consisting of exogenous variables as in equation 7 to determine the factors causing variability in labour productivity in small scale waterleaf production in the study area. The Ordinary Least Squares estimation technique was used to estimates the labour productivity model. The specified model is expressed in linear form as thus:

$$\begin{aligned} LPP = \ & \delta_0 + \delta_1 GEN + +\delta_2 AGE + \delta_3 MAR + \delta_4 EDU \\ & + \delta_5 HHS + \delta_6 FAE + \delta_7 SOC \\ & + \delta_8 FAS + \delta_9 EXT + \delta_{10} FER \\ & + \delta_{11} MAU + \delta_{12} STM + \delta_{13} NFI \\ & + \delta_{14} CRE \ldots \ldots \ldots \ldots \ldots \ldots .. \ldots .(7) \end{aligned}$$

where:

LPP = Labour productivity of a farm as defined in equation 4

GEN = Gender of a farming household head (dummy: 1 for male and 0 otherwise)
AGE = Age of farming household head (years)
MAR = Marital status of a farming household head (dummy: 1 for married and 0 otherwise)
EDU = Education of a farmer (years)
HHS = Household size (number)
FAE = Farming experience (years)
SOC = Membership in social groups (years)
FAS = Farm size (hectares)
EXT = Access to agricultural extension services (number of visits in a year)
FER = Quantity of fertilizer used (Quantity multiplied by the unit price in Naira)
MAU = Quantity of manure used (Quantity multiplied by the unit price in Naira)
STM = Quantity of planting Material (Quantity multiplied by the unit price in Naira)
NFI = Income generated outside Waterleaf enterprise by a farmer (Naira)
CRE = Access to farm credit (amount in Naira)

Also, descriptive statistics consisting of tables and means were used to examine the socioeconomic characteristics of the respondents.

Verification of Multicollinearity among Explanatory Variables Used in the Analysis

The Variance Inflating Factor (VIF) and tolerance values were estimated and used to verify the presence of multicollinearity among the explanatory variables. For VIF, the minimum possible value is 1.0; while a value greater than 10 indicates likely collinearity between the specified explanatory variable in question and the rest of the predictors in the model. According to Gujurati and Dawn, [18], VIF is estimated using the formula stated below:

$$VIF_j = \{1/1 - R_j^2\} \dots\dots\dots\dots\dots\dots\dots\dots (8)$$

where: R_j^2 represents the multiple correlation coefficient between one of the explanatory variable (designated as dependent variable) and the other specified explanatory variables in the study. The implicit model explaining the above mechanism is shown in equation 9.

$$X_j = \varphi_0 + \varphi_1 X_1 + \varphi_2 X_2 +, \dots + \varphi_n X_n + \varepsilon_n \dots\dots\dots\dots (9)$$

VIF_j has a unique relationship with the tolerance level as thus:

$$Tolerance = 1/VIF = (1 - R_j^2) \dots (10)$$

The higher the variance inflating factor, the lower the tolerance index and the higher the chance of collinearity.

RESULTS AND DISCUSSIONS

Descriptive Statistics

A summary of descriptive statistics of variables used in the study is presented in Table 1. The degree of variability in each of the specified variables showed wide dispersion as evidenced by the magnitude of the standard deviations and the degree of skewness displayed. The findings revealed that about 25.46% of sampled waterleaf farmers were male, while 74.54% were female. This connotes that female farmers dominated their male counterparts in waterleaf production in the region.

The age distribution revealed an average age of 40.48 years and is positively skewed, while 39.09% of the farmers were married. The result implies that, most waterleaf farmers are fast drifting away from their active years to older and less active age. Following FAO [15], the migration of young adults to the cities has resulted in a shift in the age structure of the farming population towards older ages, with clear implications for agricultural labour markets, production and food security. Besides, an average of 11.71 years of formal education was discovered among waterleaf farmers with a minimum of 6 years of school attainment.

Table 1. Summary Statistics for Variables

Variable	Mean	Min.	Max.	Std. Dev.	C.V.	Skewness
Gender (Male = 1; Female = 0)	0.255	0.000	1.000	0.436	1.713	1.127
Age (Years)	40.475	25.000	67.00	9.861	0.244	0.511
Marital status(M = 1; UnM = 0)	0.391	0.000	1.000	0.489	1.250	0.447
Education (Years)	11.705	6.000	16.000	2.506	0.214	-0.733
Household size (No.)	6.000	1.000	14.000	2.693	0.465	0.413
Farming experience (Years)	6.421	1.000	19.000	2.977	0.464	1.314
Socialization (Years)	1.341	0.000	30.000	4.013	2.993	5.149
Farm size (Ha)	0.028	0.002	0.123	0.027	0.976	2.028
Extension access(No. of visits per year	0.552	0.000	7.000	1.397	2.530	2.828
Value of output (₦)	28,586	2,000.0	79,000	19,174	0.671	1.004
Cost of fertilizer used (₦)	3,404.0	0.000	26,560	5,031.3	1.478	2.082
Cost of manure used (₦)	1,833.5	0.000	5,600.0	1,400.8	0.764	0.543
Cost of Waterleaf stem planted (₦)	2,091.3	10.00	1,300	3,044.4	1.456	1.739
Wage earned by labour used (₦)	9,813.7	400.00	33,000	7,342.4	0.748	1.214
Non-farm income (₦)	22,933	0.000	4.8e+05	53,732	2.343	7.046
Labour productivity (₦)	5.028	0.667	63.75	6.619	1.317	5.137
Amount of credit (₦)	1,326.1	0.000	40,000	5,852.3	4.413	4.976

Source: Computed by authors, 2019.

This means that the waterleaf farmers in the region have great potential for technology adoption for improved human capital and farm income. Also, an average household size of 6 members, and an average farming experience of 6.42 years were ferreted out among farmers. This reflects the importance of household labour in waterleaf production. The distribution of farming experience, perhaps, shows that waterleaf production is an emerging crop enterprise on the one hand, and also a transitory source of livelihood for most women folks in the study area.

In addition, the study unearthed a deteriorating nature of socialization, and access to agricultural extension services among the waterleaf farmers in the region. For instance, an average of 1.34 years of membership in social organizations among waterleaf farmers in the region was uncovered, while an average number of contacts with an extension agent during the production year stood at 0.55 times. The results depict the poor status of social capital formation among the waterleaf farmers, and the inefficient agricultural extension service delivery in the study area. Furthermore, the quantity of fertilizer bought showed a high degree of variability relative to the quantity of manure bought by the waterleaf farmers. The quantities of fertilizer and manure acquired by farmers were both skewed to the right, but the degree of skewness was greater in fertilizer than manure. The labour productivity indices were skewed to the right, and averaged at 5.0278, implying that most of the farmers had laboured productivity indices greater than unity. The average wage paid by the waterleaf farmers was recorded as ₦9,813.7 per production cycle, while the non-farm income, labour productivity and amount of credit was noticed to increase at increasing rates among waterleaf farmers in the study area.

Test for multicollinearity of specified explanatory variables in the labour productivity model

The results presented in Table 2 are the Variance Inflating Factor (VIF) estimates used to verify the nature of the collinearity among the specified independent variables. The results indicated that no significant issues of collinearity arose among the explanatory variables in the estimated model. The estimated VIF for each independent variable was greater than unity, but less than the threshold value of 10.

The finding implies that the explanatory variables carried their true signs and the estimated standard error are not inflated due to multicollinearity.

This means that the estimates of the OLS are independent, stable and not very sensitive to minor changes in the model.

Also, the tolerance factors were low, and below unity for every independent variable, implying that multicollinearity was not significant in the estimated models.

Table 2. Estimates of Variance Inflating Factors

Variable	Variance Inflation Factors	Tolerance Ratio
Gender	1.316	0.760
Age	1.747	0.572
Marital status	1.337	0.748
Education	1.323	0.756
Household size	1.406	0.711
Farming experience	1.469	0.681
Socialization	1.557	0.642
Farm size	1.689	0.592
Extension access	1.122	0.891
Quantity of fertilizer used	1.179	0.848
Quantity of manure used	1.709	0.585
Quantity of Waterleaf stems used	1.703	0.587
Non-farm income	1.199	0.834
Amount of credit	1.204	0.831

Source: Computed by authors, 2019.

Determinants of Labour Productivity of Waterleaf Farmers

The estimates of the multiple regression model based on the ordinary least squares (OLS) estimation technique are presented in Table 3. The diagnostic tests for the OLS estimation revealed that about 25.09% of the variations in the labour productivity were attributed to the specified explanatory variables. The F – statistic was significant at 1% probability level, denoting that the estimated R – square was significant and by implication, the estimated equation had goodness of fit. The normality test was statistically significant at 1% probability level, implying that the regression residuals were normally distributed and this justified the used of an Ordinary Least Squares estimation method. The RESET test was not significant at the conventional probability level, also fortifying the fact that the estimated regression had structural rigidity. The null hypotheses of no heteroskedasticity were upheld following the non-significant estimates of the Breusch – Pagan and White's tests for heteroskedasticity statistics. The test finding implies that the OLS estimators and regression predictions are BLUE (Best Linear Unbiased Estimators). This further means that, the estimates are consistent and efficient, hence validating the test of hypotheses of the F-test and the t- test in the model.

The empirical results from the Ordinary Least Squares estimates revealed that the marital status of the waterleaf farmers had a significant positive relationship with labour productivity. A unit increase in the marital status of the waterleaf farmers led to about 2.7976 units increase in labour productivity. This finding suggests that, married waterleaf farmers are more likely interested in generating additional family income from waterleaf production and as such, labour welfare would be paramount to them.

Table 3. OLS Determinants of labour productivity in small scale Waterleaf production

Variable	Coefficient	Standard error	t-value	*p-value*
Constant	−4.48044	1.93968	−2.310**	0.0214
Gender	−0.929776	0.730878	−1.272	0.2040
Age	0.0468709	0.0372474	1.258	0.2089
Marital status	2.79755	0.657778	4.253***	<0.0001
Education	0.311732	0.127549	2.444**	0.0149
Household size	0.385273	0.122346	3.149***	0.0018
Farming experience	0.400188	0.113120	3.538***	0.0004
Socialization	0.0173160	0.0864147	0.2004	0.8413
Farm size	−61.1970	13.2854	−4.606***	<0.0001
Extension access	0.0456912	0.210678	0.2169	0.8284
Quantity of fertilizer used	0.000263295	5.99795e-05	4.390***	<0.0001
Quantity of manure used	−0.000812845	0.000259317	−3.135***	0.0018
Quantity of Waterleaf stem used	0.000380705	0.000119110	3.196***	0.0015
Non-farm income	−1.57464e-05	5.66289e-06	−2.781***	0.0057
Amount of credit	8.98546e-05	5.21103e-05	1.724*	0.0854
Diagnostic Statistics				
R-squared				0.250954
F(14, 425)				10.17058***
RESET test (squares only)				F(1, 424) = 3.278
Normality test				Chi-square(2) =4.85
Breusch-Pagan				LM = 5.57
White's test for heteroscedasticity				9.962
Number of observations:	440			

Source: Data from 2018 planting season in the study area.
*, **, and *** represent a significance at 10%, 5% and 1% respectively.

Another plausible reason is the fact that married farming households would likely have the advantage of having a higher number of household labour. Since this source of labour is part of the total farm labour and sometimes might constitute the larger part of the total farm labour, then the welfare of the farm labour would surely improve, and so will its productivity.

In a similar vein, the coefficient of waterleaf farmers' years of formal education was positive, and constituted a significant determinant of labour productivity in the sub-sector. A unit increase in the years of formal education of the farmers increased farm labour productivity by 0.3117 units. This implies that the more the waterleaf farmers' acquired formal education, the greater the possibility of increasing labour productivity in the farm. Increase in years of formal education has a strong relationship with the efficient management of farm resources and technology adoption. The educated waterleaf farmer would better understand the labour laws and the need to ensure improved wage rates and other labour incentives. In addition, educated farmer would have an improved human capital capable of providing knowledge, skills, analyzing farm issues and proffering solutions as well as providing advisory services to labourers/workers in order to raise farm income and labour productivity. The finding corroborates the previous finding of Obike *et al.* [27].

Also, household size had a significant positive correlation with the labour productivity in waterleaf production. A unit increase in household size resulted in a 0.38527 unit increase in labour productivity. The result satisfies *a priori* expectations, because small scale waterleaf production is basically labour-intensive, and mostly depended on household labour. An increase in household labour would imply an increase in labour availability and, perhaps, yields or farm outputs relative to man-hours used on the farm. The finding is contrary to the submissions of Okoye *et al.,* [27] and Anyaegbunam *et al.,* [9].

Similarly, an increase in farming experience increased the units of labour productivity in the farm. For instance, a year increase in farmer's experience will result in about 0.40019 unit increase in labour productivity. An increase in years of farming experience increases the possibility of attaining an efficient farm resource mix capable of increasing the total farm output. The efficient risk management on the farm is often associated with years of experience due to the adaptive behaviour of farmer. Farming experience has been also known to affect agricultural technology adoption, including efficient farm practices. Understanding workers' welfare is a function of accumulative experiences over time. This is in consonance with the reports of Okoye *et al.* [27] and Obike *et al.* [24].

The slope coefficient of the quantity of fertilizer used was positive and statistically significant at 1% probability level. This means that a unit increase in the quantity of fertilizer used resulted in a 0.00026 unit increase in farm labour productivity. Increase in fertilizer use in arable crop production has always been associated with an increase in farm output resulting in an increase in partial factor productivity. It is the price and, sometimes, its availability and adequacy in quality that have been hindering the efficient utilization of this farm input by resource-poor farmers. Another plausible reason for the result is the economies of size relative to the man-days/man-hour of labour needed. The finding is in agreement with the reports of Reardon *et al.,* [30] and Anyaegbunam *et al.,* [9].

The coefficient of the quantity of stems used by farmers had a significant positive relationship with labour productivity. A unit increase in the quantity of waterleaf stems planted increased labour productivity by 0.00038 unit. This satisfied *a priori* expectation because an increase in the quantity of stems planted would always lead to an increase in the quantity of output correspondingly, provided appropriate agronomical practices are upheld by farmers. The finding is in line with submissions of Reardon *et al.,* [30] and Okoye *et al.,* [27].

The coefficient of farm credit in the labour productivity model indicates that the amount of credit available to waterleaf farmers had a positive and significant association with labour productivity. A unit increase in farm credit marginally increased labour productivity by 8.985 x 10^{-05} of a unit. Farm credit would help in efficient management of farm resources through mobilization of human resources such as labour. It can also be a good source of labour incentive through enhanced wage rate, which will eventually translate to higher partial factor productivity.

On the contrary, an increase in the farm size of waterleaf farmers resulted in lower labour productivity. For instance, a 1% increase in the farm size of waterleaf farmers resulted in a 61.19% decrease in labour productivity. This means that, the larger the farm size the lower the labour productivity. Given the magnitude of the farm size coefficient, it seems farm size is the most important non – wage determinant of waterleaf labour productivity in the region. The finding suggests that most of the waterleaf farmers in the region were resource-poor and could not afford expanded farm investment associated with an increase in farm size. Also, acquiring additional farmlands would have been difficult, as the farmers may not have had sufficient income left to fund other farm operations including wages. Previous reports published by Reardon *et al.*, [30] and Okoye *et al.* [27] as well as Obike *et al.* [24] supported this finding.

The slope coefficient (0.0008) of the quantity of manure used in the labour productivity model was negative. This signifies that. a unit increase in the quantity of manure used will lead to a reduction in labour productivity by 0.0008 of a unit. The result may be connected to the quality of manure utilized by the farmers. Most of the manure used in waterleaf production in the area was derived from poultry droppings. The chemicals in fresh poultry droppings may have been injurious to waterleaf growth and therefore hindered the output growth, and consequently reduced labour productivity. Waterleaf being an herbaceous plant does not have strong resistance to toxic or harmful materials compared to other arable crops like cassava and fluted pumpkins. Another possible reason for the result is that manure is readily affordable by the waterleaf farmers, hence creating an incentive to acquire large quantities for a small piece of land. Heavy application can lead to toxicity of the soil, thereby reducing the quantity of output produced. The reduction in output would lead to low labour productivity. Reardon *et al.*, [30] has reported similar results previously.

In a similar vein, an increase in non-farm income reduces the labour productivity in Waterleaf production in the region. A unit increase in non-farm income resulted in 1.575 x $10^{-05}$of a unit decline in labour productivity. Alternatively, an increase in the non-farm income reduced labour productivity in waterleaf production. This result is in line with the anticipated result because an increase in non-farm income implies increased tendency of diversification or disinvestment in waterleaf farm business. Hence, an increase in non-farm income of waterleaf farmers without adequately compensating for farm investment would likely lower farm earnings and factor productivity. Reardon *et al.*, [30] reported a similar result.

CONCLUSIONS

The achievement of the food self-sufficiency target of the south-south region of Nigeria and Akwa Ibom State, in particular, is anchored on promoting efficient resource utilization and improved productivity of small scale farmers considered as the bedrock of agricultural systems in the region. Labour productivity has become critical, given the persistent rural-urban migration of the workforce, leading to labour scarcity in some rural communities. The attempt to sustain waterleaf production, in particular, implies devising ways to attract labour into farm operations. Certain attributes of farmers are prerequisites, and identifying these characteristics was the major aim of this study. Findings have shown the importance of human capital development of the waterleaf farmers, improved technology in the farm, vibrancy of agriculture-based agencies, and economics of scale in the farm. In order to sustain production of waterleaf in Uyo agricultural zone of Akwa Ibom State, the following policy recommendations were strongly advocated:

Provision of good quality education to the waterleaf farmers should be paramount in developing any policy framework to increase labour productivity of vegetable farmers in the State. The use of fertilizers would enhance labour productivity in vegetable production in the State. The State government should therefore subsidize the price of fertilizers to enable farmers afford them for increased output and labour productivity. the provision of quality planting materials by specialized agencies and all stakeholders concerned is necessary for higher productivity of labour in vegetable production in the area. Also, farm credit is an incentive to boost labour productivity; hence modalities to ease credit supply and demand should be implemented *by* all stakeholders for vegetable farmers in the State.

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THE RELIABILITY TEST OF USING THE MODERATE SATELLITE IMAGES FOR METALS CONTAMINATED CORN PLANTS DETECTION IN THE NILE DELTA, EGYPT

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Abstract

For the synoptic assessment of corn plants content of Ca, and K accurate monitoring of land surface dynamics using remote sensing is needed. We looked at a full resolution dataset from the Medium Resolution satellite Imaging (Sentinel-2) as an open source as an alternative to the costly high resolution the more widely used high-resolution satellite Imaging (Worldview2) data for vegetation monitoring. We compared Sentinel-2 image and Worldview 2 data acquired in 2018 with in situ measured hyperspectral data and metal concentrations in plant samples collected from fields in the study area for this purpose. The current research was conducted on the experimental site during the 2018 corn cropping season (Zea Mayz). Results indicated that: The Difference Vegetation Index (DVI), the Enhanced Vegetation Index (EVI), the Green Normalized Difference Vegetation Index (GNDVI), and the Leaf Area Index (LAI) were the more sensitive indicators to Ca and K above ground corn plants content. These VIs had R^2 values more than 0.5 with the in-situ measurements for the both images. DVI, EVI, and GNDVI performed well in estimating plant dry matter Ca and K content with $R^2 > 0.5$, with a high significant level P-value < 0.001and LAI had a statistically significant impact with a P-value < 0.5 for WV2 image. The Sentinel-2 VIs performed well in estimating plant dry matter Ca and K content with R^2 values > 0.5, with a high significant level P-value 0.001. LAI had a statistically significant impact with a P-value < 0.5 with Ca concentration and P-value < 0.01 with K concentration. This study suggests that the moderate resolution satellite images can be used for corn plants Ca and K content.

Key words: *Change detection, Remote sensing, plant stress, image processing*

INTRODUCTION

Plant stress can be tracked in the field using in-field spectroscopy, which is both time and cost efficient [19]. Remote sensing change detection (CD) is commonly defined as a process to identify differences in geographical surface phenomena over time [8, 2]. Techniques of remote sensing (RS) have been shown to be a promising approach for crop development Observing [20], nutrition diagnosis, Identifying the geographical area, detecting and quantifying the types of changes, and finally determining the accuracy effects are all part of the general aim of change detection in remote sensing [11].
This field has attracted a lot of effort in research due to its applications in various areas as Land-use and land-cover (LULC). Vegetation change, Crop monitoring, Environmental change and crop stress detection [5].
Change detection (CD) on earth's surface is an active research topic since it can help in monitoring and optimal planning of Earth's resources and also help to arrest undesired changes. Any change detection system should be able to (a) define the change area and change rate; (b) distribution of change areas; (c) change trajectories; and (d) the accuracy assessment of the change detection methods [9].
[10, 8] classified CD techniques into (1) comparative analyses based on post-classified data and (2) simultaneous analyses of multitemporal images.
The conventional methods of soil contamination assessment in large areas involve field data collection, chemical analyses in a laboratory as well as

geostatistical interpolation, which are expensive and time-consuming. For instance according to [14].

Satellite image processing plays a vital role for research and developments in Astronomy, Remote Sensing, GIS, Agriculture Monitoring, Disaster Management, change detection and many other fields of study. Satellite images are recorded in digital forms and then processed by the computers to extract information. Variations in the scene characteristics are represented as variations in brightness on images. In Remote Sensing, change detection means assessing or measuring the change on the Earth's surface by jointly processing multi-temporal images of the same geographical area acquired at different times.

[16] assessed a Medium Resolution Imaging Spectrometer (MERIS) full resolution dataset for vegetation monitoring as an alternative to the more commonly used Moderate-Resolution Imaging Spectroradiometer (MODIS) data. Data from low and medium spatial resolution (SR) satellites are frequently used for land monitoring. These data are freely accessed on the web and provide for observing nearly the entire Earth's surface in a 24-hour period. The major satellite systems providing such types of data are the Moderate Resolution Imaging Spectroradiometer (MODIS)

This work indicates that optical sensors such as European constellations, such as the Sentinels can be used for change detection of corn plants content of Ca and K instead of the paid worldview 2 satellite imagery.

MATERIALS AND METHODS

Study area and data

El- Mahalla Al-Kobra, El- Gharbia Governorate, Egypt (latitude 31o 06.620 N, longitude 31o 03.665 E) is the current study site in the Middle Nile Delta. A map of the research site is shown in Figure 1. Metals resulting from manufacturing activities have polluted certain areas of the studied location by storm water discharge points. The crops in these areas are irrigated by the main drain of El Gharbia. Factory contamination has contaminated the irrigation water from this drain (textile, oil and soap, printing and chemicals).

Fig. 1. Study location
Source: QGIS 2.18.3 software [July 2018] [3].

Satellite imagery

Two different satellite imagery were used in this study for corn plants Ca and K content detection. The first image acquired from WorldView 2 sensor as a high spatial resolution image with 2m pixel spatial resolution. The second image was Sentinel 2 image. It has been developed and is being operated by the European Space Agency. The Sentinel-2 mission has 13 bands in the visible, near infrared, and short wave infrared part of the spectrum with three different spatial resolution 10, 20, and 60 m. The sensors specifications of the satellites summarised in Table 1.

Methods

The methodology considered of this paper is: (1) pre-processing of the original images. (2) processing and statistical analysis of the corresponding datasets, and (3) comparison of the results for the two images.

The data preparation involved the resampling of the S2 bands acquired at 20 m to obtain a layer stack of 10 spectral bands at 10 m. The resulting objects were labeled using the reference data and exploited for training and validation. For the object-based classification, we used various band-specific metrics (Mean, Standard deviation, Min, Median, Max, 25th and 75th Percentile) extracted from the image objects. For the pixel-based classification, we used the reflectance in the ten spectral bands for each pixel.

Reference data for the supervised classification were acquired in two ways:

- during a field survey for the cropland test site, and
- from inventory data and visual interpretation of high spatial resolution images for the test site.

Table 1. Sensor's specifications of WorldView 2 and Sentinel 2 Imagery

Sensor		
	WorldView-2 (WV2)	ESA's Sentinel 2 satellite
Acquisition date	July 2018	July 2018
Bands used	8	13
Spectral range (nm)	450-800	visible and near-infrared (VNIR) to the short-wave infrared (SWIR)
Spatial resolution (m)	2	10

Source: WorldView 2 and Sentinel 2 Imagery, July 2018 [18, 12].

A statistical analysis was run on the results. t-test, regression analysis and the significancy test were run to find the most sensitive vegetation indices. DVI, EVI, GNDVI, and LAI were the most sensitive VIs to Ca and K concentration accumulated in above ground plant dry matter. Table 2 shows the VIs were determined using ENVI 5.3 software from the WV2 and Sentinel 2 images captured on July 2018.

Table 2. The most sensitive VIs were determined using ENVI 5.3 software from the WV2 and Sentinel 2 images

Vegetation index	Apriviation	Formula	Reference
Difference Vegetation Index	DVI	$DVI = NIR - Red$	[15]
Enhanced Vegetation Index	(EVI)	$EVI = 2.5 * \frac{(NIR - Red)}{(NIR + 6 * Red - 7.5 * Blue + 1)}$	[7]
Green Normalized Difference Vegetation Index	(GNDVI)	$GNDVI = \frac{(NIR - Green)}{(NIR + Green)}$	[6]
Leaf Area Index	(LAI)	$LAI = (3.618 * EVI - 0.118)$	[1]

Source: https://www.l3harrisgeospatial.com/docs/vegetationindices.html, Accessed on July 2018 [17].

RESULTS AND DISCUSSIONS

The WV2 and Sentinel 2 images captured on July 2018 for the summer crop (corn) shown in Fig. (2a and b). The most sensitive VIs shown in Table 2 correlation coefficients with in situ hyperspectral vegetation indices were computed. The correlation coefficient, regression analysis, and the P-value for this VIs are shown in Table 3.

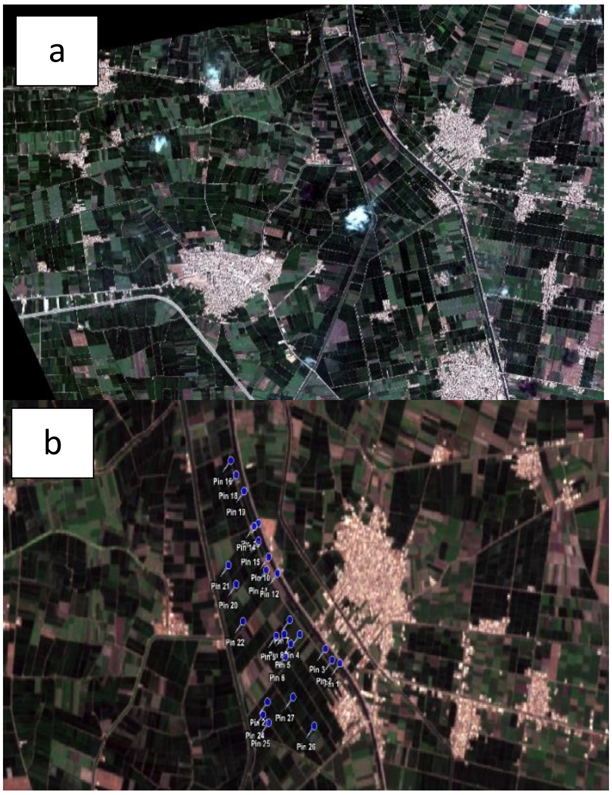

Fig. 2. (a) WorldView2 satellite image and (b) Sentinel 2 satellite image for the study location
Sources:
(a) European space agency, July2018 [4].
(b)https://www.sentinel-hub.com/, July2018 [13].

Table 3. Validation results of regression coefficient for estimating in-situ hyperspectral vegetation indices depends on hyperspectral vegetation indices calculated from the images

In-situ VIs	WorldView 2			Sentinel 2		
	r	R^2	P-value	r	R^2	P-value
DVI	0.765	0.585	0.000***	0.763	0.582	0.001**
(EVI)	0.743	0.553	0.005**	0.749	0.561	0.008**
(GNDVI)	0.823	0.675	0.329	0.876	0.767	0.2087
(LAI)	0.897	0.805	0.002**	0.820	0.673	0.000***

Source: WorldView2 data, July 2018 [18].

Using Worldview 2 image as a high spatial resolution satellite imagery for corn plants Calcium and Potassium content detection

Table 4 demonstrates the regression analysis and the fitting models of the relationship between corn plants dry matter Ca and K content and the published vegetation indices extracted from the WV 2 image. The majority of vegetation indices had negative relationships with the concentration of both elements. With R^2 values of 0.9013, 0.8019, 0.8997, and 0.783 respectively, DVI, EVI, and GNDVI performed well in estimating plant dry matter Ca and K content with high significant level P-value < 0.001. LAI had a significant effect with P-value <0.5 for both two elements. Figure 3 depict the relationships between Ca and K concentration in corn dry matter and the most highly correlated vegetation indices.

Table 4. Fitting model, R2, and P-value for the relationship between WorldView 2 VIs and calcium and potassium accumulation into the corn dry matter

VIs	WorldView 2 Image		
	Corn plants dry matter Calcium content		
	Fitting model	R^2	P - Value
DVI	Y = -0.8763X+ 2.4727	0.9013	< 0.001***
EVI	Y = -0.7661X + 2.626	0.8019	< 0.001***
GNDVI	Y= -1.9743X + 3.7517	0.8997	< 0.001***
LAI	Y= -0.2144X+ 2.6046	0.783	0.406 *
Corn plants dry matter potassium content			
DVI	Y= -0.701X + 1.9782	0.9013	< 0.001***
EVI	Y = -0.6129X+ 2.1008	0.8019	< 0.001***
GNDVI	Y = -1.5794X + 3.0013	0.8997	< 0.001***
LAI	Y = -0.1715X + 2.0837	0.783	0.1138*

Source: calculations from worldview2 satellite image , July 2018 [18].

Using Sentinel 2 image as a moderate spatial resolution satellite imagery for corn plants Calcium content detection

The regression analysis and fitting models of the relationship between corn plants dry matter Ca content and reported vegetation indices extracted from the Sentinel 2 image are shown in Table 5. The concentrations of the element had negative relationship with the majority of vegetation indices. DVI, EVI, GNDVI, and LAI performed well in estimating plant dry matter Ca content with R^2 values of 0.566, 0.5647, 0.3306, and 0.5647, respectively, with a high significant level P-value 0.001.

LAI had a statistically significant impact with a P-value of 0.5. The relationships between the concentrations of calcium and potassium in corn dry matter and the most closely associated vegetation indices are depicted in Fig. 4.

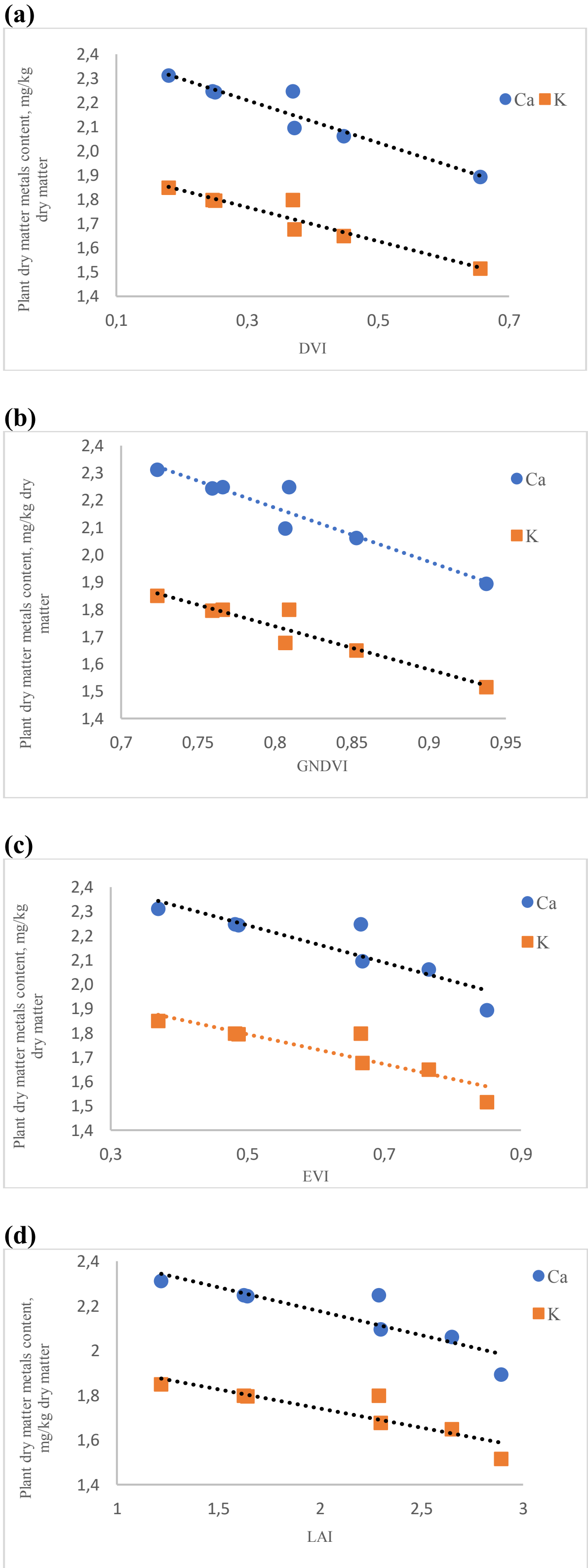

Fig. 3. Relationship between above ground plant dry matter Ca and K content and vegetation indices calculated from WorldView 2 satellite image
Source: calculations from worldview2 satellite image , July 2018 [18].

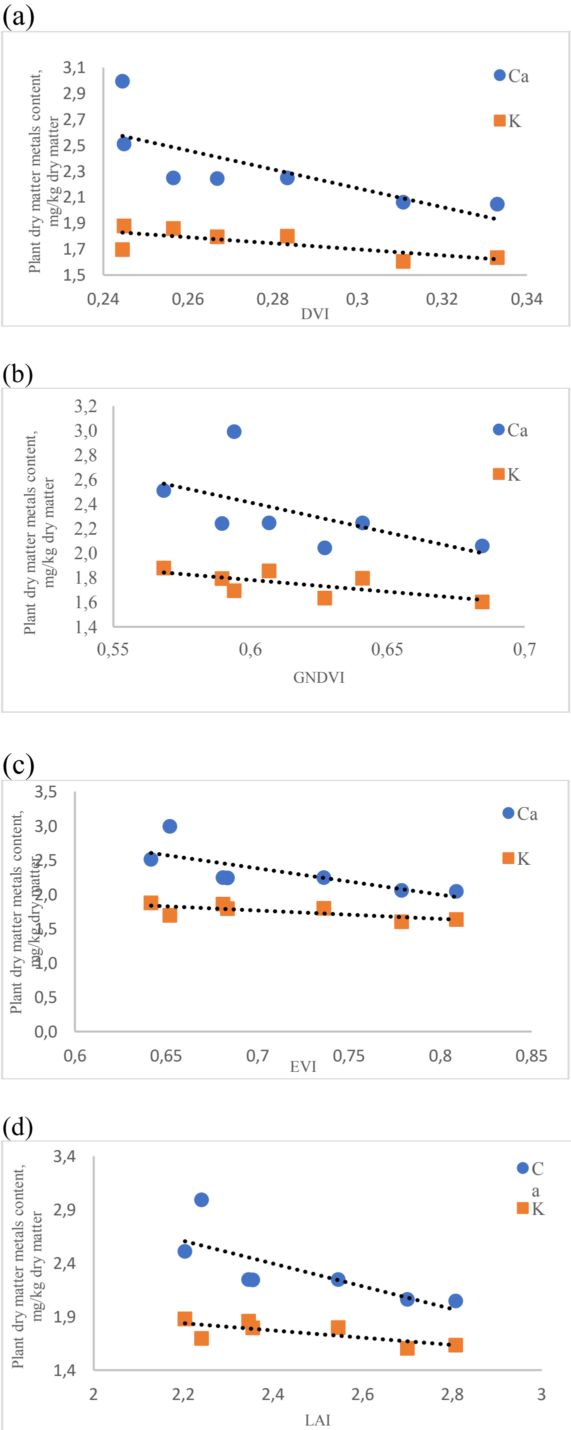

Fig. 4. Relationship between above ground plant dry matter Ca and K content and vegetation indices calculated from Sentinel 2 satellite image
Source: calculations from Sentinel 2 satellite image, July 2018 [12].

Using Sentinel 2 image as a moderate spatial resolution satellite imagery for corn plants Potassium content detection

Table 5 shows the regression analysis and fitting models for the relationship between dry matter K content of corn plants and recorded vegetation indices extracted from the Sentinel 2 image. The majority of vegetation indices showed a negative correlation with the element's concentrations. With R^2 values of 0.5343, 0.524, 0.4694, and 0.524 respectively, and a high significant level P-value < 0.001, DVI, EVI, GNDVI, and LAI performed well in estimating plant dry matter K material with a P-value < 0.01, LAI was statistically important. The associations between calcium and potassium concentrations in corn dry matter and the most closely related vegetation indices are shown in Fig. 4.

Table 5. Fitting model, R2, and P-value for the relationship between Sentinel 2 VIs and calcium and potassium accumulation into the corn dry matter

VIs	Sentinel 2 Image		
	Corn plants dry matter Calcium content		
	Fitting model	R^2	P - Value
DVI	Y= -7.2697X+ 4.3503	0.566	< 0.001***
EVI	Y= -3.8419X + 5.07	0.5647	< 0.001***
GNDVI	Y = -4.8848X + 5.3443	0.3306	< 0.001***
LAI	Y= -1.0619X + 4.9447	0.5647	0.28*
Corn plants dry matter potassium content			
DVI	Y = -2.3317X+ 2.3977	0.5343	< 0.001***
EVI	Y = -1.2217X + 2.621	0.524	< 0.001***
GNDVI	Y= -1.9214X + 2.935	0.4694	< 0.001***
LAI	Y = -0.3377X + 2.5812	0.524	0.001**

Source: calculations from worldview2 satellite image, July 2018 [18].

CONCLUSIONS

This study compared the using of multi-temporal Sentinel-2 images with the high resolution Worldview 2 image to detect Ca and K concentration on corn plants growing in a natural agriculture ecosystem irrigated with industrial waste water on the regional scale. (DVI), (EVI), (GNDVI), and (LAI) were selected as an effective indicator for Ca and K corn plants content based on data measured in the field and comparisons between ASD VIs , Sentinel-2 VIs, and WorldView 2 Vis, and these results also proved that the Sentinel-2 images are an effective remote data source for detecting plant stress.
The price volatility is reflected at all chin stages level and especially at the production stage and to a lesser degree at the marketing and processing levels.

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RESEARCH ON BIOETHANOL PRODUCTION IN ROMANIA

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Abstract

Biofuels have many advantages over traditional fuels as they are easier to be obtained, they are considered to be environmentally friendly, biodegradable and could be achieved through sustainable technologies. The aim of the paper is to identify the potential for bioethanol production in Romania, from the two main representative agricultural crops, namely: wheat and corn. For this purpose, the method of quantitative and qualitative analysis of data about the area, production, consumption, import and export was used. Unlike the United States or Brazil, the production of bioethanol in Romania and in the European Union remains an under-exploited branch despite the valuable potential of this renewable energy source. This can also be explained by the rather low demand for such a fuel.

Key words*: *bioethanol, production potential, import, export

INTRODUCTION

One of the most current problems facing human society at the present stage is the energy problem. Population growth, the fast development of industry and the demands of the social sphere, the accelerated depletion of fossil fuel resources, together with the process of global warming caused by the increase in greenhouse gas emissions have motivated the research towards finding other energy resources, a renewable type of energy resources [1, 2, 6].

Overexploitation of our planet's resources have irreparably affected the environment, which is now suffering more than ever from climate change. Increased gas emissions, the greenhouse effect and global warming have contributed to the search for renewable energy sources which are in harmony with the energy needs of the world.

Research to obtain new alternative and sustainable fuels has become increasingly important due to the accelerated depletion of fossil fuel resources but also the increasing level of CO_2 in the atmosphere that helps form the greenhouse effect and thus trigger global warming. More than 30% of the total energy needed by developing countries it is used on the transport sector [3, 4, 5].

Currently, the transport sector is totally dependent on fossil fuels and is responsible for 60% of global fuel consumption. As a result, 70% of the carbon monoxide released into the atmosphere worldwide is generated by this sector as well as 19% of global carbon dioxide emissions [4].

The dramatic increase in fuel prices from day to day, the reduction of fossil fuel reserves and their non-renewable nature, the growing impact of pollution on the environment especially greenhouse gas emissions have directed research in this area to new energy sources and the development of alternative methods of obtaining consumer goods, more efficient and more ecological [4].

Biofuels have many advantages over fossil fuels: they are much easier to obtain from common biomass resources, are considered environmentally friendly, are biodegradable and are obtained through sustainable technologies [7, 11].

Bioethanol is obtained by distillation and dehydration processes and is obtained by fermentation of energy sources. Typical materials used to obtain bioethanol include: wheat, corn, rye, rice or potatoes.

Among the steps in the process of obtaining bioethanol we mention, transformation into sludge, fermentation, distillation, rectification, dehydration, CO2 recovery, treatment of distillation residues [13].

Table 1. Annual global ethanol production (million kilotons)

Region	2015	2016	2017	2018	2019	% of world production
United States	56.05	58.34	60.32	60.91	59.73	54%
Brazil	27.25	25.55	25.17	30.25	32.52	30%
E.U.	5.15	5.15	5.38	5.49	5.19	5%
China	2.91	2.54	3.03	2.91	3.79	3%
Canada	1.70	1.74	1.74	1.74	1.97	2%
India	0.72	1.06	0.76	1.63	1.93	2%
Thailand	1.17	1.29	1.48	1.48	1.63	1%
Argentine	0.83	0.91	1.10	1.10	1.06	1%
The rest of the world	1.49	1.84	1.72	2.00	1.98	2%
Total	**97.29**	**98.42**	**100.69**	**107.51**	**109.78**	**-**

Source: https://ethanolrfa.org/statistics/annual-ethanol-production/, Accessed on 09.04.2021 [10].

The global trend in terms of obtaining bioethanol is increasing, so that if in 2015 a production of 97.29 million kiloliters was recorded, in 2019 it was 109.78 million kiloliters, representing an increase of 12.8% (Table 1).

The world leader in terms of obtaining bioethanol is the United States of America, which obtained in 2019, a production of 59.76 million kiloliters, with a share of 54% of total ethanol production (Table 1).

In the case of the European Union, the cumulative production of the 28 Member States was only 5%, being almost 12 times lower than the production recorded by the main ethanol producer worldwide (Table 1).

Of note, Brazil ranks second in terms of ethanol production, due to high domestic demand, used as an energy source for means of transport, with a share of 30% of world ethanol production (Table 1).

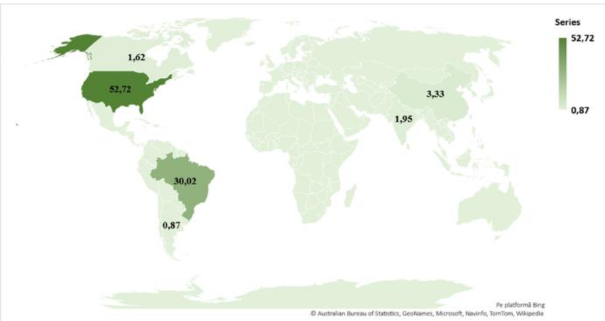

Fig. 1. World map of ethanol production, at the level of 2020

Source: data processing, https://ethanolrfa.org/statistics/annual-ethanol-production/, Accessed on 09.04.2021 [10].

At the level of 2020, the main producer of ethanol was the United States of America, producing 52.72 million kilotons, down 11.7% from the previous year, when a production of 59.72 million kilotons was obtained (Figure 1).

And in the case of the world's second largest producer of ethanol, there was a decrease in production in 2020, compared to 2019, of 7.7%, producing 30.02 million kilotons (Figure 1).

Regarding the production of ethanol in the European Union, there is a decrease of 8.8%, thus registering a production of 4.73 million kilotons. These declines in 2020 can be attributed to poor production, affected by weather conditions, as well as declining market demand for ethanol, caused by measures taken by Member States to combat the COVID-19 pandemic (Figure 1).

According to the work "Wheat as a promising substitute for maize for bioethanol production", by Neha Patni, Shibu Pillai and Ankur Dwivedi, there were made the following calculations on yield of bioethanol and also production costs from different crops [6].

The research conducted by the authors mentioned above proved that from 5 tons obtained per hectare, a quantity of 410 liters of bioethanol is obtained/ton, respectively 390 liters/ton, in the case of wheat (Table 2).

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Table 2. Comparison between production costs and yield of bioethanol from different energy crops

Culture type	Yield (t/ha/ year)	Conversion rate to sugar or starch (%)	Bioethanol conversion rate (l / t)
Sugarcane	70	12.5	70
Cassava	40	25	150
Sweet sorghum	35	14	80
Maize	5	69	410
Wheat	4	66	390

Source: Patni et al., Wheat as a promising substitute for maize for bioethanol production [9].

At the level of Romania, the predominant crops are represented by those of corn and wheat.
In this sense, the purpose of the paper was to analyze the extent to which Romania could generate sufficient bioethanol production to cover consumption needs and whether this renewable energy source is a sustainable solution or not.

MATERIALS AND METHODS

For identify the potential of bioethanol production for Romania, in this paper we used the method of quantitative analysis of data on the area cultivated with wheat and corn, production obtained for the two crops, consumption, import and export of wheat and corn, using data from the National Institute of Statistics, and the international basis Trademap.
Using the bioethanol conversion rate mentioned in Table 2, it was calculated the bioethanol production potential for the two crops taken into analysis.

RESULTS AND DISCUSSIONS

Romania benefits from a significant agricultural area. In the study, the main agricultural crops that could be used to obtain bioethanol and which have the highest share of area were analyzed. At the level of 2019, Romania used an agricultural area of 8.74 million hectares, increasing by 11.9% compared to 2010, the trend being one of growth.
Of this total area, 63.74% was cultivated with grain cereals, accumulating an area of 5.57 million hectares, increasing by 10.5% compared to the area recorded in 2010 (5.04 million ha).
Romania cultivated, in 2019, an area of 2.17 million hectares of wheat, increasing by 0.3% compared to 2010 (2.16 million ha). These oscillations can be attributed to the demand registered in previous years, the variations being significant, from one year to another, registering a maximum in 2019 (2.17 million ha) and a minimum in 2011. The share of cultivated area with wheat, out of the total cultivated area in Romania, was 24.8% (1.95 million ha) (Figure 2).
In the case of maize cultivation, in 2019 an area of 2.69 million hectares was used, increasing by 27.6% compared to the area used in 2010, respectively 2.1 million hectares. The share of the area cultivated with corn, out of the total area cultivated in Romania, was 30.65% (Figure 2).

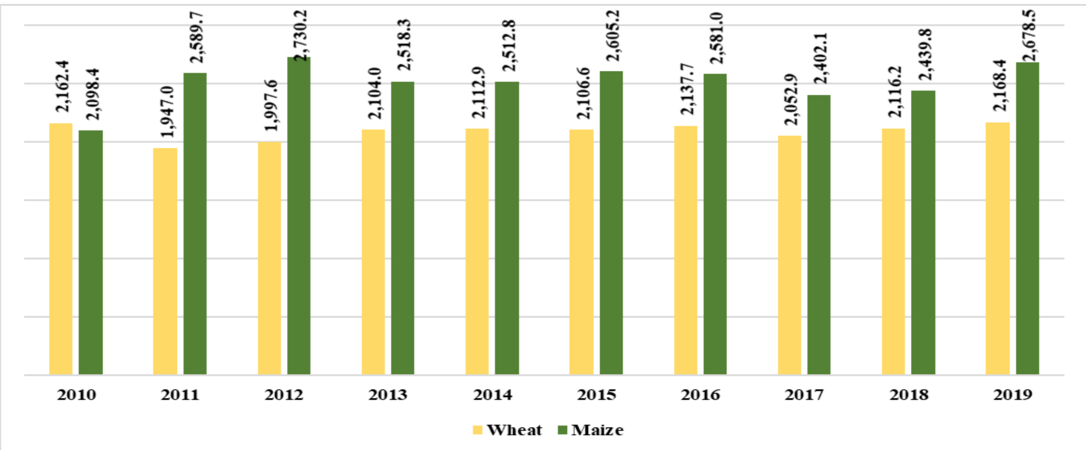

Fig. 2. Evolution of the cultivated area with wheat and corn, in the period 2010-2019 (thousand ha)
Source: NIS statistical data processing, Accessed on 09.04.2021 [8].

The total wheat production registered a substantial increase, during the analyzed period, of 77.2%, aspect determined by the increase of the surface, but also by the new technological machines used in agricultural farms, which led to the increase of the yield per hectare, so if in 2010, the registered production was 5.8 million tons, in 2019 it was 10.3 million tons (Figure 3).

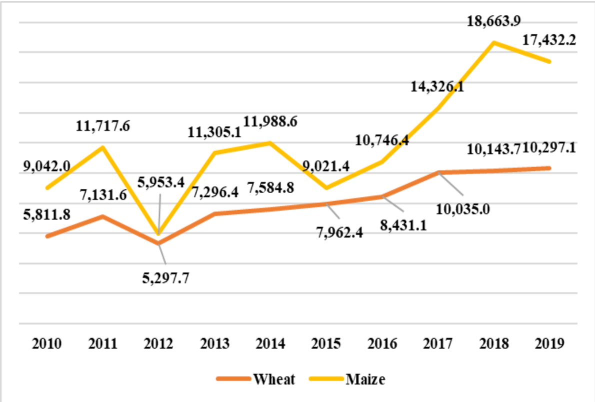

Fig. 3. Evolution of wheat and corn production, in the period 2010-2019 (thousand tons)
Source: NIS statistical data processing, Accessed on 09.04.2021 [8].

During the analyzed period, the total production of corn registered an important increase, of 92.8%, aspect generated by the increase of the cultivated areas with corn, but also by investments in technology and equipment. At the level of 2010 the registered corn production was 9.04 million tons, in 2019 the production reached the value of 17.4 million tons (Figure 3).

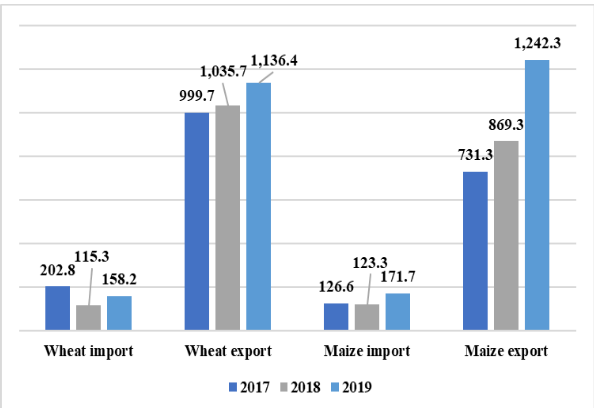

Fig. 4. Evolution of wheat and maize imports and exports, in terms of value (million EUR)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

In 2019, Romania imported wheat worth 158.2 million euros, but exported 1.14 billion euros. Also, in the case of corn, Romania imported 171.7 million euros, and exported 1.24 billion euros (Figure 4).

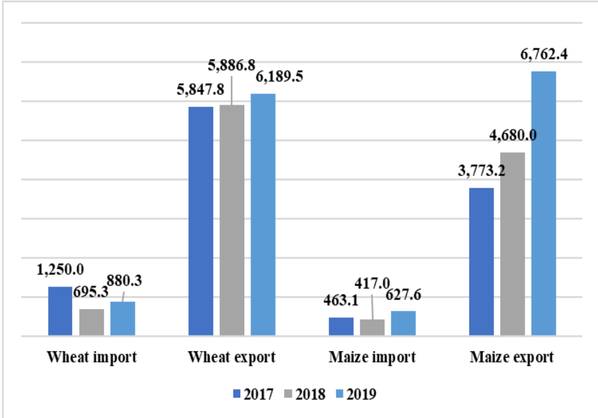

Fig. 5. Evolution of wheat and maize imports and exports, in quantitative terms (thousand tons)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

From a quantitative point of view, in 2019, Romania imported a quantity of 880.3 thousand tons, and exported a quantity of 6.19 million tons, while in the case of corn Romania imported 627.6 thousand tons, and exported a quantity of 6.8 million tons (Figure 5.).

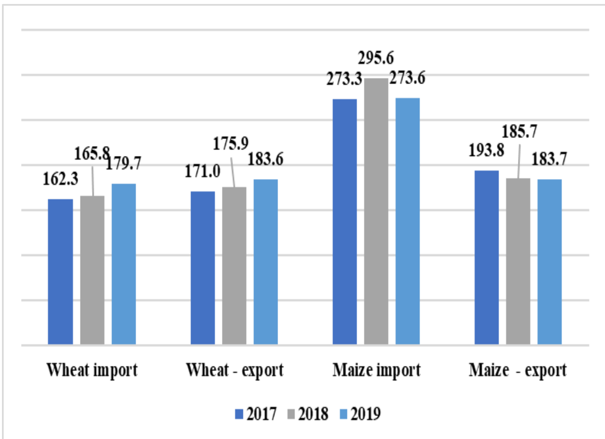

Fig. 6. Evolution of the import/export price for wheat and corn, in the period 2017-2019 (euro/ton)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

At the level of 2019, we noted the fact that wheat purchase was 179.7 euro/ton, lower than the sale price of 183.6 euro/ton. This can be explained by Romania's geographical position with an exit to the Black Sea, which

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favors trade with the Middle East countries. In the case of maize, the purchase price is 273.6 euro/ton, being by 50% higher than the export price, because the imported maize has a higher quality (Figure 6).

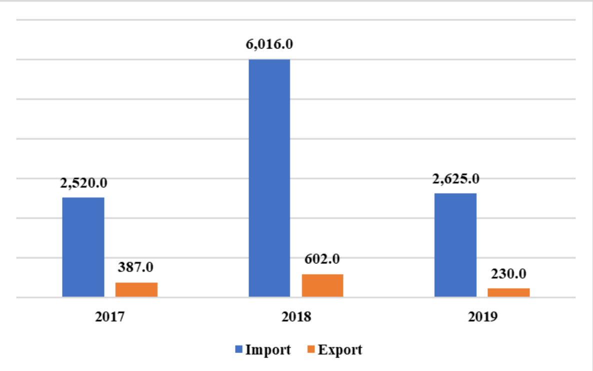

Fig. 7. Import and export (value) of ethanol worldwide in the period 2017-2019 (thousand euros)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

Regarding the import of ethanol worldwide, it shows oscillating values, so that in 2019 it was 2.62 million euros, while the export value was 230 thousand euros. These differences between the value of the import and the value of the export can be attributed to the purchase of ethanol, which is resold (Figure 7).

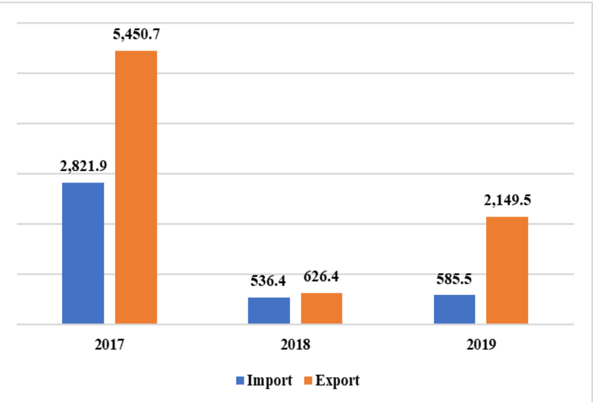

Fig. 8. Evolution of import/export price for ethanol worldwide during 2017-2019 (euro/tons)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

Analyzing the average import price of ethanol, in 2019 it was 585.5 euro/ton, being approximately 5 times lower than the import price recorded in 2017.
Also, the export price of ethanol in 2019 was of 2149.5 euro/ton, being 2 times lower than the price registered in 2017, when it was 5,450.7 euro/ton (Figure 8.).

Table 3. Bioethanol production potential in Romania

Specification	2017	2018	2019
Wheat surplus (million tons)	4.60	5.19	5.31
Maize surplus (mil. Tons)	3.31	4.26	6.13
Wheat bioethanol production potential (mil. Kilotons)	1.8	2.0	2.1
Bioethanol production potential of maize (mil. Kilotons)	1.4	1.7	2.5
Total bioethanol production (wheat + maize)	3.2	3.8	4.6

Source: own calculation.

At the level of 2019, the surplus of wheat registered by Romania was 5.31 million tons, which means that the production potential of bioethanol would be 2.1 million kilotons.
In the case of maize surplus, in 2019 it was 6.13 million tons, so that the production potential of bioethanol would be 2.5 million kilotons (Table 3).

CONCLUSIONS

At present, at the level of the European Union, the demand for bioethanol is quite low, an aspect highlighted by the transactions that take place between the Member States of the European Union.
Also, countries that need bioethanol are provided in most of their own production.
At least for the time being, both the countries of the European Union, among them Romania, do not consider an opportunity in this field, leaving the United States and Brazil to dominate this market.
The total production of bioethanol, from the two analyzed productions, at the level of 2019, would be 4.6 million kilotons, which would rank Romania, close to the total production registered at the level of the European Union, which in 2019 was 5.4 million kilotons of bioethanol.

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THE NEW PAYMENT SCHEME FOR ROMANIAN YOUNG FARMERS: EVOLUTION AND TERRITORIAL CHARACTERISTICS

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Abstract

The purpose of this study is to analyze the evolution of the volume of direct payments for young farmers from Pillar I of the Common Agricultural Policy (The Young Farmer Payment Scheme) in the period of 2015 to 2019, at national and European level. The study also analyze the links between the volume of the amount authorized for this support scheme and various socio-economic indicators of rural areas in Romania. The statistical data used in the study has been taken from the structured national bases at county level and analyzed using the correlation method. The results of this study is indicating that the support of the payment scheme has contributed to the growth of the share of young farmers numbers, with strong territorial differences. Determining the intensity of the relationship between the volumes of the amount authorized for the payment of young farmers through the first pillar and certain socio-economic variables of the rural environment may contribute to the explanation of certain regional patterns.

Key words: *young farmers, payment scheme for young farmers, pillar I, correlation*

INTRODUCTION

The renewal of young farmers' generations it is a constant concern for decision-makers in the European Union. The research on this topic has intensified in the last decade, representing a topical issue widely debated both at European level and in the specialized literature.

The European Council has highlighted since 2014 [9] that young farmers and the renewal of the agricultural generation are key to the long-term sustainability and competitiveness of European agriculture.

On the other hand, a high number of studies indicate that the number of young farmers has decreased both in European and in global level, due to technology development, socio-economic and demographic changes (Chen et al., 2014 [7], Duesberga et al., 2017 [10]; Leonard et al., 2017 [10]; Morais et al., 2017 [21]).

According to Eurostat statistics on the farming structure [13], only about 11% of all farmers were under 40 years of age, in 2016 at European level. The share of farmers with the appropriate retirement age (54-64 years) and the share of farmers over 64 years are twice as high, each by about 27% than the category of farmers under 40 years. Is considered that the young farmers have the necessary potential to create efficient, competitive, innovative agricultural enterprises, thus becoming more profitable and sustainable (Council of the European Union, 2014; Zagata and Sutherland, 2015) [33].

The reform package of the common agricultural policy, approved by the EU on 16 December 2013, addresses the age imbalance of the farmers, introducing an additional payment for young farmers under Pillar I as a justification for overcoming the demographic challenge affecting all Member States. This payment is associated with the measure on the setting up of young farmers in the second pillar, as it will provide the necessary impetus for the activity of young farmers.

The total budget allocated by the European Union for supporting young farmers, in the period of 2007 to 2020, rose up to the value of 9.6 billion euros. This budget has doubled, from 3.26 billion euros in the period 2007-2013, provided for the measure on the installation, under the second pillar, to the value of 6.36 million euros in the period 2014-2020. This increase is due to the introduction of the additional direct payment for young farmers under Pillar I, complementary to the support of this category of farmers through Pillar II measures.

The income support for young farmers introduced in Pillar I by the Payment for Young Farmers in 2014 (an additional payment of 25% of the direct payment) is intended for young farmers who are starting their agricultural activity. They should not exceed the age of 40 in the year of the first deposit of the application under the basic payment scheme or under the single area payment scheme (Reg. 1307/2013). The payment for young farmers is a compulsory aid scheme for all Member States of the European Union and it can represent up to 2% of the total national direct payment allocations.

The predominant flow of scientific literature has identified that there are a number of positive effects of the direct payments on rural sustainability (Smedzik-Ambrozy, 2013; Cortignani et al., 2017) [30, 8].

The idea of sustainability has been widely debated so that, for the rural environment, sustainable development is defined as meeting current needs without compromising future generations from meeting their own needs [32], and for this to happen it is necessary to build structured relations between economic growth and social factors. One of the main objectives of the financial support provided by the CAP is to support rural sustainability, the most common measures being those with an economic effect (increasing production, consumption, gross domestic product and income) [14].

A sereas of researches emphasize that the financial support in the EU has the purpose of employment in rural areas, whitch maintains the viability of these regions by contributing to increasing the sustainability of rural areas (Helming and Tabeau, 2018) [17]. One of the main threats to rural sustainability is the depopulation trend, in which case the stimulation of the economic activity would allow the reversal of this trend and the support of the living standards of the population from the rural areas, (Garcia-Llorente et al., 2016) [15]. The favorable impact on economic sustainability in the agricultural sector has also been demonstrated by Marta Guth et al., (2020) [16], with direct financial support to farmers proving to be significant for agricultural incomes and with a positive impact on increasing farm profitability.

Balezentisa et. colab, 2020 [4], analyzing the perceived benefits of the PYF scheme in Lithuania, using a questionnaire as a research tool, notes that this support scheme contributes, to a large extent, to income support, encourages investigations and the continuation of agricultural activities, the smallest perceived effect is to find new markets.

There are also a number of research studies that claim that there are doubts about the effectiveness of payments for young farmers. Carbone and Subioli (2008) [6] concluded that the level of support available to young farmers, in the case of Italy, is insufficient to attract young people to the agricultural sector or to encourage family succession on existing farms. Andersons (2015) [3] studying the phenomenon concluded that these payments to young farmers in recent CAP reforms provide a limited amount of financial support, with few long-term consequences. ECA, 2017 also argued that the overall objective of encouraging generational renewal was not reflected in the objective of Pillar 1 payments to young farmers.

Taking into consideration the specialized studies on the effects of direct payments, as well as the impact of payments to young farmers, the present study’s purpose is to analyze the evolution of the Support Scheme for young farmers and the link between the volume of the amount authorized for this support scheme and the variables rural areas in Romania.

MATERIALS AND METHODS

In order to achieve the purpose of the research, the following were performed:

- in the first part of the paper were analyzed the statistical data on the Support Scheme for young farmers both in European and at national level, thus determining Romania's position between States Members, but also the

existence of a difference in the distribution of this support at territorial level;
- in order to achieve the purpose of the research, a set of socio-economic variables were analyzed, in the second part of the study (Table 1). The statistical data used were processed using the Correl function, thus determining the correlation coefficient among the variables. The statistical data processed in the paper were analyzed at the level of the 41 counties in Romania.

Table 1. Description of technical indicators used in the study

Variables	Description	Period	Source
Authorized amount	The authorized amount is the amount of money approved and debited to the beneficiaries of the Payment Scheme for young farmers	2015-2019	Agency for Payments and Intervention in Agriculture - APIA
Socio-economic indicators:			
Demographic data	The share at county level of the rural population aged 18-40, eligible for the submission of the file for the Young Farmers Payment Scheme, out of the total rural population	2015-2019	National Institute of Statistics, NIS, Statistical Yearbook of Romania
Demographic dependency	The demographic dependency ratio is the ratio between the number of dependent people (under 15 and over 64) and the number of able-bodied people (15-64 years) expressed per 100 people	2015-2019	National Institute of Statistics, NIS, Statistical Yearbook of Romania
Employed agric.	Population employed in agriculture al county level	2015-2019	National Institute of Statistics, NIS, Statistical Yearbook of Romania
Population migration	Internal migration determined by the change of domicile (arrivals, departures, balance) for the rural environment in 2015 (no. population)	2015	National Institute of Statistics, NIS, Statistical Yearbook of Romania
GDP	Gross domestic product at county level	2015-2019	National Institute of Statistics, NIS
Value of Agricultural Production (VAP)	The value of agricultural production at county level	2015-2019	National Institute of Statistics, NIS
Contracted value SM6.1	Value contracted on Sub-Measure 6.1.	2014-2020	Agency for the Financing of Rural Investments - AFIR
No. projects SM6.1	Number of projects contracted under Sub-Measure 6.1.	2014-2020	Agency for the Financing of Rural Investments - AFIR
Agricultural indicator:			
Agricultural area	Agricultural area at county level	2016	NIS, Structural Survey in Agriculture 2016
Holdings 1-10ha	Nr. holdings with areas between 1-10 ha, at county level	2016	NIS, Structural Survey in Agriculture 2016
Holdings 10-100ha	Nr. holdings with areas between 10-100 ha, at county level	2016	NIS, Structural Survey in Agriculture 2016
Holding 100 and over	Nr. holdings with areas larger than 100 hectares, at county level	2016	NIS, Structural Survey in Agriculture 2016

Source: [1, 2, 22, 23, 24].

The correlation represents the degree of statistical connection between the quantitative variables.
The correlation coefficient was determined using the formula [31]:

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

where:
$x = x_1, x_2, ..., x_n$ and $y = y_1, y_2, ... y_3$ are the measured values;

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$\bar{x}$ *and* $\bar{y}$ are the sampling averages of the respective series.

The correlation coefficient (r) has values between -1 and 1. The correlation sign indicates the nature of the positive or negative bond, and the value describes the strength of the bond that appears between the variables so that: we have a weak bond for $r < 0.30$; average bond for $r = 0.30 - 0.50$; strong bond for $r > 0.50$.

RESULTS AND DISCUSSIONS

Direct payments are a key element of agricultural policy, their purpose being to support incomes for farmers while promoting good agricultural and environmental practices.

Distribution of expenses with direct payments at U.E. in 2018 it was as follows: the majority share of the total was held by the Basic Payment Schemes, with 42.2% and SAPS with 29%. The lowest expenditures were registered for Coupled Support with a weight of 9.9%, Redistributive Payment with 4.1%, Scheme for small farmers with 2.2% and Payment for Young Farmers.

The payment for young farmers in 2018 accounted for 1.3% of the total direct payments at EU level (41.33 billion euros), the equivalent of 545.63 million euros (Figure 1).

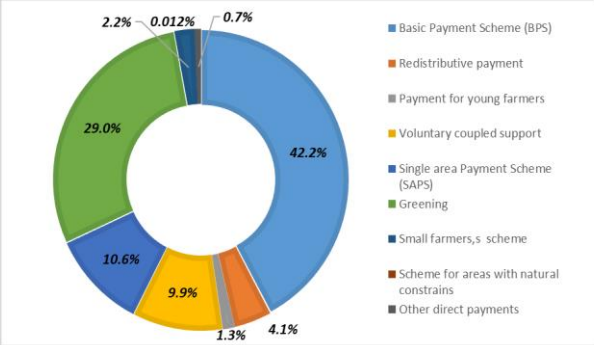

Fig. 1. Distribution of direct payments at U.E.
Source: processed data according to AGREX database (System for Agriculture Refund Expenditure) [12].

Direct payments to young farmers under Pillar I have been introduced in all EU Member States, so that in the period 2015-2018, according to EAGF reports an amount of EUR 1.59 billion has been allocated, at European level.

The amounts allocated for payments to young farmers at EU level, increased over the four years studied, thus finding that the popularity of this support has increased and the requests have been more numerous. (Special Report, EU 2017).

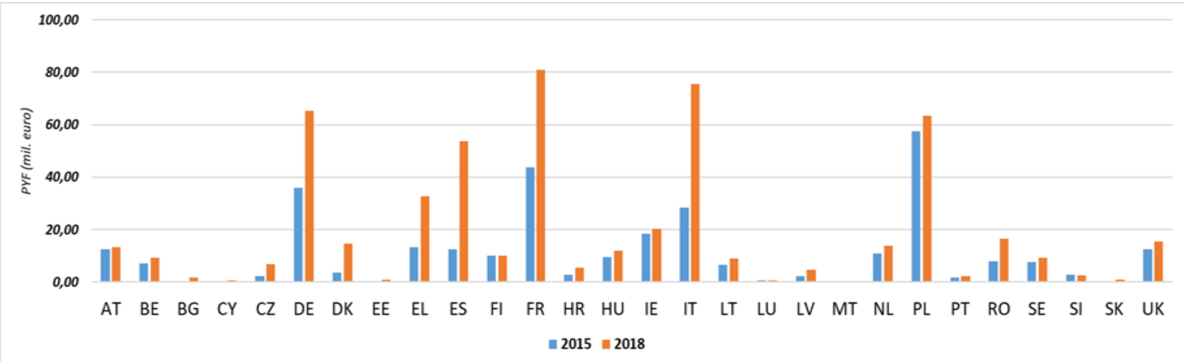

Fig. 2. Distribution of amounts allocated for payments to young farmers
Source: EAGF report data [11].

The allocated amount for the payment of support for young farmers in the period 2015-2018 for Romania varied between 7.91 million euros and 16.63 million euros, representing a share of the value allocated to direct payments at national level of 0.52% up to 0.66%. The trend of the amounts allocated to this payment is an upward one, this direct payment representing a stimulus in the takeover of new holdings by the young managers (heads of holding).

At national level, according to the GEO. 3/2015, the Young Farmers Scheme Payment involves the granting of an annual payment to new farmers installed at the head of the holding, who are entitled to the single area payment and meet certain conditions [28]. This support is granted to each farmer for a maximum period of five years. A maximum of 2% of the annual national ceiling provided for in Annex II to Regulation (EU) No 1307/2013 shall be used to finance the payment for young farmers [29].

The amount of payment for young farmers is established annually by Governmental decision. (According to GEO no. 3/2015). The value of the scheme amount support the for young farmers per hectare, which was established on the basis of decisions taken at national level for the period 2015-2019, has registered a gradual increase, so that if in 2015, it was 19.93 euro/ha, in 2019, it reached the value of 31.24 euro/ha, with an increase of 56.8%.

Over 70% of the total funds allocated to the agricultural sector are managed by the Agency for Payments and Intervention for Agriculture, at national level, for the benefit of over 1 million users, with a funding of over 15 billion euros.

Table 1. Indicators calculated at national level on the Payment Scheme for young farmers

Specification	2015	2019	2019/2015 (%)	Mean	Annual rhythm (%)
Beneficiaries	45,512	59,096	29.84	51,168.4	6.75
Area (thousand ha)	472.04	720.21	52.70	583.65	11.14
Authorized amount (milion euro)	9.40	22.50	139.20	14.82	24.36
Average area per beneficiary (ha)	10.37	12.19	17.50	11.36	4.11
Average amount authorized per beneficiary (euro)	206.71	380.82	84.22	16.50	16.50

Source: processed according to APIA data, 10.12.2020 [2].

The number of beneficiaries who received support through the Young Farmers Scheme has been on the rise. In 2019 compared to 2015, it increased by 29.84%, from 45.5 thousand to 59 thousand, the support enjoying popularity among young newly established farmers. The largest share of beneficiaries of this scheme is held by the North-West Region and the South-West Oltenia Region with 20.4% and 15.8% respectively of the total beneficiaries at national level.

At national level, the values authorized for the support for Young Farmers Scheme increased gradually, with an average annual rate of 24.36%, ranging between 9.4 million euros (2015) and 22.5 million euros (2019).

The main counties that benefited from funds accessing the Support Scheme for young farmers in 2019 are Olt, Timiș, Dolj, Tulcea and Constanța, these totaling a percentage of 24% of the total authorized amount. Among the counties that registered the lowest authorized amounts are: Bucharest, Gorj, Ilfov, Vâlcea and Prahova, holding 2.63% of the total amount authorized at national level.

Comparatively analyzing the year 2019 with the year 2015 (the year in which this support scheme was introduced) it was possible to observe the fact that at county level the ranking was maintained, although the amounts authorized as value in the year 2015 were much lower than in the year 2019.

According to the representation in Figure 3, in 2015 the counties of Ilfov, Tulcea, Călărași and Constanța registered the highest amounts related to the number of beneficiaries.

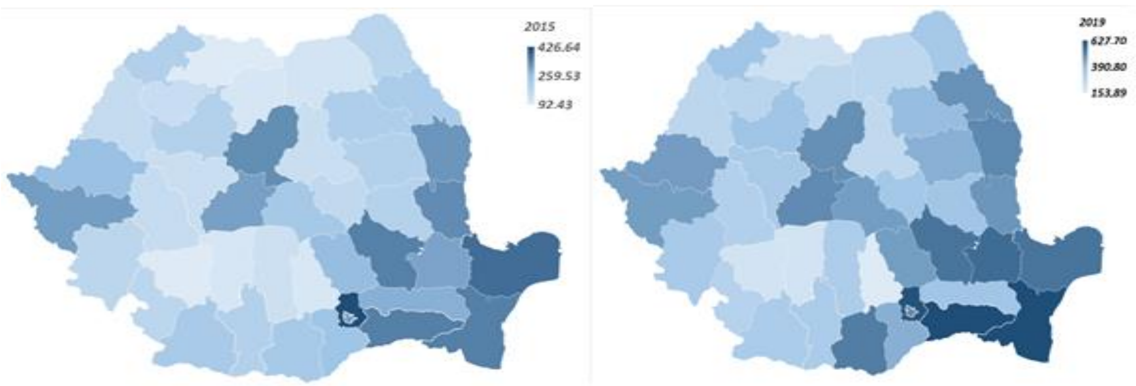

Fig. 3. Average authorized amount per beneficiary (euro) al counties level, 2015 vs 2019
Source: authors calculations, using STATA s spmap.

It is about 382.01 euro, 369.38 euro and 355.27 euro, respectively, these being much higher than the national average of 206.71 euros.

In the case of the year 2019, concerning Ilfov, Constanța,

Călărași and Tulcea counties, there are average amounts per beneficiary higher than the national average of 380.8 euros.

Maintaining the ranking at national level is due to the larger size of farms owned by young farmers in these counties, which exceed the national average.

The average area of the farming exploatation that nationally benefited from PYF varied in the time period of 2015-2019 between 10.37 ha and 12.19 ha.

Regarding the surface distribution at county level, it can be seen in Figure. 4 that in 2019 the counties that benefited from PYF with the highest average areas on the farm were Ilfov with 19.73 ha/farm, Tulcea with 17.59 ha/ farm, Călărași with 19.98 ha/farm and Constanța with 20.09 ha/farm.

Analyzing the average dimensions of farms benefiting of PYF from 2015 till 2019, it was found that 35.71% of counties recorded average values between 6-10 ha/farm, while 64.29% of counties recorded average values of areas between 10-19.4 ha/farm.

The correlation coefficient was calculated in order to determine a link between the support for the payment scheme of young farmers and the socio-economic variables specified above.

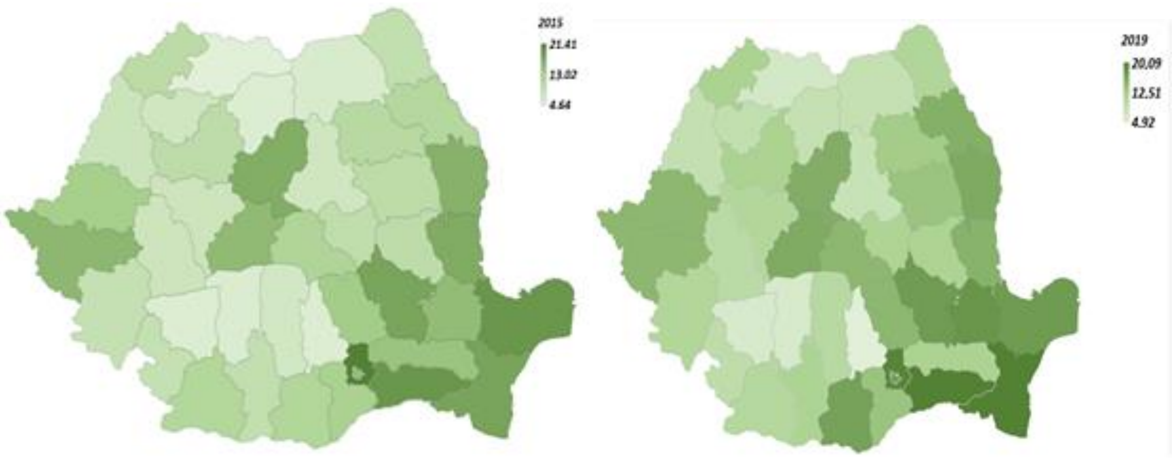

Fig. 4. The average area of the holding for which support is received, by counties (ha), 2015 vs.2019
Source: authors calculations, using STATA s spmap.

In Table 3 it can be find that there are 9 links of medium and tight intensity, between the volume of the authorized amount and the technical indicators taken into analysis.

Analyzing the correlation coefficients between the authorized amount and the demographic indicators (the share of the rural population aged 18-40 years and the employed population in the agricultural sector) it is observed that there is an average and positive link. This indicates that the Payment Scheme for Young Farmers tends to be higher in areas where the demographic indicators studied have higher values, thus meeting one of the general conditions for job creation in agriculture for the population up to in 40 years. Nordin M., (2014) [25], studied the effect of direct payments on the labor force, which is a positive and supportive job in agriculture. On the other hand, the general effect of investment support on labor productivity (Ratinger et al., 2012) [27] and labor reduction (Petrik and Zier, 2011) [26] is relatively well known.

Regarding the link between the authorized amount and the demographic dependency ratio, according to the correlation coefficient determined, a very weak link is observed (r <0.30). Payment scheme for young farmers tends to be higher in areas where the number of dependents for each person of working age has a higher value, which indicates that these areas able-bodied persons can apply for PYF, age is a considerable advantage in accessing funds.

Table 3. Analysis of the correlation coefficient

	Authorized amount	Demographic data	Demographic dependency	Employed in agric.	Internal Migration Rural			GDP	VAP	Contracted Value SM6.1	No. projects SM6.1	Agricultural area	Holdings 1-10ha	Holdings 10-100ha	Holding 100 and over
					Arrive	Leave	Balance								
Authorized amount	1														
Demographic data	0.359	1													
Demographic dependency	0.181	0.579	1												
Eemployed in agric.	0.430	0.365	0.389	1											
Internal migration Rural – Arrive	0.300	0.371	0.210	0.619	1										
Internal migration Rural – Leave	0.288	0.377	0.293	0.783	0.837	1									
Internal migration Rural – Balance	0.154	0.189	0.007	0.119	0.729	0.236	1								
GDP	-0.189	-0.777	-0.882	-0.294	-0.082	-0.210	0.118	1							
VAP	0.639	0.384	0.206	0.658	0.432	0.534	0.099	-0.232	1						
Contracted value SM6.1	0.537	0.198	0.015	0.276	0.204	0.195	0.118	-0.099	0.388	1					
No. projects SM6.1	0.528	0.196	0.015	0.276	0.202	0.194	0.116	-0.099	0.382	1.000	1				
Agricultural area	0.746	0.381	0.421	0.553	0.169	0.329	-0.111	-0.388	0.628	0.281	0.276	1			
Holdings 1-10ha	0.017	0.204	0.365	0.769	0.430	0.726	-0.144	-0.299	0.356	0.178	0.182	0.212	1		
Holdings 10-100ha	0.381	0.398	0.170	0.143	-0.039	-0.067	0.015	-0.238	0.193	0.148	0.146	0.371	-0.055	1	
Holding 100 and over	0.720	0.324	0.139	0.364	0.267	0.318	0.077	-0.150	0.767	0.230	0.222	0.737	-0.036	0.131	1

Source: own calculations based on APIA, AFIR, Agricultural Structural Survey 2016 and NIS using Data Analysis of MS Excel [1, 12, 23, 22, 24].

Analyzing the correlation coefficient between the authorized amount and the indicators that characterize the internal migration of the rural area (rural arrivals, rural departures, rural balance), a positive link between variables is observed. In areas where the number of people who have migrated to rural areas is higher, the amount allowed is higher, fact that may indicate that the Payment Scheme for Young Farmers may stimulate the return of young people to rural areas. This support could become a means of limiting migration trends in rural areas.

A direct correlation is found between the authorized amount and the value of agricultural production (VAP), because the two variables vary in the same direction. Also, the value of the correlation coefficient of 0.639 indicates a very close level of intensity between the two variables. In this context, it can be seen that there is a possibility that access to the support scheme for young farmers can be made in areas with predominant economic activity in the agricultural sector, thus the value of agricultural production is higher. Kravcakova Vozarova et al., 2016, confirms this link and the results indicating a close correlation between the volume of allocated subsidies and the value of agricultural production [19].

In order to identify the relationship with the general level of development, the average gross domestic product (GDP) at the level of the 41 counties was used as a variable. Analyzing the correlation coefficient between the authorized amount and GDP, a negative correlation is observed, the two variables varying in opposite directions. The value of the correlation coefficient of -0.181 indicates a weak link between the two variables. In areas where GDP is higher, the amount allowed is lower, which could indicate that the area's economy is geared towards higher value-added branches and sectors, with young people's interest in agricultural activities being lower.

The support scheme for young farmers was introduced as an income support for young farmers newly established at the head of a farm. Thus, this represents an additional income in addition to the funds allocated through Sub-Measure 6.1. „Support for the installation of young farmers „ from Pillar II. Analyzing the existence of a link between the two measures with the same recipient, a positive, strong correlation was observed, with a correlation coefficient r> 0.50. Thus, in areas where the value of projects contracted on SM6.1. it is higher and the amounts authorized by the payment scheme are higher, which indicates the complementarity of the instruments in the development of the holding at the beginning.

Analyzing the correlation coefficient between the authorized amount and the agricultural area, a positive correlation is observed, the two correlated variables vary in the same direction. The value of the correlation coefficient of r = 0.746 indicates a close link between the two variables. The data analyzed shows that if the areas in certain zones are larger then the amount authorized tends to increase, the amount allocated to the support measure being directly proportional to the size of the agricultural area owned by young farmers. Here, however, the level of accessibility of young people to agricultural lands must also be taken into account.

After calculating the correlation coefficients between the authorized amount and the number of holdings according to the agricultural size: holdings with a size between 1-10 ha, holdings with a size between 10-100 ha and holdings with over 100 ha, it was found that:

- there is a positive but very weak link between the amounts authorized for the payment of young farmers and the number of farms with the size between 1-10 ha. Taking into consideration the fact that approximately 15% of the counties registered an average size of the farm benefiting from PYF between 6-10 ha, this measure can play a structural role in integration of small areas;
- there is an average link between the authorized amounts and the farms with the size of 10-100 ha, the correlation is a positive one, taking into account the fact that the support increases depending on the number of hectares owned per farm;
- regarding the correlation coefficient between the authorized amount and the number of holdings with a size of over 100 ha, its value is 0.720, which indicates a close level of correlation between the two variables. Thus, in areas where the number of farms with a size of over 100 ha is higher, the authorized amount is higher. Duska (2012) states that the frequency of applications for payments to young farmers is higher for young owners of large farms. [18]. Stefan Bojneca et al., (2013) [5] emphasize that both the size of the farm and the performance of the farms play a substantial role in farm performance.

CONCLUSIONS

Income support for young farmers has been introduced in Pillar I by Young Farmers' Payment Scheme since 2014, representing a compulsory aid scheme for all EU Member States. The introduction of this support scheme aimed to provide a necessary impulse to the activity of young farmers, the broader objective being to rejuvenate generations of farmers and to encourage the transfer of farms between generations.

According to the study, both in European and at the national level it was found that the support scheme has contributed to increasing the share of young farmers, thus arousing the interest of young people to start an activity in agriculture.

Following the analysis, the results indicate that there is a close connection between the volume of the authorized amount for the Young Farmers' Payment Scheme and the agricultural indicators, given the fact that the support is granted according on the measure of the area owned by young beneficiaries of the support.

A positive and strong correlation has resulted between the value of agricultural production and the volume of the amount authorized. This situation indicates that it is possible for young farmers to access the support scheme in areas with predominant economic activity in the agricultural sector.

The gross domestic product, which defines the general level of development of an area/county, has a weak link with the volume of the amount authorized for PYF, the two variables varying in opposite directions, which could indicate that the economy of the area is oriented towards branches and sectors. with higher added value.

This paper analyzed the relationship between direct payments to young farmers and certain structural variables that characterize the rural areas. In order to assess the impact of these tools that encourage young people to work in agriculture for improving the age structure of farmers in the sustainable development of agriculture and rural areas, more detailed analyzes is needed.

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COMPARATIVE ANALYSIS OF SOME GLADIOLUS VARIETIES IN RELATION TO VEGETATIVE INDICES AND FLORAL QUALITY PARAMETERS

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Abstract

The present study aimed to analyze and characterize five gladiolus varieties, based on flower quality parameters in relation to some vegetation indices. The studied gladiolus varieties were: 'Plumtart' (Plu), as control variant (Mt), 'Flower Song' (Flo_S), 'Tequendame' (Teq), 'Princess Margaret Rose' (PMR), and 'Praha' (Pra). For the comparative analysis of the five gladiolus varieties, vegetation indices and flower quality parameters were used: vegetation period until flowering (VPuF), plant height (PH), floral stem number (FSN), inflorescences length (IL), flowers number (FN), flowering time (FT), and total vegetation period (TVP). Inflorescences length (IL) recorded values between 30.33 cm for the 'Praha' (Pra) variety and 64.00 cm for the 'Flower Song' (Flo_S) variety. The flowers number (FN) in the inflorescence registered values between 12.50 for the 'Praha' (Pra) variety, and 19.17 for the 'Flower Song' (Flo_S) variety. Flowering time (FT) varied between 24 days for 'Praha' and 'Flower Song' varieties, and 28 days for 'Princess Margaret Rose' and 'Plumtart' varieties. The regression analysis facilitated the obtaining of equations that described the variation of the flowers number (FN) in relation to the flower stem number (FSN), and inflorescence length (IL), respectively the variation of FT in relation to VPuF and FSN, under statistical safety conditions. According to PCA, PC1 explained 90.243% of variance, and PC2 7.3695% of variance. Cluster analysis facilitated the grouping of the studied gladiolus varieties based on similarities in relation to the vegetative indices and floral quality parameters, in conditions of statistical safety (Coph.corr = 0.955).

Key words: *floral quality parameters, flowering time, gladiolus, models, vegetation indices*

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), are part of the Iridaceae Family, with over 250 known species. They are bulbous plants, cultivated for ornamental purposes, over 150 endemic species, originating from South Africa [23], [18].

Different species of gladiolus have been studied in order to diversify and enrich the palette of ornamental flowers for cut flowers, gardening or green spaces [15]. Some studies have analyzed different varieties of gladiolus in order to characterize them based on phenolic profile and molecular markers [26].

For ornamental purposes, a quality biological material is necessary, so that numerous studies on gladioli have analyzed the multiplication process and have been carried out in relation to corms production for the production of cut flowers [30], [6], [7], [31].

Some studies have analyzed the relationship and response of gladioli to vegetation conditions, water regime, and bioactive substances [25].

Vegetative growth, plant development and flower quality in gladioli were analyzed in relation to different growth media as well as in relation to climatic conditions [19], [33].

The growth and development of plants and the quality of flowers in different gladiolus genotypes and cultivars, have been studied in relation to various fertilizing, mineral and organic resources, as well as in relation to certain nutrients, such as nitrogen, phosphorus, potassium, etc. [1], [3], [12], [9], [20], [35]. The stages of growth and development, respectively the quality of flowers in gladiolus, were evaluated in relation to the fertilization rate [2].

Given the demand for flowers on the market and their quality, some studies have analyzed the growth and development of gladiolus in relation to commercial fertilizers, in nutrient film growth systems [24].

The flowering period of gladiolus is genotype dependent, but is also influenced by climatic and technological factors [28]. Studies on the behavior of some varieties of gladiolus, in relation to the period and duration of flowering were performed and communicated by Cantor et al. [8].

The behavior of some gladiolus varieties in relation to the planting period, flower production, physiological and flower quality indices, as well as genetic factors were studied [4], [5].

Some studies have approached the use of gladiolus as cut flowers, in order to ensure the quality of flowers in different market conditions [21].

The behavior of gladioli and the level of tolerance in relation to different stress factors (eg. saline, water, etc.) were also studied [10].

Simulation models regarding the development of gladiolus were developed in some studies, in relation to different factors [32].

The present study aimed to analyze and characterize some gladiolus varieties based on floral quality parameters in relation to vegetation indices.

MATERIALS AND METHODS

The study aimed at the comparative evaluation of five gladiolus varieties, to assess their value in relation to certain flowering parameters associated.

The biological material was represented by the following gladiolus varieties: 'Plumtart' (Plu), as control variant (Mt), 'Flower Song' (Flo_S), 'Tequendame' (Teq), 'Princess Margaret Rose' (PMR), and 'Praha' (Pra), (Figure 1).

'Plumtart' (Plu) is a semi-early variety with a flower stem of 100 cm, with an inflorescence of 70-80 cm; cyclamen flowers color. It is recommended for cut flowers.

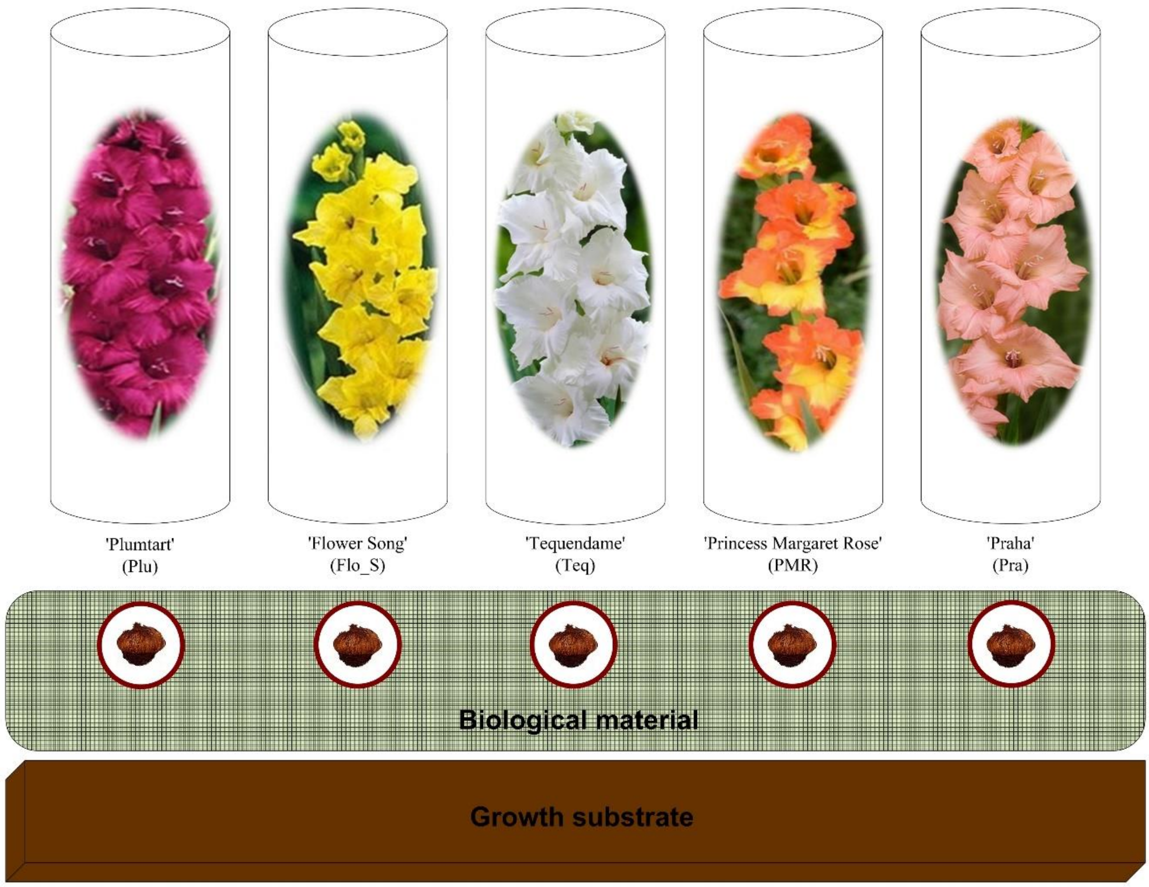

Fig. 1. The gladiolus varieties studied
Source: Original.

'Flower Song' (Flo_S) is an early variety, with a flower stem of 100 cm and inflorescences of 60-70 cm length. The flowers are yellow. It is used for cut flowers.
'Tequendame' (Teq) is a midseason variety, with a floral stem of 100 cm, and an inflorescence of 70-80 cm length. The flowers are white. It is used alone or in combination with other species in floral arrangements or bouquets.
'Princess Margaret Rose' (PMR) is a late (very late) variety, with a flower stem of 90 cm and inflorescences of 60-70 cm length. The flowers are yellow with a red border, which gives it the appearance of embers.
'Praha' (Pra) is a late (very late) variety, with a flower stem of 90 cm and inflorescences of 60 - 70 cm length; light pink flowers. It is recommended for cut flowers.
For the comparative analysis of the five varieties of gladiolus, vegetation indices and flower quality parameters were used: Vegetation period until flowering (VPuF), Plant height (PH), Floral stem number (FSN), Inflorescences length (IL), Flowers number (FN), Flowering time (FT), total vegetation period (TVP).
The experimental data were analyzed by appropriate statistical methods, in relation to the proposed objectives (variance analysis, correlation analysis, regression analysis, Principal Component Analysis, Cluster analysis). To estimate the significance of differences between varieties, the significance limits of differences (LSD) were calculated for the statistical thresholds of 5%, 1% and 0.1% respectively.
PAST software [16], and Wolfram Alpha software [34] respectively were used for data analysis and processing.

RESULTS AND DISCUSSIONS

After planting the bulbs, the five varieties of gladiolus were studied from the perspective of some vegetation indices and flower quality parameters. The floral stems number (FST) recorded average values between 1.50 for 'Plumtart' and 3.50 for the 'Princess Margaret Rose' variety (Table 1). The differences compared to the control variant (Plu) presented the statistical safety in conditions of LSD5% in the case of Teq and Pra variants, respectively in conditions of LSD0.1% for the PRM variant.

Table 1. Floral stem number in the studied gladiolus varieties

Variety	Average values	Relative value (%)	Differences and significance
'Plumtart' (Mt)	1.50	100.00	-
'Flower Song'	2.17	144.44	0.67
'Tequendame'	2.33	155.56	0.83*
'Princess Margaret Rose'	3.50	233.33	2.00***
'Praha'	2.33	155.56	0.83*
LSD	LSD5%=0.76; LSD1%=1.03; LSD0.1%=1.40		

Source: Original data from experiment.

The five gladiolus varieties had variable plant height, in accordance with the biological specificity of each. Thus, the plant height varied between 83.17 cm in the case of the 'Praha' variety (Pra) and 127.50 cm in the case of the 'Tequendame' (Teq) variety (Table 2). Compared to the control variant (Plu), a hight variety, the differences in plant height showed differences in statistical safety conditions in the Flo_S variant (LSD1%) and in the PRM and Pra variants (LSD0.1%).

Table 2. Plant height in the studied gladiolus varieties

Variety	Average values	Relative value (%)	Differences and significance
'Plumtart' (Mt)	126.67	100.00	-
'Flower Song'	115.67	91.32	-11.00 ºº
'Tequendame'	127.50	100.66	0.83
'Princess Margaret Rose'	92.83	73.29	-33.83 ººº
'Praha'	83.17	65.66	-43.50 ººº
LSD	LSD5%=6.72; LSD1%=9.13; LSD0.1%=12.38		

Source: Original data from experiment.

The length of the inflorescences (IL) registered values between 30.33 cm for the 'Praha' variety (Pra) and 64.00 cm for the 'Flower Song' variety (Flo_S) (Table 3). The differences registered in relation to the control variant (Plu) presented statistical safety to the variety 'Tequendame' (Teq) in conditions of LSD 5%, for 'Princess Margaret Rose' (PRM) variety in conditions of LSD1%, and for 'Flower Song' (Flo_S) respectively 'Praha' (Pra) varieties in conditions of 0.1%.

Table 3. The length of the inflorescences in the studied gladiolus varieties

Variety	Average values	Relative value (%)	Differences and significance
'Plumtart' (Mt)	49.17	100.00	-
'Flower Song'	64.00	130.17	14.83***
'Tequendame'	52.83	107.46	3.67*
'Princess Margaret Rose'	43.33	88.14	-5.83°°
'Praha'	30.33	61.69	-18.83°°°
LSD	LSD5%=3.30; LSD1%=4.48; LSD0.1%=6.07		

Source: Original data from experiment.

The number of flowers in the inflorescence (FN) registered values between 12.50 for the 'Praha' variety (Pra), and 19.17 for the 'Flower Song' variety (Flo_S) (Table 4). The differences between the variants, in relation to the control variant (Mt), presented statistical safety in conditions of LSD1% for the 'Flower Song' and 'Princess Margaret Rose' varieties, respectively in conditions of 0.1% for the 'Praha' variety. With higher values was the 'Flower Song' (Flo_S) variety, and with negative differences were the 'Princess Margaret Rose' (PMR) and 'Praha' (Pra) varieties.

Table 4. Number of flowers in inflorescence in the studied gladiolus varieties

Variety	Average values	Relative value (%)	Differences and significance
'Plumtart' (Mt)	17.00	100.00	-
'Flower Song'	19.17	112.75	2.17**
'Tequendame'	17.50	102.94	0.50
'Princess Margaret Rose'	14.67	86.27	-2.33°°
'Praha'	12.50	73.53	-4.50°°°
LSD	LSD5%=1.47; LSD1%=2.00; LSD0.1%=2.71		

Source: Original data from experiment.

The five gladiolus varieties were planted on April 27. As a result of the biology specific to each variety, they had a different period of vegetation until flowering, with values between 73 days for the 'Flower Song' (Flo_S) variety, and 103 days for the 'Praha' (Pra) variety (Table 5). The flowering period, on all the studied varieties, was registered between July 10 (Flo_S) and September 3 (PRM), with a variation specific to each variety (Table 5, Figure 2).

Table 5. Vegetation and flowering period for the studied gladiolus varieties

Variety	Date og planting	Vegetation period until flowering (VPuF)	Beginning of flowering	End of flowering	Flowering Time (days)	Total vegetation period (TVP)
'Plumtart' (Mt)	27 April	74	11 July	7 August	28	102
'Flower Song'		73	10 July	2 August	24	97
'Tequendame'		81	18 July	12 August	26	107
'Princess Margaret Rose'		101	7 August	3 September	28	129
'Praha'		103	9 August	1 September	24	127

Source: Original data from experiment.

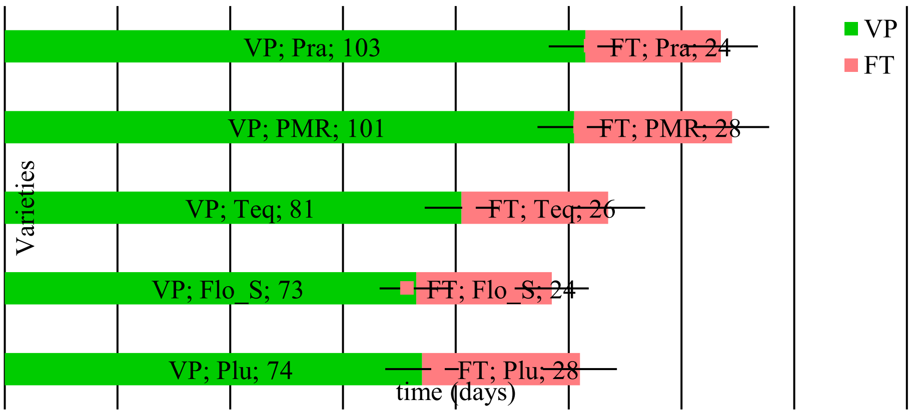

Fig. 2. Graphic distribution of vegetation period under flowering (VPuF), and flowering time (FT) in gladiolus varieties studied
Source: Original graph based on experimental data.

The relationship between flowers number (FN) and inflorescence length (IL) was described by a degree 2 equation, equation (1), in statistical safety conditions (R^2 = 0.973, p = 0.026, F = 36.14).

$$FN = -0.001103 \cdot IL^2 + 0.3105 \cdot IL + 3.957 \quad (1)$$

Principal Component Analysis led to the diagram in Figure 3, in which the spatial distribution of the gladiolus varieties was obtained, in relation to the vegetation indices and flowers quality parameters of the studied flowers.

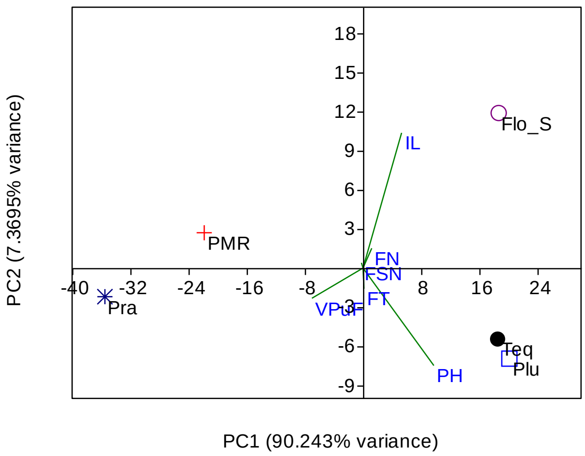

Fig. 3. PCA diagram with the distribution of gladiolus varieties in relation to vegetation and flower quality parameters, as biplot
Source: Original graph based on experimental data.

PC1 explained 90.243% of variance, and PC2 explained 7.3695% of variance. The distribution of the Flo_S variant in relation to IL, of the Teq and Plu variants in relation to PH, of the Pra variant with VP, and an independent position in the case of the PMR variant was found.

The cluster analysis led to the grouping of the studied gladiolus varieties, based on similarity, in relation to the physiological and floral parameters studied, in conditions of statistical safety (Coph.corr = 0.955). A high degree of similarity were presented by the variants Teq and Plu (SDI = 8.2476). They were followed, with lower values, the variants Pra and PMR (SDI = 16.982), the variants Teq and Flo_S (SDI = 18.318) and Flo_S with Plu (SDI = 19.055).

Gladioli are ornamental plants with flowers. Thus, the variation of the flower number in relation to flowers stem number (FSN) and inflorescence length (IL) was analyzed.

Regression analysis was used to evaluate the variation of the number of flowers in relation to the indices and parameters studied. For the accuracy of the calculations, the values of the coefficients of the equations were used with up to 16 decimals.

The variation of the flowers number (FN) in relation to the flower stem number (FSN) and inflorescence length (IL) was described by equation (2), in statistical safety conditions (R^2 = 0.998, p <0.001).

$$FN = ax^2 + by^2 + cx + dy + exy + f \quad (2)$$

where: FN - flowers number
x – FSN - flower stem number;
y –IL – inflorescence length;
a, b, c, d, e, f – coefficients of the equation (2);
a= -0.3710560;
b= -0.0023982;
c= 1.6873838;
d= 0.4427256;
e= -0.0090402;
f= 0.

The ANOVA test confirmed the statistical safety for the values of the coefficients of equation (2), p <0.001. The graphical distribution of the FN variation in relation to FSN (x-axis) and IL (y-axis) is shown in 3D form in Figure 4, and in the form of isoquants in Figure 5.

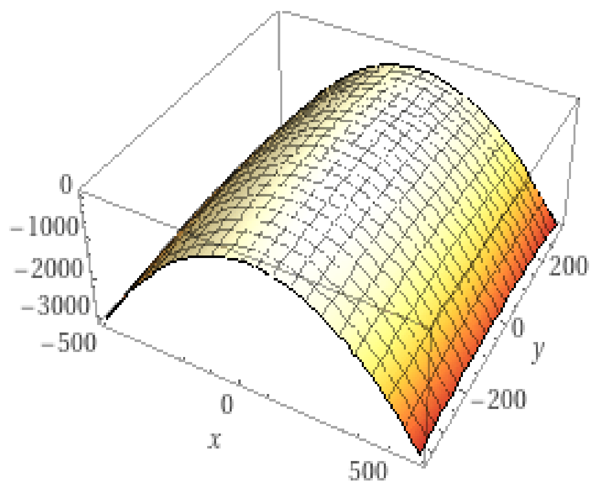

Fig. 4. 3D graphical distribution of FN parameter values in relation to FSN (x-axis) and IL (y-axis)
Source: Original graph, generated based on experimental data.

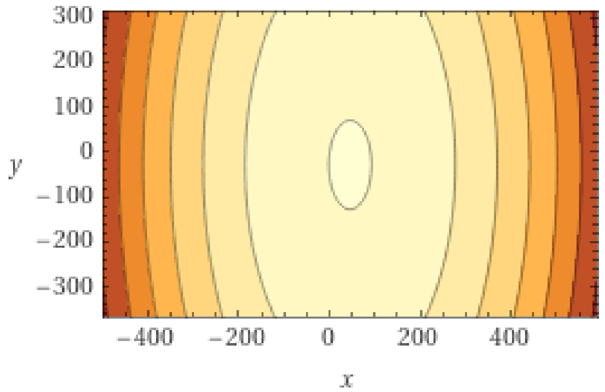

Fig. 5. Graphic distribution in the form of isoquants of the values of the FN parameter in relation to FSN (x-axis) and IL (y-axis)
Source: Original graph, generated based on experimental data.

From the data analysis, as well as from the 3D graphic distribution (3D graphic model), it was found a very small variation of the number of flowers in relation to IL (inflorescence length), specific to each variety. Instead, the number of flowers varied widely in relation to FSN. This indicates that the number of flowers can be directed through the flower stem number. This aspect is given either by the use of large, developed bulbs, or by using a larger number of medium-sized bulbs. From the analysis of the obtained data, optimal values for FSN (x_{opt} = 1,176) and IL (y_{opt} = 90.08 cm) were found.
The regression analysis facilitated the evaluation of the FT (flowering time) variation in relation to VPuF and FSN, equation (3), in safety statistical conditions, according to $R^2 = 0.998$, $p <0.001$.

$$FT = ax^2 + by^2 + cx + dy + exy + f \qquad (3)$$

where: FT - flowering time;
x – VPuF – vegetation period until flowering;
y – FSN – flower stem number;
a, b, c, d, e, f – coefficients of the equation (3);
a= -0.0182723;
b= -5.2777201;
c= 1.6051579;
d= -38.8113120;
e= 0.7150408;
f= 0.

The ANOVA test confirmed the statistical safety for the values of the coefficients of equation (3), p <0.001. The graphical distribution of FT values in relation to VPuF (x-axis) and FSN (y-axis) is shown in figure 6, in 3D form, and in Figure 7 as isoquants format.

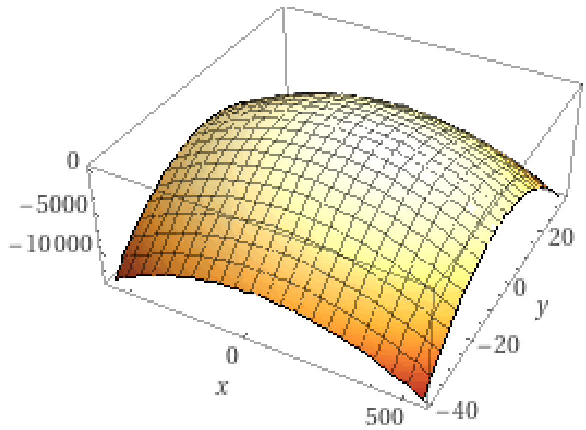

Fig. 6. 3D graphical distribution of FT values in relation to VPuF (x-axis) and FSN (y-axis)
Source: Original graph, generated based on experimental data.

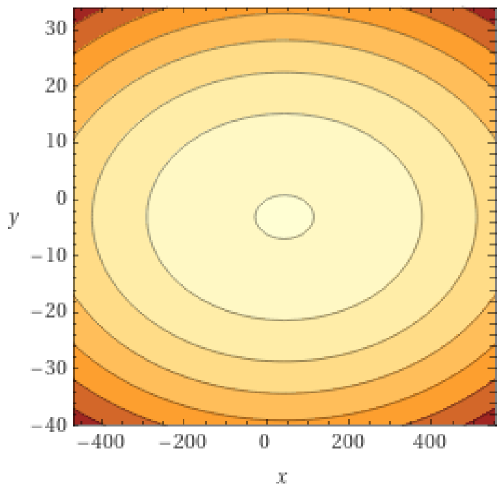

Fig. 7. Graphic distribution in the form of isoquants of the values of the FT index in relation to VPuF (x-axis) and FSN (y-axis)
Source: Original graph, generated based on experimental data

Starting from equation (3), the optimal values for VPuF and FSN in relation to flowering time (FT) were calculated. The values x_{opt} = 86.09 days (VPuF), and y_{opt} = 2.15 (FSN) were obtained.
FSN adjustment can be achieved by using vigorous, well-developed, healthy bulbs. Ensuring a fertile substrate and maintaining the plants during the vegetation period through watering works are also adequate cultivation measures. Controlling the number of flower stem number, by eliminating some competing or poorly developed ones, if

necessary, can also help control the number of flowers, the quality of flowers and the duration of flowering.

It is recommended to maintain the gladiolus plants after flowering, by watering and fertilizing, for a period of 4-5 weeks, to result in vigorous bulbs for the next crop cycle.

Cantor et al. (2010) [8] presented classes of vegetation periods in gladiolus. In relation to these, among the varieties analyzed in the present study, 'Flower Song' (Flo_S) and 'Plumtart' (Plu) had an early period, 'Tequendame' (Teq) was in midseason, and the varieties 'Princess Margaret Rose' (PMR) and 'Praha' (Pra) they had a very late period.

Gladioli have high requirements for the growing substrate, as a nutrition media, whether it is represented by the soil or by various organo-mineral components, as mixtures [27].

The evaluation of the state of vegetation and plant health, as a general aspect, at the foliar level or of some expressive organs, is important in order to direct some influencing factors or to establish prophylactic measures [29], [13], [14].

Green spaces, with an ornamental and agreement role, are essential components in the urban ecosystems, strongly anthropized and influenced by climatic conditions, buildings, and other specific urban elements [17]. Urban habitats were studied in relation to different influencing factors and some specific indicators at the level of some plant species, considered as indicator plants [11]. In the context of the specificity of urban areas, gladioli may be of interest as ornamental garden plants [22], [5].

The results of this study are in line with the research direction on the use of ornamental plant species for decorative purposes or as market products

CONCLUSIONS

The studied gladiolus varieties showed a specific variation of vegetation indices and flower quality indices, and the differences registered, compared to the control variant, presented statistical certainty.

Models were found that described the variation of some flowers parameters in relation to vegetation indices, which allows the formulation of vegetation management measures in gladiolus crops order to obtain high floral quality parameters.

The clusters analysis and PCA facilitated the grouping of the studied varieties based on similarity in relation to the vegetative and floral parameters studied, which allows the choice of appropriate genotypes, in relation to the purpose of cultivating and capitalizing the flowers.

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MODELS FOR DESCRIBING FLOWER SIZE AND FLOWERING TIME IN CHRYSANTHEMUMS

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Abstract

The study evaluated the vegetation and quality parameters associated with chrysanthemum flowers. Four cultivars of chrysanthemums were studied, cultivated in protected conditions: 'Yellow Snowdon', 'Tom Pearce', 'Palisade' si 'Avignon'. Shoots height (SH) and shoots number (SN) were evaluated as vegetative parameters that express the vegetation state of the plants; the determinations were made at the beginning of August - T1 and at the beginning of September - T2. Flowers diameter (FD) and flowering time (FT) were also evaluated as floral quality indices. The 'Yellow Snowdon' and 'Palisade' cultivars had high shoot height, with significant differences (LSD5%, LSD1%). Regarding the number of shoots, significant differences were registered for the cultivars 'Tom Pearce', 'Palisade', 'Avignon' (LSD5%, LSD1%). Flowers dimension (FD), as a quality parameter, showed significant differences for the cultivars 'Palisade' (LSD0.1%), 'Yellow Snowdon' and 'Tom Pearce' (LSD1%, LSD5%). Longer flowering time was recorded for the 'Avignon' cultivar (58 days) and shorter for the 'Yellow Snowdon' cultivar (52 days). The regression analysis facilitated the obtaining of some equations, as models that described the variation of FD and FT in relation to vegetative parameters (SH and SN), in statistical safety conditions ($p < 0.001$). It was found that a number of 2.223 shoots (SN-T1), respectively 2.765 shoots (SN-T2), provided large flowers. The height of the shoots of 27.191 cm (SH-T1) and 91.816 cm (SH-T2) showed optimal values in relation to the flowering time (FT).

Key words: *chrysanthemum, flower size, flowering time, model, vegetative indices*

INTRODUCTION

In the category of ornamental plants, chrysanthemums (*Chrysanthemum* L.) have special importance, aesthetic, popular and cultural in different areas around the world, but also a great economic importance [37], [24], [28].

Chrysanthemums are used for ornamental purposes most often as cut flowers, but also as potted flowers and garden flowers [39]. As a result, different genotypes of chrysanthemums have been studied and characterized in this regard for the production of cut flowers [34].

Some studies have evaluated different varieties of chrysanthemums in relation to growing systems and conditions, water regime, daylength and temperature [19], [36], [28] and flower quality indices [23], [13].

Due to the importance of chrysanthemums, these ornamental plants have been studied in relation to different growing substrates, mulches and organic fertilization [34], organic and conventional cultivation systems [24], aeroponic culture [5].

Plant growth and flower quality in chrysanthemums have been studied in relation to different nutrients, mineral nutrition and nutrient management [38], [40], [6], [1], [29]. Studies have also been conducted on the influence of fertilizer resources with controlled release of nutrients, or some bioactive substances on chrysanthemums [17], [13].

The cultivation of chrysanthemums has also been studied in relation to resistance to diseases and pathogens, in order to obtain quality ornamental plants [38].

Given the food resource requirements of humans, some studies have evaluated chrysanthemums as a sources of minerals and functional foods (minerals, antioxidants etc.) for human nutrition [30], and as a germplasm resource for medicinal purposes and for teas [33], [43].

Chrysanthemums also have different meanings, and special symbolism. Chrysanthemum flowers are present as elements and symbols in the cultural life of many peoples [33].

Chrysanthemums have been cultivated in China since the 15th century BC. An ancient Chinese city was named Chu-Hsien, in translation "Chrysanthemum City" [27].

As a result of the significance of chrysanthemums, cultural and artistic manifestations of these flowers have been dedicated in different areas of the world (“Sapporo Chrysanthemum festival” (2020), “Kasama Chrysanthemum festival” (2021) in Japan; “Chrysanthemum festival” every year in Tongxiang, China etc.).

In Romania, Teodorescu (2010) [38] mentions "Chrysanthemum festival", organized every autumn, in Targoviste, but there are other events associated with these flowers.

The present study evaluated four varieties of chrysanthemum in order to model the behavior of some flower quality parameters in relation to vegetative parameters.

MATERIALS AND METHODS

The study evaluated the behavior of some chrysanthemum cultivars in relation to vegetative and flower quality parameters and used regression analysis to find models to describe flower parameters. Four cultivars were analyzed: 'Yellow Snowdon' (lemon-yellow colour), 'Tom Pearce' (red colour), 'Palisade' (white colour) and 'Avignon' (pale-pink colour), Figure 1.

The experiments were organized in a protected space (greenhouse), on two experimental cycles, in different years, in relation to the chrysanthemums biology (experimental cycle I - ExpCI, experimental cycle II - ExpCII).

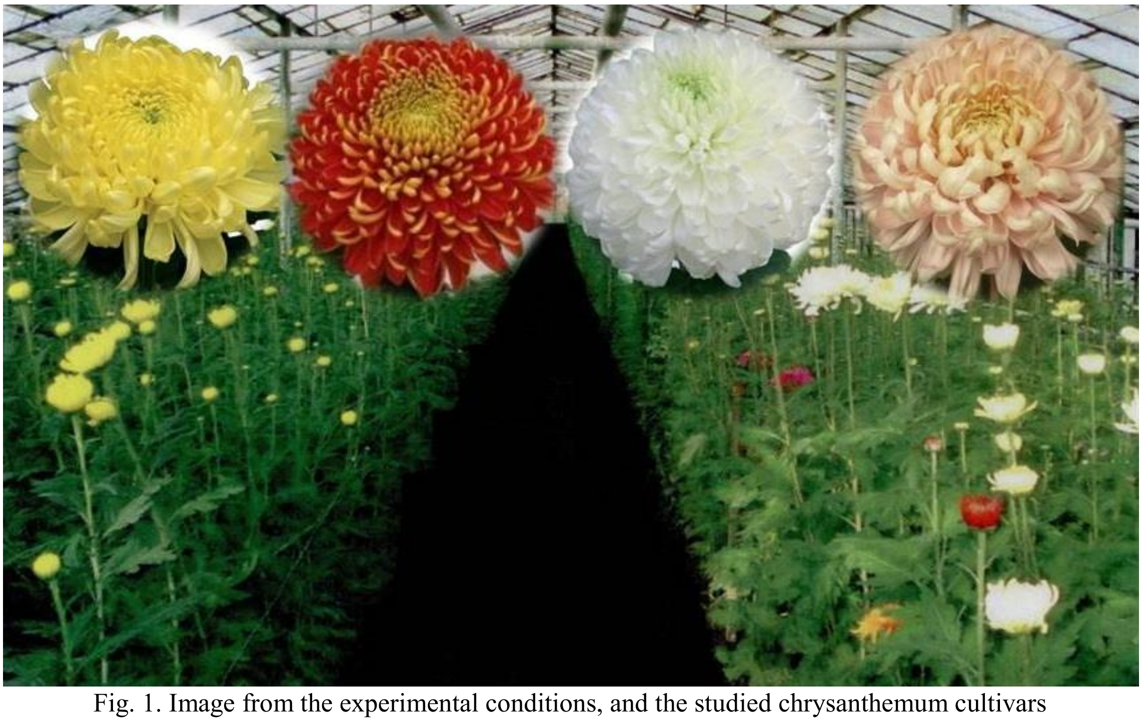

Fig. 1. Image from the experimental conditions, and the studied chrysanthemum cultivars
Source: Original image, from experimental field.

Vegetative parameters were studied that express the vegetation state of the plants and influence the quality of the chrysanthemums flowers: shoots height (SH) and shoots number (SN). During the vegetation period, the determination of the vegetative parameters was made at two plants evolutionary moments, at the beginning of August (T1) and at the beginning of September (T2), in both experimental cycles.

Chrysanthemums are ornamental plants with flowers. Flower quality was assessed by flower diameter (FD). The determination was made in early October (ExpCI and ExpCII).

To assess flowering time (FT), the beginning of flowering and the end of flowering were monitored, and the flowering time in days (FT) was calculated.

The data obtained were analyzed by Variance analysis, Correlation analysis, Cluster analysis, Regression analysis. For the interpretation of the results and the differences between the studied chrysanthemum cultivars, as well as in relation to the average of the experiment (control variant), the limits of significance of the differences (LSD), cophenetic coefficient (Coph. corr.), correlation coefficient (r), and regression coefficient (R^2) were calculated and used.

The calculation module from EXCEL, PAST software [12] and Wolfram Alpha (2020) [41] were used.

RESULTS AND DISCUSSIONS

Physiological parameters, such as shoots height (SH) and shoots number (SN), were determined at two different times in relation to the biology and vegetation cycle specific to chrysanthemums. Thus, determinations were made at the beginning of August - T1 and at the beginning of September - T2, on the two experimental cycles (Experimental cycle I - ExpCI, Experimental cycle II - ExpCII). The height of the shoots (SH) at the moment T1 registered values between 25.16 cm for the 'Palisade' cultivar and 31.40 cm for the 'Avignon' cultivar (ExpCI), respectively 24.65 cm for the 'Palisade' cultivar and 32.00 cm for the 'Avignon' cultivar (ExpCII), Table 1. The Variance analysis highlighted the significance of the differences between the varieties, in conditions of statistical safety for the 'Palisade' and 'Avignon' cultivars (LSD5%, LSD1%).

The evaluation made at the time of T2 showed values of shoots height between 82.19 cm for the 'Tom Pearce' cultivar and 98.42 cm for the 'Yellow Snowdon' cultivar (ExpCI), respectively 92.45 cm for the 'Palisade' cultivar and 102.25 cm for the 'Yellow Snowdon' cultivar (ExpCII), Table 2. The Variance analysis highlighted the significance of the differences between the cultivars for 'Yellow Snowdon' and 'Tom Pearce' (LSD5%).

Table 1. The height of the shoots in the studied chrysanthemum cultivars (T1)

Cultivars	ExpCI			ExpCII		
	Average value (cm)	Relative value (%)	Differences	Average value (cm)	Relative value (%)	Differences
Control	28.06	100.00	-	28.58	100.00	-
'Yellow Snowdon'	27.48	97.93	-0.58	28.35	99.20	-0.23
'Tom Pearce'	28.20	100.50	0.14	29.35	102.69	0.77
'Palisade'	25.16	89.67	-2.90°	24.65	86.25	-3.93°°
'Avignon'	31.40	111.90	3.34*	32.00	111.97	3.42*
LSD values	LSD5%=2.31; LSD1%=3.36; LSD0.1%=5.04			LSD5%=2.54; LSD1%=3.70; LSD0.1%=5.54		

Source: original data, resulted from our experiments.

Table 2. The height of the shoots in the studied chrysanthemum cultivars (T2)

Cultivars	ExpCI			ExpCII		
	Average value (cm)	Relative value (%)	Differences	Average value (cm)	Relative value (%)	Differences
Control	90.47	100.00	-	93.63	100.00	-
'Yellow Snowdon'	98.42	108.79	7.95*	102.25	109.21	8.62*
'Tom Pearce'	82.19	90.85	-8.28°	86.40	92.28	-7.23°
'Palisade'	92.40	102.13	1.93	92.45	98.74	-1.18
'Avignon'	88.90	98.26	-1.57	89.99	96.11	-3.64
LSD values	LSD5%=6.47; LSD1%=9.41; LSD0.1%=14.11			LSD5%=6.35; LSD1%=9.24; LSD0.1%=13.86		

Source: original data, resulted from our experiments.

The number of shoots (SN) at T1 recorded values between 2.40 for the 'Palisade' cultivar and 3.90 for the 'Avignon' cultivar (ExpCI), respectively 2.71 for the 'Tom Pearce' cultivar and 3.63 for the 'Avignon' cultivar (ExpCII), Table 3. The Variance analysis highlighted the significance of the differences between the cultivars, in conditions of statistical safety for the 'Tom Pearce', 'Palisade' and 'Avignon' cultivars (LSD5%, respectively LSD1%).

The evaluation made at the time of T2 showed values of the number of shoots between 2.97 for the 'Palisade' cultivar and 4.32 for the 'Avignon' cultivar (ExpCI), respectively 3.20 for the 'Palisade' cultivar and 4.25 for the 'Avignon' cultivar (ExpCII), Table 4. The Variance analysis highlighted the significance of the differences between the cultivars for 'Tom Pearce', 'Palisade' and 'Avignon' (LSD1%, LSD5%).

Table 3. Number of shoots in the studied chrysanthemum cultivars (T1)

Cultivars	ExpCI			ExpCII		
	Average value (no)	Relative value (%)	Differences	Average value (no)	Relative value (%)	Differences
Control	2.95	100.00	-	3.12	100.00	-
'Yellow Snowdon'	3.00	101.69	0.05	3.24	103.85	0.12
'Tom Pearce'	2.51	85.08	-0.44	2.71	86.86	-0.41°
'Palisade'	2.40	81.36	-0.55°	2.89	92.63	-0.23
'Avignon'	3.90	132.20	0.95**	3.63	116.35	0.51**
LSD values	LSD5%=0.46; LSD1%=0.67; LSD0.1%=1.01			LSD5%=0.33; LSD1%=0.49; LSD0.1%=0.72		

Source: original data, resulted from our experiments.

Table 4. Number of shoots in the studied chrysanthemum cultivars (T2)

Cultivars	ExpCI			ExpCII		
	Average value (no)	Relative value (%)	Differences	Average value (no)	Relative value (%)	Differences
Control	3.63	100.00	-	3.64	100.00	-
'Yellow Snowdon'	4.15	114.33	0.52	3.80	104.39	0.16
'Tom Pearce'	3.08	84.85	-0.55°	3.30	90.66	-0.34
'Palisade'	2.97	81.82	-0.66°	3.20	87.91	-0.44°
'Avignon'	4.32	119.01	0.69*	4.25	116.76	0.61**
LSD values	LSD5%=0.54; LSD1%=0.73; LSD0.1%=1.09			LSD5%=0.42; LSD1%=0.60; LSD0.1%=0.91		

Source: original data, resulted from our experiments.

The diameter of the flowers (FD), determined in early October, registered values between 8.31 cm for the 'Tom Pearce' cultivar and 13.66 cm for the 'Palisade' cultivar (ExpCI), Table 5, respectively 8.56 cm for the 'Yellow Snowdon' cultivar and 12.31 cm for the 'Palisade' cultivar (ExpCII), Table 6.

Table 5. Flower diameter in the studied chrysanthemum cultivars, ExpCI

Cultivars	Average value (cm)	Relative value (%)	Differences
Control	10.19	100.00	-
'Yellow Snowdon'	9.18	90.09	-1.01°
'Tom Pearce'	8.31	81.55	-1.88°°
'Palisade'	13.66	134.05	3.47***
'Avignon'	9.63	94.50	-0.56
LSD values	LSD5%=0.89; LSD1%=1.27; LSD0.1%=2.14		

Source: original data, resulted from our experiments.

The Variance analysis highlighted the significance of the differences between the cultivars, in statistical safety conditions for 'Yellow Snowdon' (LSD5%), 'Tom Pearce' (LSD1%), and 'Palisade' (LSD0.1%) in the case of ExpCI, respectively for 'Yellow Snowdon', 'Tom Pearce' (LSD1%), and 'Palisade' (LSD0.1%) in the case of ExpCII.

Table 6. Flower diameter in the studied chrysanthemum cultivars, ExpCII

Cultivars	Average value (cm)	Relative value (%)	Differences
Control	9.86	100.00	-
'Yellow Snowdon'	8.56	86.81	-1.30°°
'Tom Pearce'	8.83	89.55	-1.03°°
'Palisade'	12.31	124.85	2.45***
'Avignon'	9.74	98.78	-0.12
LSD values	LSD5%=0.65; LSD1%=0.93; LSD0.1%=1.36		

Source: original data, resulted from our experiments.

In order to evaluate the flowering time (FT), the data regarding the beginning and the end of the flowering were recorded, and the values obtained for FT are presented in the form of a graphical diagram, Figure 2.

A longer flowering time was recorded for the 'Avignon' cultivar and a shorter flowering time for the 'Yellow Snowdon' and 'Palisade' cultivars. The 'Palisade' cultivar showed a constant regarding FT, while the other cultivars showed variability in relation to the experimental cycle.

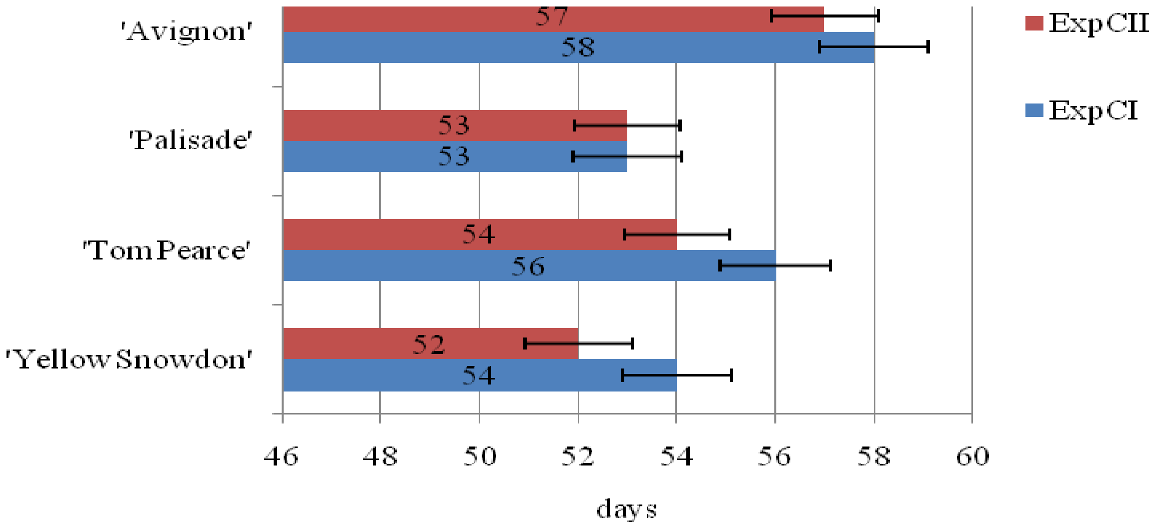

Fig. 2. Flowering time (FT) diagram for the studied chrysanthemum cultivars
Source: original graph, generated based on experimental data.

The cluster analysis that took into account FD and FT led to the diagram in Figure 3, in statistical safety conditions, Coph.corr = 0.893 (ExpCI), respectively Coph.corr = 0.799 (ExpCII).
The 'Tom Pearce' (TP) and 'Yellow Snowdon' (YS) cultivars showed a high level of similarity (SDI = 2.181, for ExpCI; SDI = 2.02181 for ExpCII). The two cultivars were associated in the diagram with the 'Avignon' (Avi) cultivar, the three cultivars being grouped in a cluster. The 'Palisade' (Pal) cultivar was placed in a separate position.
Correlation analysis revealed very strong correlation levels between FT and SH-T1 (r = 0.965) under ExpCI conditions, and between SN-T1 and SN-T2 (r = 0.964) under ExpCII conditions.
Strong correlations were recorded between SN-T1 and SH-T1 (r = 0.885), respectively between SN-T1 and SN-T2 (r = 0.892) under ExpCI conditions.
Moderate correlations were recorded between FT and SN-T1 (r = 0.761) under ExpCI conditions, respectively between FT and SH-T1 (r = 0.743) under ExpCII conditions. Other correlations of lower intensity were also recorded.

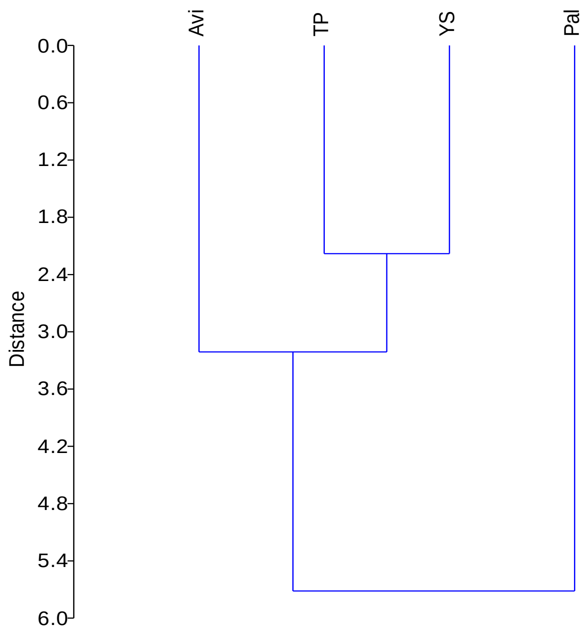

Fig. 3. Dendrogram of the group of chrysanthemum cultivars studied based on Euclidean distances, in relation to FD and FT
Source: original graph, generated based on experimental data.

Regression analysis was used to evaluate the variation of FD and FT in relation to vegetative parameters in the studied chrysanthemum cultivars.

The variation of the flower diameter (FD) for the chrysanthemums studied cultivars, on the two experimental cycles, in relation to shoots number (SN-T1 and SN-T2) was described by the equation (1), in statistical safety conditions ($R^2 = 0.978$, $p < 0.001$).

The graphical representation of the FD variation in relation to vegetative parameters (SN-T1, x-axis, and SN-T2, y-axis) is presented graphically in 3D form (Figure 4), and in isoquants form (Figure 5).

Based on the values of the coefficients of equation (1), the optimal values for x (SN-T1) and y (SN-T2) were calculated in relation to the flower diameter (FD). The values of $x_{opt} = 2.223$ and $y_{opt} = 2.765$ were found.

$$FD = ax^2 + by^2 + cx + dy + exy + f \qquad (1)$$

where: FD - flower diameter;
x – SN-T1 – shoots height at T1 determination;
y –SN-T2 – shoots number at T2 determination;
a, b, c, d, e, f – coefficients of the equation (1);
a= -1.4986899;
b= 8.8506251;
c= 13.5567693;
d= 6.9468557;
e= -21.2598468;
f= 0.

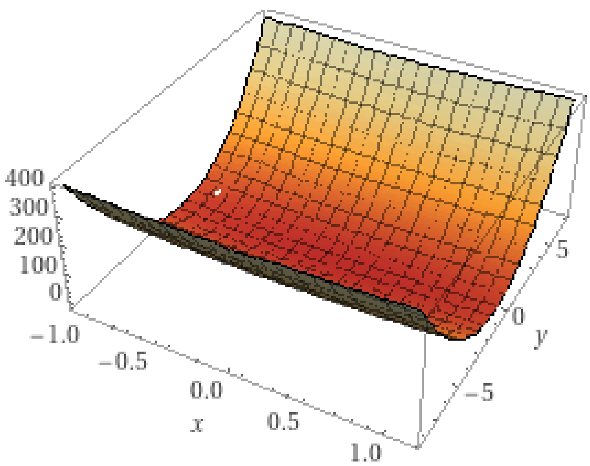

Fig. 4. 3D graphical representation of FD in relation to SN-T1 (x-axis) and SN-T2 (y-axis) on the two experimental cycles (ExpCI, ExpCII)
Source: original graph, generated based on experimental data.

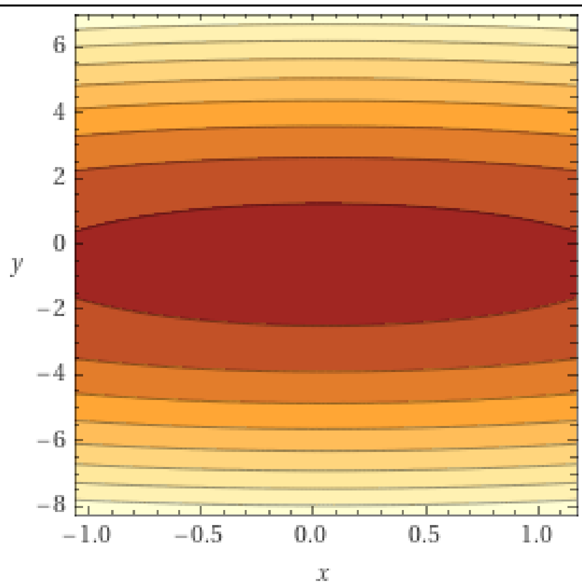

Fig. 5. Flower dimension (FD) graphical representation in the form of isoquants in relation to SN-T1 (x-axis) and SN-T2 (y-axis) on the two experimental cycles (ExpCI, ExpCII)
Source: original graph, generated based on experimental data.

From the graphic analysis, as well as of the obtained values, it was found the high importance of SN-T2 in the variation of FD in the studied chrysanthemum cultivars. This suggests the importance of controlling the number of shoots through specific maintenance works, but also the water and nutrients supply for the purpose of proper plant nutrition.

The variation of the flower size in chrysanthemums, the studied cultivars, on the two experimental cycles (flower diameter - FD) in relation to shoots height (SH-T1) and shoots number (SN-T1), was described by equation (2), in statistical safety conditions (R^2=0.986, p<0.001).

The graphical representation of the FD variation in relation to vegetative parameters (SH-T1, x-axis and SN-T1, y-axis) is represented graphically in 3D form in the Figure 6, and in the form of isoquants in the Figure 7.

Based on the values of the coefficients of equation (2), the optimal values for x (SH-T1) and y (SN-T1) were calculated in relation to the flower diameter (FD). The values of x_{opt} = 30.109 cm and y_{opt} = 3.793 were found.

$$FD = ax^2 + by^2 + cx + dy + exy + f \quad (2)$$

where: FD - flower diameter
x – SH-T1 – shoots height at T1 determination;
y –SN-T1 – shoots number at T1 determination;
a, b, c, d, e, f – coefficients of the equation (2);
a= -0.2136185;
b= -2.8130313;
c= 5.4156014;
d= -37.7753417;
e= 1.9634209;
f= 0.

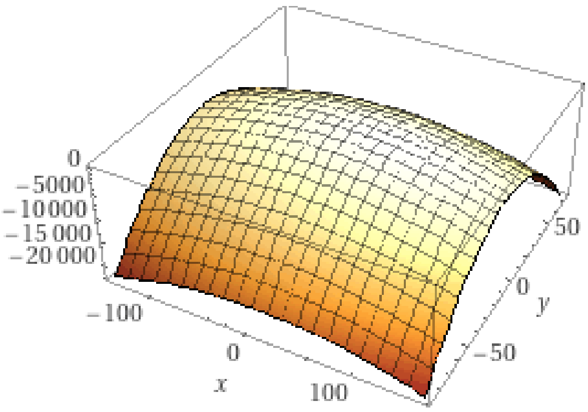

Fig. 6. 3D representation of FD in relation to SH-T1 (x-axis) and SN-T1 (y-axis) on the two experimental cycles
Source: original graph, generated based on experimental data.

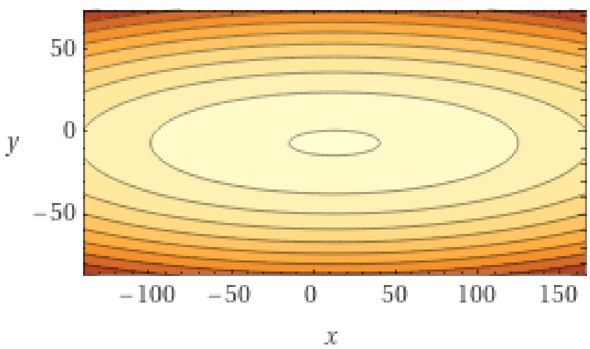

Fig. 7. Representation in the form of isoquants of FD in relation to SH-T1 (x-axis) and SN-T1 (y-axis) on the two experimental cycles
Source: original graph, generated based on experimental data.

The variation of the flowering time (FT) in relation to the values of the vegetative parameters (SH-T1 and SH-T2) was described by equation (3), in statistical safety conditions (R^2=0.999, p<0.001).

The graphical representation of the FT variation in relation to vegetative parameters (SH-T1, x-axis and SH-T2, y-axis) is rendered graphically in 3D form in Figure 8, and in the form of isoquants in Figure 9.

$$FT = ax^2 + by^2 + cx + dy + exy + f \quad (3)$$

where: FT - flowering time in relation to vegetative parameters SH;
x – SH-T1 – shoots height at T1 determination;
y –SH-T2 – shoots number at T2 determination;
a, b, c, d, e, f – coefficients of the equation (3);
a= 0.1760536;
b= 0.0212712;
c= 3.7200560;
d= 0.0311723;
e= -0.1447952;
f= 0.

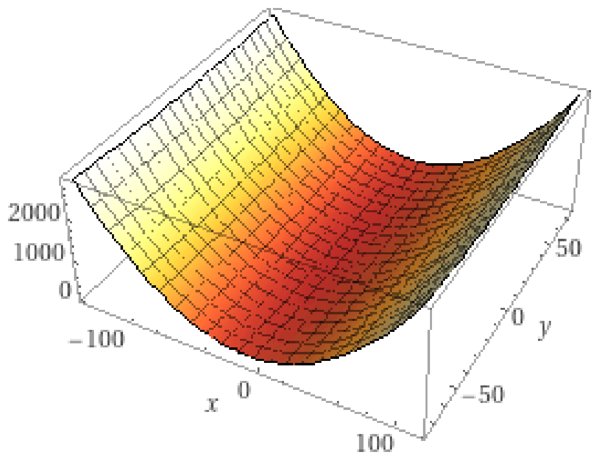

Fig. 8. 3D graphical representation of FT in relation to SH-T1 (x-axis) and SH-T2 (y-axis) on the two experimental cycles
Source: original graph, generated based on experimental data.

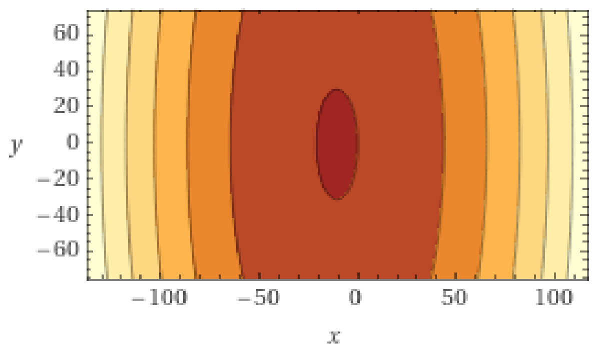

Fig. 9. Flowering time (FT) representation in the form of isoquants in relation to SH-T1 (x-axis) and SH-T2 (y-axis) on the two experimental cycles
Source: original graph, generated based on experimental data.

Based on the values of the coefficients of the equation (3), the optimal values for x (SH-T1) and y (SH-T2) were calculated in relation to the flowering time (FT). The values x_{opt} = 27.191 cm and y_{opt} = 91.816 cm were found.

From the FD and FT analysis in relation to SN and SH (T1 and T2; ExpCI, ExpCII), values were found for physiological parameters, figure 10, which suggest the need to control the number of shoots; fewer shoots provide large flowers.

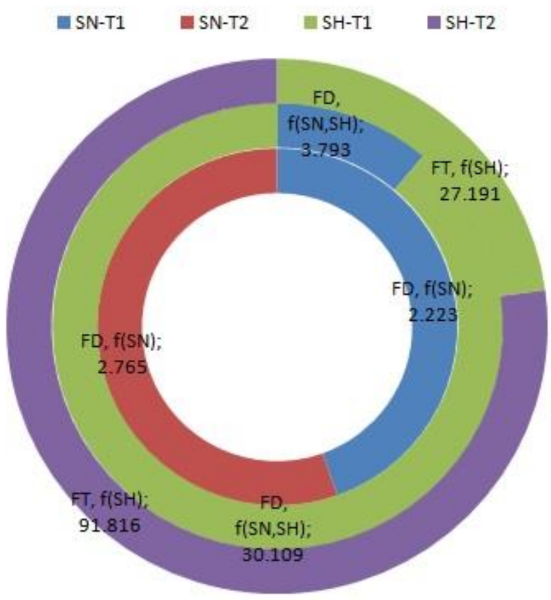

Fig. 10. Graphic distribution of optimal SN and SH values in relation to FD and FT for the studied chrysanthemum cultivars
Source: original graph, generated based on experimental data.

Also, maintenance works are needed to ensure water and nutrients in relation to the growing substrate, for the normal growth and development of plants.

The status of plant development is important; water supply and nutrients, as well as plant protection are needed to obtain vigorous shoots, which will provide large and quality flowers.

A small number of shoots and the vigorous development of the shoots ensure quality flowers and a longer flowering time.

For monitoring plants in relation to pathogens, non-destructive methods are recommended for rapid assessment, with a high level of safety, in order to estimate the attack on the leaves or plants and the decision to intervene with adequate treatments [9], [10], [21], [39]. Also, for the characterization and comparative analysis of different plant genotypes, non-destructive methods and imaging analysis is very useful [32].

Many models have been studied and developed in relation to crops plants [31], but ornamental plants have a high economic value and a high importance for the market [4]; [7], [41], and the modeling of these plants is also important [26], [25], [15].

By knowing their behaviour, some chrysanthemum genotypes can also occupy an important niche as garden plants in urban ecosystems [3], [2], [22], [11], studied in relation to various anthropogenic or natural factors of influence [14].

Interest to modeling, in chrysanthemums plants research, has also been found in other studies, in relation to stem elongation [18], the growth of chrysanthemum crops [20], the structure and response of plants to influencing factors [8], [16].

The present study, through the approach and the obtained results, contributes to the development of the information base and approach in the cultivation of chrysanthemums, in relation to the quality of the flowers and the flowering period.

CONCLUSIONS

The regression analysis facilitated the finding of equations as models to describe the variation of FD and FT in relation to vegetative parameters (SH and SN) for the four varieties of chrysanthemums studied.

Based on the coefficients of the equations obtained, it was possible to find the optimal values for vegetative parameters in relation to FD and FT, for the study conditions. This approach can be adapted to other study conditions, varieties of chrysanthemums, or ornamental plants.

The values obtained for vegetative parameters, in relation to the flowers dimension (FD), or the flowering time (FT), recommend the need for specific care works for chrysanthemums, in order to obtain quality flowers and a longer period of flowering.

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CLUSTER ANALYSIS OF SOCIO-ECONOMIC DEVELOPMENT OF RURAL AREAS AND PEASANT FARMS IN THE SYSTEM OF FORMATION OF RURAL TERRITORIAL COMMUNITIES: A CASE STUDY OF VOLYN REGION, UKRAINE

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Abstract

In the article we proved that the clustering of regions in terms of socio-economic conditions of rural development and farms located on them using a selected range of indicators by scientists was not carried out. The obtained results provide an opportunity to conduct a comprehensive assessment and generalization of the territorial differentiation of socio-economic conditions for the development of rural areas and farms located in the Volyn region of Ukraine. Visualization of the territorial-spatial distribution of selected clusters using a cartogram allows optimizing the visual perception of the information load on the clustering results. The general generalizations of regional differentiation of separate elements of social and economic conditions of development of rural territories and peasant farms located on them for real realities prompt to think about perspective prospects of development of the system of these farms, their place, and role in the organizational structure of agrarian sector of market type.

Key words: *rural areas, clusters, socio-economic development, peasant farms, hierarchical clustering algorithm, cartogram of cluster analysis results*

INTRODUCTION

In the realities of the current economic conditions, peasant farms, due to the influence of a number of systemic factors and trends, act as an alternative, and efficient agricultural producer. However, in the context of permanent reforms in the agro-industrial sector, it is important, in our opinion, to outline the forecast parameters of rural development, and farms located on them, and develop in this aspect a comprehensive system of recommendations aimed at forming a progressive agricultural policy. After all, the range of scholars` opinions on the further functioning of peasant farms is quite ambiguous and even polar: from recognizing them as one of the most flexible, dynamic, and resilient to difficult economic conditions forms of management to claims of absolute futility from the standpoint of agricultural development in terms of European integration. In our opinion, the differentiation of forecast models of functioning of rural areas and peasant farms is largely formed on the basis of a system of socio-economic indicators, territorial and spatial configurations of development of each region.

Territorial differences in the development of socio-economic conditions for the functioning of various organizational, and legal forms of management, including peasant farms, are inherent in the vast majority of countries, in particular, as evidenced by numerous studies in recent years, significant regional asymmetry is characteristic of Ukraine. In addition, there is virtually no scientific research on the complex ranking of administrative-territorial entities of the country at lower hierarchical levels. At the same time, the need to reduce and settle interregional territorial disparities has become especially important, and therefore – the primary importance now belongs to the identification, and ordering (ranking) of the most problematic (depressive) territorial entities.

We believe that in the context of this scientific research it is advisable to emphasize the so-called "threshold of complexity", according to which adequate analysis of a particular problem situation by the analyst is possible as a result of targeted observation and simultaneous comparative evaluation of a relatively small number of parameters (not more than 7-10), which significantly impoverishes the possibility of multifactor calibration of the studied phenomenon or object. It is in this aspect that it is necessary to emphasize the expediency of using cluster analysis, which is a set of methods for classifying multidimensional observations [15], and its ability to operate with a large number of features to compare objects with each other.

Cluster analysis is widely used in much of modern scientific research. In particular, - for the purpose of classification of consumers of the electric power (Ya. Yeleiko, R. Hryshchuk), an estimation of the economic risk of the enterprises (N. Podolchak) [15], classification of areas of the country on the release of foodstuff (O. Totska), the grouping of regional labour markets of the country (S. Volkova, O. Nosach) [41] and explored other aspects of the research, in particular O. Agres [1], O. Apostolyuk [2], O. Binert [4], M. Dziamulych [6-9], A. Popescu [16-27], T. Shmatkovska [28-30], R. Sodoma [32-33], O. Stashchuk [34-36], I. Tsymbaliuk [40], Ya. Yanyshyn [42], I. Zhurakovska [43]. However, the clustering of regions in terms of socio-economic conditions of rural development and farms located on them using a selected range of indicators by scientists was not carried out, which confirms the special relevance of the selected issues.

MATERIALS AND METHODS

The purpose of the publication is to carry out a cluster analysis of the districts of the Volyn region on the socio-economic conditions of development of rural areas and farms. Among the targets are: the need to build a matrix of input data on the study, standardization of the array of initial information by the selected method, building a symmetric matrix of distances, combining objects into clusters, forming the optimal number of clusters, building a map of the Volyn region of Ukraine based on clustering and their scientific interpretation.

It should be noted that a necessary condition for cluster analysis is to ensure the proportionality and unidirectionality of the initial indicators [12]. We standardized the indicators selected for analytical research by the method of the so-called z-transformation.

The z-transformation method is one of the most common methods and consists of the normalization of the studied indicators relative to the standard deviation [15]:

$$z_{ij} = \frac{(x_{ij} - \overline{x_j})}{\sigma_j},$$

where: z_{ij} – standardized value of the i-th indicator of the j-th feature;

$x_{ij}\,(i = \overline{1,n};\ j = \overline{1,m})$ – the initial value of the i-th indicator of the j-th feature;

n – the number of indicators that characterize the j-th feature;

m – number of signs;

$\overline{x}_j = \left(\sum_{i=1}^{n} x_{ij}\right)/n$ – the arithmetic mean of the initial indicators of the j-th sign;

$\sigma_j = \sqrt{\frac{\sum_{i=1}^{n}(x_{ij}-\overline{x_j})^2}{n}}$ – the standard deviation of the values of the j-th feature.

For clustering of districts of the Volyn region of Ukraine one of the most widespread distances – «squared Euclidean distances» is used, which is calculated as the sum of squares of a difference of values of indicators of the same name for each pair of objects. [15]:

$$d_{fq} = \sum_{k=1}^{p}(z_{fk} - z_{qk})^2 ,$$

where: d_{fq} – Euclidean distance between the f -th and q-th objects (in this study - areas of the Volyn region);

z_{fk} – standardized value of the k -th indicator for the f-th object;

z_{qk} – standardized value of the k -th indicator for the q -th object;

p – the number of pairs of indicators of the same name (in this study – 36).

To simplify the calculations and automate part of the computational processes in the study involved the functional resources of the software package StatSoft Statistica 6.0.

RESULTS AND DISCUSSIONS

At the first stage of the study, indicators were selected from the initial data set that, in our opinion, most fully represent the socio-economic conditions of personal farms by building a matrix of their pairwise correlation-regression dependence and analysis of the significance of the interaction between each pair of indicators.

It is pertinent to note that a significant amount of initial data (more than 90 indicators) and the need to ensure maximum objectivity of the final results, led to the feasibility of introducing restrictions on the materiality of the identified relationships. So, further, only those communications which durability was reflected by the coefficient of pair correlation $r>|0,3|$ were recognized as essential. According to the results of counting the number of significant correlations for each of the indicators, selected those of them that are characterized by the largest number of significant dependencies.

Thus, the final list of indicators selected for clustering areas of the Volyn region in the context of socio-economic conditions of peasant farms included those that correlate with 70-100% of their block and 60-100% of other blocks (Table 1).

It should be noted that in the case of an equal number of significant links, preference was given to those indicators that are more correlated with the representatives of other blocks. Thus, according to the results of the analysis, we selected 36 indicators, among which the Ist block, which allows us to assess the general economic situation, is represented by eight indicators: gross agricultural output per 1 person (in comparable prices in 2005), UAH (X_1); fixed capital investment per 1 person, UAH (X_2); the share of districts in the regional volume of meat sales through all channels, % (X_3); the gross harvest of cereals per 1 person, t (X_4); the gross harvest of sugar beets, factory, per 1 person, t (X_5); cattle per 1 person, at the end of the year, heads (X_6); meat production, in slaughter weight per 1 person, t (X_7); milk production per 1 person, t (X_8).

The block of indicators that characterize the economic base of rural settlements is represented by three indicators: the number of farms located in rural areas, units. (X_9); area of agricultural land per 1 person. for all categories of farms, at the end of the year, ha (X_{10}); the share of personal farms in the value of gross agricultural output in all categories of farms, % (X_{11}). Among the indicators of the demographic situation (III-rd block) there are eight: the birth rate of the rural population, per 1,000 people (X_{12}); share of births in rural areas for mothers who were not in a registered marriage,% of the total number of births (X_{13}); proportion of children born in rural areas to women under 20 years,% of the total number of births (X14); divorce of the rural population, per 1,000 people (X_{15}); balance of interstate migration of rural population, per 1,000 people (X_{16}); the median age of the rural population, years (X_{17}); demographic burden on the rural population of working age by persons who have not reached working age, pers. (X_{18}); the share of rural settlements, wherein 2016-2019. the number of deaths exceeded the number of births, % (X_{19}).

Table 1. Matrix of initial data for cluster analysis of districts of the Volyn region by socio-economic conditions of rural development*

Indexes	Districts of the Volyn region of Ukraine															
	Volodymyr-Volynskyi	Horokhiv	Ivanychi	Kamin-Kashyrskyi	Kivertsi	Kovel	Lokachi	Lutsk	Lyubeshiv	Liuboml	Manevytshi	Ratno	Rozhysche	Stara Vyzhivka	Turiysk	Shatsk
X_1	9,122	5,595	5,188	3,227	2,231	4,923	5,896	5,108	4,178	2,649	3,296	3,485	4,367	3,053	5,208	2,209
X_2	2,262.7	1,175.0	955.0	305.8	448.6	1,720.1	925.6	2,784	439.3	1,910.4	283.2	529.6	942.0	304.4	431.3	542.9
X_3	30.4	16.3	2.7	0.3	1.2	6.7	9.9	9.5	0.8	0.7	1.0	2.8	4.9	0.8	11.7	0.3
X_4	2.94	1.67	1.67	0.44	0.41	1.08	2.01	1.85	0.46	0.47	0.41	0.45	0.86	0.60	1.56	0.47
X_5	5.41	3.36	2.18	0.11	0.30	0.69	1.57	2.05	0.02	0.17	0.07	0.12	0.90	0.10	1.06	0.07
X_6	0.48	0.59	0.41	0.26	0.20	0.76	0.37	0.47	0.37	0.26	0.32	0.44	0.47	0.29	0.67	0.20
X_7	0.31	0.13	0.09	0.06	0.05	0.08	0.16	0.08	0.07	0.05	0.06	0.06	0.08	0.06	0.15	0.05
X_8	0.91	1.04	1.09	0.65	0.56	0.93	0.70	0.91	0.87	0.63	0.72	0.80	0.93	0.69	1.12	0.56
X_9	88	79	57	22	39	86	84	108	8	12	6	13	11	24	20	2
X_{10}	2.2	1.4	1.2	0.9	0.8	1.9	1.9	1.2	0.9	1.2	0.9	1.0	1.7	1.4	2.5	0.9
X_{11}	45.3	61.3	76.1	98.7	93.2	79.9	70.7	66.6	96.6	97	97.2	89.5	77.6	95.1	63.1	97.7
X_{12}	12.6	11.1	10.6	17.8	12.4	12.1	9.8	13.3	17.4	12.7	16.5	15.9	11.3	11.7	12	12.9
X_{13}	14.3	11.4	11.2	4.2	12.0	10.4	10.7	10	4.9	8.6	4.8	6.9	12.5	6.7	11.8	7.5
X_{14}	12.6	13.3	11.6	8.6	12.0	11.4	11.7	9.8	12.7	11.0	6.1	9.1	12.5	8.3	13.3	10.2
X_{15}	2.8	2.9	2.2	1.4	1.7	1.8	2.1	2.4	1.6	2.0	1.6	1.2	2.0	1.0	2.5	1.6
X_{16}	0.0	0.1	-0.3	-0.4	-0.3	-0.1	-0.1	-0.3	-1.7	-0.4	-0.8	-1.3	0.0	-0.9	-0.2	-1.4
X_{17}	37.8	38.7	38.4	31.4	35.4	38.7	36.8	34.5	32.4	37.2	34.0	33.2	36.9	37.5	39.8	37.6
X_{18}	360	380	341	480	418	401	385	363	459	400	463	449	390	394	415	392
X_{19}	93.5	91.1	94.8	42.2	90.3	94.5	83.0	87.7	45.7	88.2	72.5	70.1	92.4	84.8	90.5	73.3
X_{20}	3.9	8.9	5.2	28.1	13.9	4.4	3.8	16.1	26.1	5.9	14.5	19.4	7.6	17.4	0.0	13.3
X_{21}	7.4	8.0	9.0	3.7	5.1	5.3	7.4	8.5	3.2	4.6	3.0	4.7	7.1	4.1	6.1	3.9
X_{22}	318	451	479	789	560	365	383	628	661	415	609	573	402	596	255	403
X_{23}	2.1	2.0	1.9	2.9	2.5	2.5	2.1	1.9	3.2	2.6	3.2	2.6	2.1	2.8	2.3	2.8
X_{24}	40.2	37.0	32.5	48.0	42.8	45.0	46.2	46.8	46.9	41.0	48.2	44.7	43.1	43.2	35.3	47.8
X_{25}	12.0	27.1	16.0	4.2	10.8	20.0	11.2	17.8	8.1	6.6	6.5	12.5	24.5	6.8	26.0	8.0
X_{26}	6.9	17.9	6.2	2.8	7.0	8.0	6.7	13.2	0.4	2.1	0.4	2.8	4.3	4.6	16.5	0.1
X_{27}	33.7	42.4	26.9	74.9	41.6	44.2	64.4	23.1	63.1	61.1	71.4	66.8	46.6	69.1	36.0	63.6
X_{28}	42.6	17.8	43.3	6.9	33.4	20.8	11.8	47.2	12.8	15.6	7.5	8.2	17.0	9.3	21.3	9.2
X_{29}	22.9	24.4	23.3	19.3	19.0	23.3	22.2	21.5	21.3	21.0	18.5	20.2	22.7	21.3	24.0	21.3
X_{30}	42.07	33.49	46.41	1.09	17.12	12.33	8.78	60.49	0.02	3.30	4.94	8.69	24.53	5.13	34.0	2.26
X_{31}	45.5	32.2	29.3	20.3	25.0	35.2	37.7	55.6	15.2	35.3	18.8	44.8	36.4	15.2	48.6	43.3
X_{32}	68.8	57.8	56.9	28.1	37.5	60.4	50.9	56.8	34.8	55.9	47.8	53.7	53.0	54.3	63.5	60.0
X_{33}	70.1	63.3	62.1	46.9	66.7	64.8	58.5	56.8	47.8	66.2	53.6	61.2	56.1	43.5	66.2	70.0
X_{34}	49.4	48.9	50.0	28.1	37.5	37.4	41.5	54.3	34.8	38.2	23.2	44.8	27.3	47.8	47.3	23.3
X_{35}	39	116	102	411	205	182	200	83	278	231	169	201	113	370	105	34
X_{36}	24	40	1	544	72	188	183	5	614	174	211	335	6	330	55	263

Source: *some of the indicators are calculated independently on the basis of processing these sources: [3, 11, 13, 31, 37, 38, 39].

The IVth block, which characterizes the peculiarities of the settlement of the rural population – is represented by four indicators: the share of rural settlements with a population of more than 1,000 people, % of the total number of rural settlements (X_{20}); density of rural settlements, units/100 km^2 (X_{21}); average population of rural settlements, people (X_{22}); average distance between villages, km (X_{23}).

Among the indicators of the block (Vth), representing employment, there are five: the share of employees in the total number of the available rural population, % (X_{24}); the share of those employed in agriculture from the total working rural population, % (X_{25}); the share of employees employed on farms from their total number in the region as a whole, % (X_{26}); the share of employees in personal farms in the total working rural population, % (X_{27}); the share of the rural population employed outside their locality in the total number of employed, % (X_{28}).

The VIth block, which represents the development of social infrastructure and assessment of living conditions of the rural population, is characterized by eight indicators: rural housing, m2 of the total area on average per 1 person (X_{29}); share of apartments in rural settlements with central heating, % (X_{30}); share of rural settlements where there are school-age children, but no schools, % (X_{31}); share of rural settlements where there are no libraries, % (X_{32}); the specific weight of rural settlements where there are no communication departments, % (X_{33}); share of rural settlements where there are no clubs, houses of culture,% (X_{34}); the average number of the rural population living in apartments where there is no sewerage, per 1 village, pers. (X_{35}); the average number of the rural population living in apartments where there is no central heating, per 1 village, pers. (X_{36}).

Note that cluster – is a method of multidimensional statistical analysis, allowing organize the studied objects into homogeneous groups [15].

When carrying out clustering, it is necessary to take into account that the semantic load of the term “cluster analysis” implies the presence of a set of different classification algorithms. Since the results of clustering obtained using different classification algorithms can differ significantly [5], to ensure maximum reliability of the final results, as well as to substantiate the stability of the cluster structure, we consider it appropriate to carry out cluster analysis of the Volyn region by synthesizing several methods, namely, at the first stage to apply agglomerative hierarchical algorithms. next - iterative (non-hierarchical) k -medium method (k -means clustering), which is quite common [12] among iterative procedures. We believe that the use of cluster analysis in two stages will provide sufficient quality grouping results.

To simplify calculations and automate some computational processes, the resources of the software package StatSoft Statistica 6.0, which enjoys a high rating among other software products.

The peculiarity of most iterative procedures is that clusters are formed in a predetermined number [12]. Therefore, we believe that before establishing the optimal number of clusters, it is advisable to classify the studied objects, using one of the agglomerative hierarchical procedures, and based on its results (relative to the probable number of clusters) to apply iterative procedures.

It should be noted that a necessary condition for cluster analysis is to ensure the proportionality and unidirectionality of the initial indicators [12]. Since the indicators selected at the previous stage of the study are presented in different dimensions and units, it is advisable to standardize them (so-called z-transformation).

As a result of z-transformation, a matrix of standardized indicators for each of the features was obtained, which was selected for clustering. Since it is quite cumbersome, we consider it appropriate not to submit it within the publication, but to visualize the normalized indicators using a three-dimensional image, which allows assessing the degree of their differentiation by regions of the Volyn region of Ukraine (Fig. 1).

Note that in the implementation of hierarchical clustering, the choice of the distance between objects is a key point of the study, it largely depends on the final version of the division of objects into clusters [10].

Therefore, for the clustering of districts of the Volyn region used one of the most common distances – "squared Euclidean distances", which is calculated as the sum of squares of the difference of values of the same indicators for each pair of objects [15].

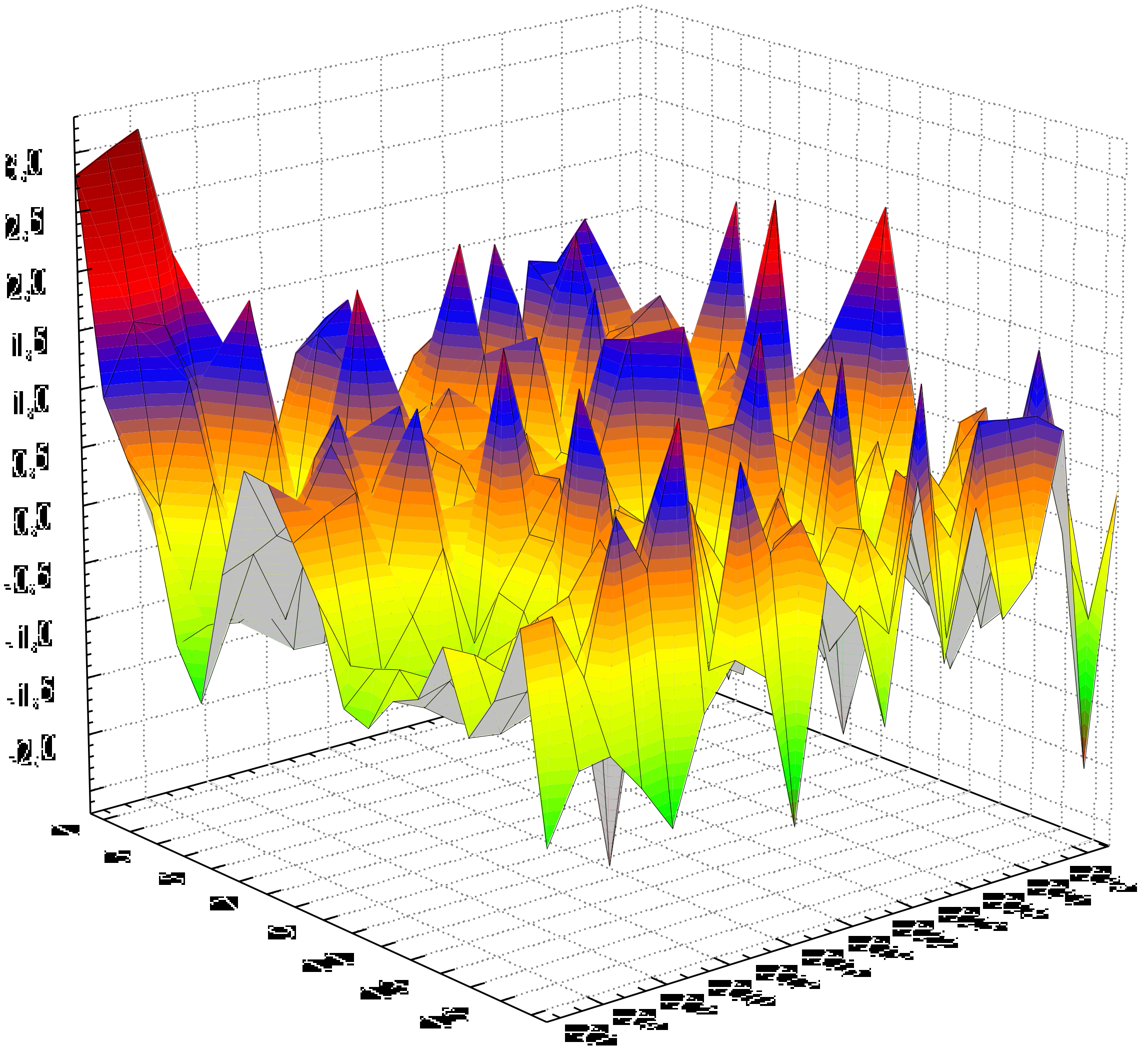

Fig. 1. Three-dimensional image of differentiation of values of standardized indicators on the basis of which clustering of districts of Volyn region of Ukraine is carried out.
Source: own development.

Having chosen the measure of distances, as a result of calculations a symmetrical matrix of distances between objects (districts of the Volyn region of Ukraine) with dimension $16x16$ is formed, however, in our opinion, it is inexpedient to present it within the limits of publication due to excessive cumbersomeness.
When performing hierarchical clustering from a set of different algorithms for combining objects into clusters, the Ward method is chosen. Note that the use of Ward`s method (Ward`s method) minimizes intra-cluster scattering of objects (intra-group variance within the cluster) and the dendrogram is formed by the results of its work with deeply divided, compact clusters of small size [10].
In addition, according to Ward`s method, objects are joined to clusters in the case of a minimal increase in the intragroup sum of squares of deviations, and therefore its application leads to a more accurate clustering.

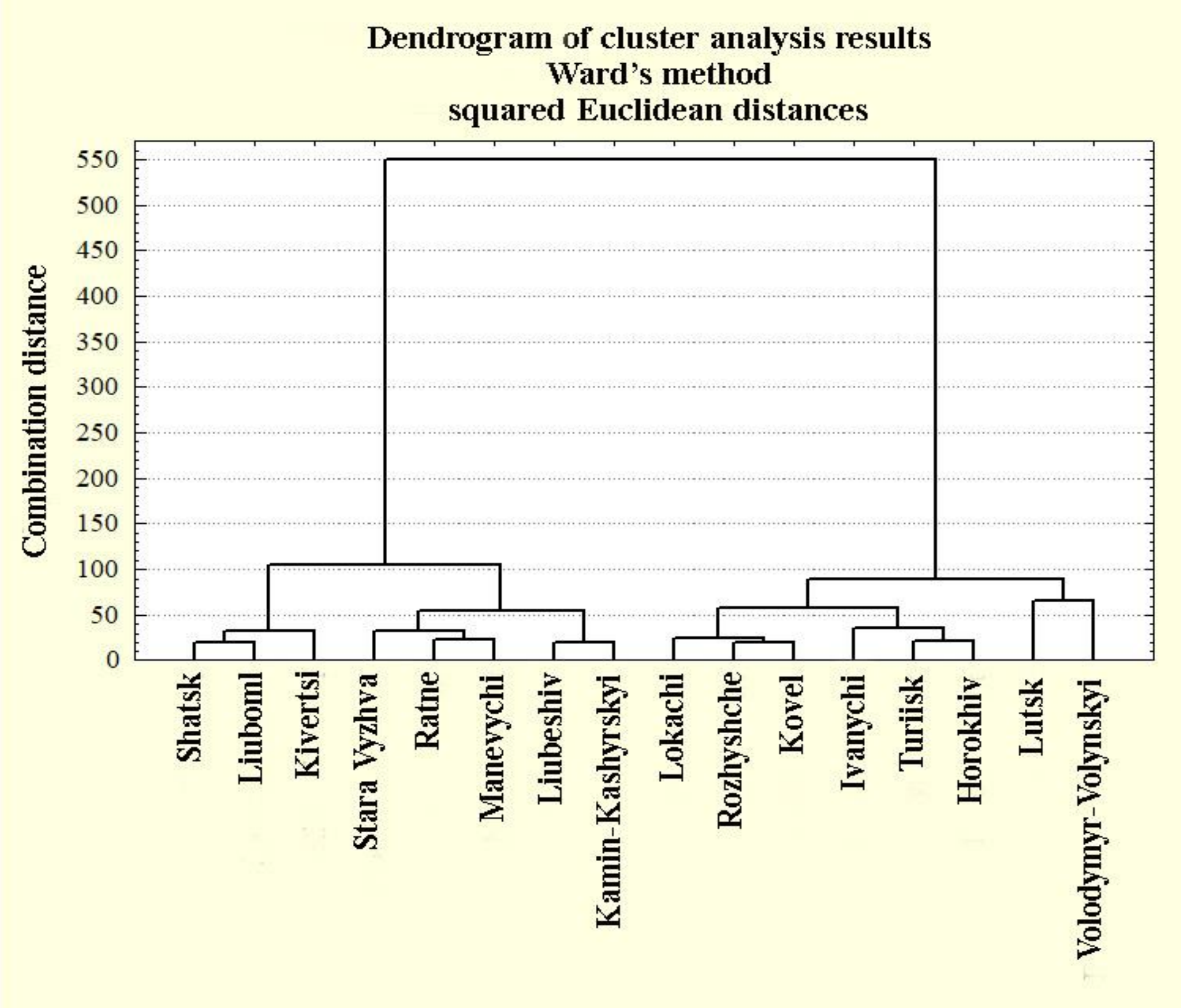

Fig. 2. The dendrogram of the cluster analysis results of the districts of the Volyn region of Ukraine in terms of socio-economic conditions of development of rural areas and peasant farms
Source: own development.

At this step of hierarchical clustering there is a process of sequential integration of the studied objects, which is subject to geometric interpretation and can be represented as a tree diagram - dendrogram (Fig. 2) on the vertical axis of which is the distance of the areas into clusters, and along the horizontal axis - the names of areas.

Therefore, based on the data of the dendrogram, at this step, the hypothesis of the presence of four clusters is preliminarily accepted. At the next stage of the study in order to confirm or refute the hypothesis used the method k -medium.

Summarizing the features of the clustering method k -medium, we note that its application predetermines the number of clusters that you want to get, in addition, the affiliation of objects to a particular cluster changes so as to minimize the differentiation of the studied indicators within clusters and maximize their intercluster [5]. However, the implementation of cluster analysis by the method k - averages allows determining the average values of standardized indicators for each of the formed clusters (Fig. 3).

It should be noted that the results of clustering by selected methods completely coincide, which confirms the correctness of the previous hypothesis of the presence of four clusters of the Volyn region of Ukraine, formed in terms of socio-economic conditions of rural development and farms located on them.

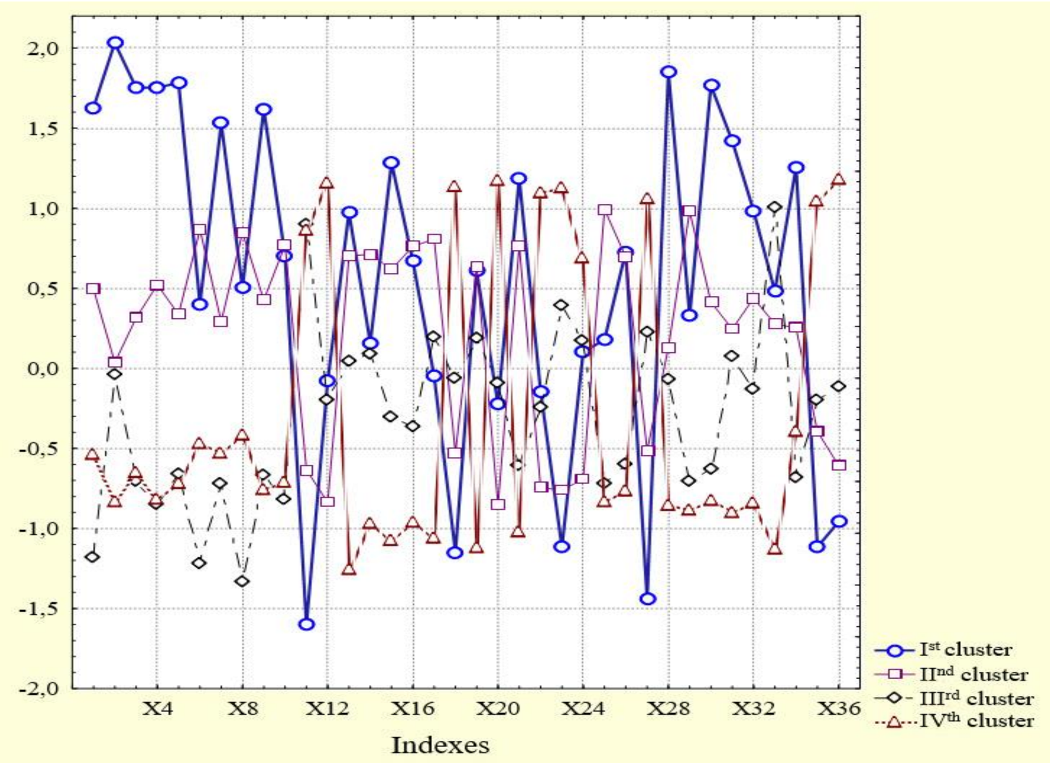

Fig. 3. Average values of the standardized indicators for each cluster of districts of the Volyn region of Ukraine, formed by the results of the study of socio-economic conditions of development of rural areas and peasant farms
Source: own development.

Visualization of the territorial-spatial distribution of selected clusters using a cartogram (Fig. 4) allows optimizing the visual perception of the information load on the clustering results.

Fig. 4. The cartogram of the clustering results of districts of the Volyn region of Ukraine according to the research results of socio-economic conditions of the rural territories and peasant farms development
Source: own development.

CONCLUSIONS

The obtained results provide an opportunity to conduct a comprehensive assessment and generalization of the territorial differentiation of socio-economic conditions for the development of rural areas and farms located in the Volyn region of Ukraine.

In particular, the first cluster, which is not territorially integral and covers Lutsk and Volodymyr-Volynskyi districts, is characterized by relatively high average values of indicators of gross agricultural output per capita (UAH 7,115.0), the number of farms in rural areas (98 units), investments in fixed capital per capita (UAH 2,523.4), the density of rural settlements (7.95 units/100 km2), the share of apartments in rural settlements with central heating (51.3%) and the lowest average the value of the share of personal farms in the value of gross agricultural output (56.0%), the average distance between villages (2 km), the average number of the rural population living in apartments without central heating (14.8 people/village).

The general generalizations of regional differentiation of separate elements of social and economic conditions of development of rural territories and peasant farms located on them for real realities prompt to think about perspective prospects of development of the system of these farms, their place, and role in the organizational structure of agrarian sector of market type.

Agreeing with the opinion of O. Onyschenko and many other scientists that peasant farms, while remaining small producers, cannot be considered as a promising form of management in a developed market structure of the agricultural sector [14] one of the dominant factors that objectively determine the need and feasibility of their further development, in our opinion, is the insufficient level of production in agricultural enterprises.

Thus, based on a comparative analysis of selected socio-economic indicators between the formed clusters, we believe that for farms of the first cluster it is possible to further develop by transforming them into farms and (or) integration into the functioning of formal or informal agricultural associations in agricultural producers including large enterprises). In our opinion, due to the benefits of wholesale production and mutually beneficial symbiosis with other agricultural formations, it becomes obvious the possibility of establishing a qualitatively new system of production, storage, processing, and marketing, which will move from uncompetitive methods of economic activity. Peasant farms were positioned as a fundamental basis for social stability of the population, to a progressive form of management of the European model.

In our opinion, the second cluster of districts of the Volyn region of Ukraine is characterized by the presence of personal farms mainly of the commodity-consumer type. In general, this cluster is characterized by relatively positive conditions for their further development on the basis that was formulated for the first cluster. In addition, in our opinion, it is advisable to pay considerable attention to the recreational direction of the development of farms in the Shatsk district, especially those located in the settlements of the coastal zone of the Shatsk lakes.

However, since the socio-economic conditions for the development of peasant farms in the second cluster are slightly lower than in the first, we believe that some of these farms, mostly consumer type, will cease to function in the future, and their owners will be employed in large agricultural enterprises or in the non-agricultural sector.

According to the results of the study, it was found that the third cluster, which covers the central and southern part of the region and includes the largest number of districts (37.5% of their total number), is characterized by the presence of farms mainly consumer type, operating to the self-sufficiency of the rural population, with separate elements of personal households of consumer and commodity type. In our opinion, in the long run, as the growth of production in agricultural enterprises stabilizes, the bulk of such farms will not function.

Note that according to the results of the study, the IV cluster, which territorially covers a continuous area in the north-eastern part of the region, includes five districts of the Volyn region of Ukraine (or 31.3% of their total number) and is characterized by the worst socio-economic conditions rural areas and peasant farms located on them, the functional purpose of which is mainly aimed at self-sufficiency of the rural population with food products. Characterizing the features of this cluster, we note that the average value of fixed capital investment per person for him is 6.8 times less than for the first cluster; gross agricultural output per 1 person – 2.1 times; the share of apartments in rural settlements with central heating – 12.9 times; density of rural settlements – 2.1 times. At the same time, the average value of the share of personal farms in the value of gross agricultural output in all categories of farms for the IV cluster is 1.7 times higher than for the I; the share of those employed in peasant farms out of the total working rural population is 2.4 times; the number of the rural population living in apartments without central heating – 27.4 times.

It is important to note that in the areas of the IV cluster on average 69.1% (or more than two thirds) of the working rural population is employed in farms, which given the range of shortcomings and limitations in the possibilities of further development of personal forms of management in this cluster should not be, in our opinion, to consider positive and to allow further prolongation of the current situation. Under such conditions, we believe that in order to ensure the priority of development and implementation of measures and mechanisms to optimize the number and prospects of rural areas and farms located on them and a sufficient level of employment of the rural population in the Volyn region of Ukraine, forming the IV cluster, it should be attributed to depressed (underdeveloped) rural areas in order to further develop and implement a set of specialized measures aimed directly at the development of such rural areas.

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ASSESSING THE QUALITY OF SERVICES PROVIDED BY RURAL TOURISM TOUR OPERATORS IN OVERCOMING THE COVID-19 PANDEMIC CONSEQUENCES IN UKRAINE

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Abstract

In the context of overcoming the COVID-19 pandemic consequences, the concept of total quality management should serve as the basis for rethinking the role of customer service for travel services, in accordance with the requirements of the international service quality standards. The paper aimed to approach the theoretical, methodological and practical problems of assessing the quality of the travel services of regional enterprises that organize rural tourism tours in Ukraine. The main attention was paid to the analysis of the quality of components of standard travel services on the directions of rural tourism routes having hidden features. To assess the services quality, in accordance with their latent features in the field of rural tourism, the authors used the benchmarking methodology, which combines the number of statistical comparison methods based on multidimensional objects. The article offers an algorithm for the benchmarking of the quality of services provided by rural tourism tour operators. As part of the benchmarking tools for assessing the quality of service provided by travel business entities, the authors used the taxonomic analysis method. The approaches proposed by the authors to assessing the quality of travel services allow rural tourism business entities to form the measures to restore the sale and rendering of travel services in the context of overcoming the COVID-19 pandemic consequences.

Key words: *tour operators, rural tourism, benchmarking, taxonomic analysis, security*

INTRODUCTION

During the crisis caused by the global pandemic and quarantine, the tourist flow in Ukraine fell by 75%. A lockdown in the tourism, culture and creative industries can lead to the loss of about 10% of GDP over the next 5 years [26]. To overcome the crisis and restore mobility, the enterprises of the international travel industry are actively looking for the ways to stimulate the tourist flow. For example, the tour operator ANEX Tour, participating in the program "Certification of Healthy Tourism" of the Ministry of Culture and Tourism of Turkey in the framework of measures to combat the coronavirus epidemic, became the first certified Turkish tour operator. To guarantee the safety in the hotels of the International Accor Group, enhanced hygiene and prevention measures were introduced. The ALLSAFE Certificate, developed in collaboration with Bureau Veritas, introduces new protocols and standards of high cleanliness and ensures that all anti-epidemic measures are met in the Accor Group Hotels. The possibility of contactless check-in at the hotel and subsequent check-out, including contactless payments are also provided [1]. Therefore, since July 07, 2020, Egypt tour operators have started receiving inbound tourism in certified hotels and resorts located in the coastal governorates (Red Sea, South Sinai and Matrouh) with a maximum occupancy rate of 50%. Obtaining the "Hygiene Safety Certificate" given by the Ministry of Tourism and Antiquities of Egypt and complying with the new set regulations, are prerequisites for hospitality establishments to operate [19].

In the conditions of the limited mobility of travelers, a new direction in the development of rural tourism can be "Gastronomic Routes" – an innovative tourism product for Ukraine, with high potential to promote rural development: by supporting producers of traditional products, preserving, enhancing biodiversity and cultural heritage of local communities; through the integrated development of agricultural production and tourism, which provides diversification of production activities in rural areas and attraction of additional financial income from tourists, tour operators and investors. European experience shows that this area of tourism provides the basis for the development of a regional network and cooperation of agricultural producers and tour operators for the development and commercialization of culinary routes as a regional tourist product [13]. Therefore, enterprises of the travel business developing this direction of travel should focus on the measures to improve the safety and quality of travel services under quarantine restrictions and overcome the pandemic consequences [23]. Therefore, the destinations that strongly depend on the provision of travel services need to achieve a balance between health issues and economic interests, as indicated by scientific researches [11].

In the current limited conditions of restoring the tourist flow, the use of technologies and methods for assessing the quality of services and sanitary safety measures is relevant for enterprises that focus on the quality of domestic tourism services.

MATERIALS AND METHODS

The purpose of the study is to improve the tools for benchmarking the quality of the services of small businesses in the rural tourism sector based on taxonomic analysis for further management decisions to improve the services quality. The analysis of the quality of travel services is based on the hypothesis that the indicators that characterize its quality depend both on the objective characteristics of tourist consumption (conditions of service to consumers in travel agencies and agricultural hotels, conditions for providing food services, booking, transportation), and on some values that are not directly observed and assessed (hobby interests of tourists, attractiveness of recreational resources, gastronomic tastes). The knowledge of the specific features of travel services allows us to formulate the main criteria for quality assessment, according to which the consumer expresses his attitude to a service [8]. Based on the analysis of scientific literature, we can assume that some characteristics of service quality indicators are latent indicators, that is, they are not amenable to direct assessment, and are described by a set of so-called signs-symptoms [30]. Conducted researches give us the grounds to consider the quality of service in the field of rural tourism as a set of properties, characteristics of a tourist product, resources and forms of service that give it the ability to meet the predetermined or expected needs of consumers [12], [14], [17]. The scientists also consider the quality system of service enterprises as a set of organizational structure, methods, processes and resources necessary for the implementation of general quality management and propose measures to improve it [1], [7], [16].

The definition of the concept "benchmarking" (English "bench" and "mark") first appeared in 1972 at the Cambridge Institute for Strategic Planning during the research activities of the PIMS Consulting Group. Then the basic principle of benchmarking was formulated: "in order to find an effective solution in the competitive field, it is necessary to know the best experience of other enterprises that have succeeded in similar conditions" [22]. Thus, benchmarking is used to analyze the effectiveness of individual functions and processes in the enterprise. This allows you to more accurately determine the causes of production activities inefficiency and provide recommendations to solve the identified problems. In the modern literature, there are a huge number of interpretations of benchmarking [21]. Some consider it a product of the evolutionary development of the concept of competitiveness, others a program to improve quality, and still others consider it an innovative product of modern business practice. The most famous definition of benchmarking is provided by the American scientist R. Camp. He defined it as "a constant process of studying and assessing the products, services, and experience of the most serious competitors or those companies that are recognized leaders in their industries" [6].

In our opinion, benchmarking in a travel company reveals its problems or problems in the travel market with costs and quality, reveals competitive advantages or disadvantages in the activities of travel companies. It reveals problems in the work, specifies them. For example, the management of the German travel corporation "TUI" is convinced that the benchmarking should be an ongoing process aimed not only at supporting competition, but also at winning over it. In the travel business, the basis of benchmarking is to compare the tourist service of a competitor or any part of it (transfer, accommodation) with the travel service of the enterprise under study in order to improve the quality of its own services. The collected information allows you to get an idea of the nature of competition, innovative technologies in the activities of leaders of the competitive environment, factors of their success in the travel business, summarize and use the collected data to improve management in the process of building a model of high-quality service of the company [10]. The main content of benchmarking methods is to identify reference travel companies that have achieved significant success in any functional areas, carefully studied their business processes and adapted the information obtained to the conditions of their own business [4], [15], [24].

The researchers use various benchmarking methods to analyze the performance of sectoral enterprises in the tourism industry [5], [27]. Some scientists are of the opinion that the benchmarking is a key tool for checking the effectiveness of travel services in the field of sports and event tourism to further determine the directions of development of tourist destinations [29]. Then, modern benchmarking is a research and analytical tool that consists in finding and studying the best-known methods of doing business, which helps to improve business processes relatively quickly and at the lowest cost.

In this study, the authors offer an algorithm for the benchmarking of the quality of services in the travel companies, which is shown in Fig.1. For further analysis, we used the methodology to determine the priority areas for improving the quality of service for consumers of rural tourism services, which includes a number of consecutive stages carried out using taxonomic analysis of tour operators [28]. In our opinion, it is advisable to use the taxonomic analysis method as a part of the benchmarking tools for assessing the quality of travel services. The taxonomy method is characterized by the simplicity of the mathematical apparatus, the absence of any requirements for the totality of the studied objects, and a more convenient scale of the obtained estimates, which facilitate the objects analysis and ranking.

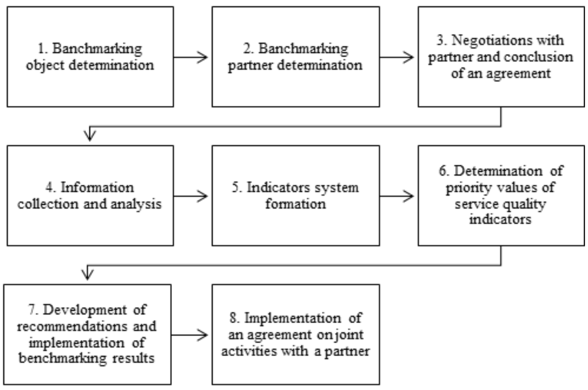

Fig.1. Algorithm of the benchmarking process in the study of the quality of travel services
Source: compiled by the authors.

Further calculations of indicators for assessing the quality of services will be carried out according to the following stages:

(1)Based on the initial data, an initial taxonomic analysis is carried out in the context of individual components of the quality of services of travel companies in the field of rural tourism.

(2)Based on the results of the initial taxonomic analysis, the percentage distance of the analyzed enterprise from the leading enterprise in terms of the level of taxonomic indicator is determined (h_o^{μ}):

$$h_o^{\mu} = \frac{\mu_l - \mu_a}{\mu_l} \times 100, \quad (1)$$

where: μ_a, μ_l is the level of the taxonomic indicator of the analyzed enterprise and the leading company, respectively, calculated based on the results of the initial taxonomic analysis.

(3)Step-by-step taxonomic analysis is carried out with the isolated use of reserves for improving the j factor indicator of the analyzed company. At the same time, at each step, the actual value of the j factor indicator is replaced with the best one, while the values of other indicators remain unchanged.

Based on the results of taxonomic analysis, each step determines:

-distance of the analyzed company from the leading company in terms of taxonomic indicator level (h_j^{μ}), as a percentage:

$$h_j^{\mu} = \frac{\mu_{1.j} - \mu_{a.j}}{\mu_{1.j}} \times 100, \qquad (2)$$

where: μ_a.j, $\mu_{1.j}$ is the level of the taxonomic indicator based on the results of taxonomic analysis with isolated use of reserves for improving the j factor indicator at the analyzed enterprise, respectively, for the analyzed company and the leading company;

-the value of reducing the distance from the leading company in terms of the level of taxonomic indicator due to the improvement of the j factor indicator at the analyzed company (Δh_j^{μ}), as a percentage:

$$\Delta h_j^{\mu} = h_o^{\mu} - h_j^{\mu} \qquad (3)$$

This indicator, in our opinion, is highly informative, since its values fully characterize the existing reserves for improving the quality of travel services at the analyzed company by improving the corresponding j factor indicator. The larger the latter, the higher the value Δh_j^{μ}.

(4)Based on the calculated values, Δh_j^{μ} the priority of each indicator is determined. The higher the value Δh_j^{μ}, the higher the priority of the j factor indicator, and accordingly this direction of improving the quality of services of the travel companies, will be.

RESULTS AND DISCUSSIONS

The study of the quality of services provided was conducted on the example of tourism operators of Odesa region. Ten small travel companies that are participants of the pilot project of enogastronomy tourism "Roads of Wine and Taste of Danube Bessarabia" within the framework of the EU project "Support for the System of Geographical Indications in Ukraine" were selected for experimental research [20]. We emphasize that Article 404 of the Association Agreement between Ukraine and the European Union provides for cooperation in the field of quality policy and requirements for the production of products and services in rural areas, quality schemes [25]. To implement the project, international experts chose Odesa region precisely because there is a modern Odesa-Reni autobahn, in the south of the region there are cohesive national wine producers and rural tourism and hospitality infrastructure. The touristic route "Roads of Wine and Taste of Danube Bessarabia" is aimed at introducing the best experience of the European Union in the field of diversification of agricultural tourism services and rural development. This will allow the business owners to attract tourists not only from Ukraine, but also from Europe, and thanks to the project, the travel companies will be able to learn from the experience of the European Union in promoting enogastronomy route services. Modern gastronomic routes are the tool for creating a travel offer in rural areas, attracting tourists, and developing destinations through community partnership with tourism entrepreneurs [2], [9], [31], [18].

It is advisable to provide information about the enterprises included in an impersonal form, that is, they are provided with two-digit numbers, under which they will appear in the process of presenting the research results. Note that differences in the methods of calculating the taxonomic indicator inherent in classical and modified algorithms, as a rule, cause differences in the values of the obtained estimates. The classical algorithm more accurately determines the scores for leading objects, while the modified algorithm determines scores for outsider objects.

Based on the unified taxonomy algorithm, a study of the quality of services for ten travel companies was conducted. According to the results of an expert assessment, the company "01" was identified as the leader among the studied travel companies. To compare the results of the analysis of service quality levels related to the comparative enterprise, the experts selected the travel company "04".

Table 1 shows the primary values of service quality indicators in travel companies and their weight coefficients determined by experts. Stimulant factors include indicators 1-2, 4-6 (Table 1). The third indicator – the average time spent on tour preparation should be attributed to distimulants.

Table 1. Primary values of indicators for assessing the quality of services in travel companies

Company	1.Safe tourist service environment, points	2.Services focusing on local food traditions, points	3.Average time spent on online tour booking, min.	4.Quality and safety of tourist accommodation services, points	5.Compliance of advertising with the actual security state at the place of consumption, %	6.Compliance of the tourist's expectations with the actual services provided in terms of volume, %
01	9	8	45.0	7.0	100.0	90.0
02	7	6	65.0	6.0	75.0	75.0
03	8	7	50.0	8.0	80.0	80.0
04	6	6	60.0	7.0	70.0	65.0
05	5	5	60.0	5.0	50.0	70.0
06	6	4	70.0	4.0	45.0	60.0
07	4	3	55.0	6.0	60.0	55.0
08	8	7	50.0	8.0	75.0	75.0
09	7	6	65.0	6.0	65.0	65.0
10	6	7	60.0	7.0	70.0	70.0
Weight coefficients	0.10	0.25	0.15	0.15	0.10	0.25

Source: original data, resulting from own experiences.

In our case (when using the taxonomy method as a tool for comparative analysis of the quality of services provided by travel company), high accuracy is required in the assessments of all objects – both leaders and outsiders. Achievement of this goal is possible by combining these algorithms based on the calculation of the results for each object of the total combined assessment (Table 2).

Table 2. The results of taxonomic analysis of the quality of services at travel companies, performed on the basis of the combined taxonomy method

Company	Classic algorithm		Modified algorithm		United results	
	μ^c_i	R^c_i	μ^m_i	R^m_i	μ^u_i	R^u_i
01	0.9103	1	0.9490	1	0.9490	1
02	0.5141	5	0.5201	5	0.5279	5
03	0.7693	2	0.7647	2	0.7829	2
04	0.4633	6	0.4774	6	0.4802	6
05	0.3409	8	0.3311	8	0.3428	8
06	0.1428	10	0.1731	10	0.1601	10
07	0.1687	9	0.2684	9	0.2125	9
08	0.7045	3	0.7250	3	0.7297	3
09	0.4161	7	0.4349	7	0.4343	7
10	0.5381	4	0.5656	4	0.5633	4

Source: original data, resulting from own experiences.

The authors used the algorithm of comparative assessment of the quality of travel services at travel companies, which is carried out on the basis of the combined taxonomy method [3].

(1)The value of the taxonomic indicator for the leading company "01" (μ_l) according to the results of the unified analysis is 0.9490, for the analyzed company "04" (μ_a) – 0.4802 (Table 2). Use formula (1) to calculate the value h_o^{μ}.

$$h_o^{\mu} = \frac{0.9490-0.4802}{0.9490} \times 100 = 49.40\%$$

(2)We perform a step-by-step taxonomic analysis.
At the 1st step, the actual value of the indicator "Safe tourist service environment", which is six points, is replaced with the maximum value – nine, which was achieved at the company "01" (Table 1). We perform taxonomic analysis using modified data. The new values of the taxonomic indicator for the leader and the analyzed company will be:

$\mu_{l.1} = 0.9424$; $\mu_{a.1} = 0.5238$.

(3)Using formula (2), we calculate the distance of the analyzed company from the leading company by the level of taxonomic indicator (h_1^{μ}):

$$h_1^{\mu} = \frac{0.9424-0.5238}{0.9424} \times 100 = 44.42\%$$

Similar calculations will be made for all indicators that determine the quality of services. The results of calculations performed for all six indicators are presented in Table. 3.

Table 3. Change in the distance of the company "04" from the leading company in terms of taxonomic indicator level with isolated use of reserves for improving the quality of services at the analyzed company

Indicators	Value of the taxonomic indicator in case of isolated use of improvement reserves of j factor indicator at the company "04"		Distance from the leading company in terms of taxonomic indicator level (h_j^{μ}), %
	leader "01" (μ_{1j})	analyzed company "04" (μ_{4j})	
1. Safe tourist service environment, points	0.9424	0.5238	44.42
2. Services focusing on local food traditions, points	0.9391	0.5433	42.14
3. Average time spent on online tour booking, min.	0.9367	0.5382	42.54
4. Quality and safety of tourist accommodation services, points	0.9502	0.5024	47.13
5. Compliance of advertising with the actual security state at the place of consumption, %	0.9411	0.5180	44.96
6. Compliance of the tourist's expectations with the actual services provided in terms of volume, %	0.9219	0.6166	33.11

Source: original data, resulting from own experiences.

(4)Using formula (3), we calculate the reduction of the distance between the leading company by the level of taxonomic indicator due to the improvement of each j factor indicator that determines the quality of services at the analyzed company (Δh_j^{μ}).
For the "Safe tourist service environment" indicator, it will be:

$$\Delta h_j^{\mu} = 49.40 - 44.42 = 4.98 \text{ (Percentage item)}$$

The results of similar calculations performed for all six indicators are shown in Table 3. It also provides information on the priorities of indicators and areas for improving the quality of customer service. Based on the results of the calculations, we found that the largest reserves for improving the quality of tourist services are associated with the ensuring that the tourist's expectations meet the actual volume of services provided, correspondence of advertising to the actual security state at the place, and the average time spent on tour online booking (Table 4). It is the use of these reserves that will make it possible to minimize the distance between the analyzed company and the leader in terms of service quality.

Table 4. Determination of priority areas for improving the quality of services at the travel company "04"

Indicators	Distance from the leading company in terms of taxonomic indicator level (h_j^μ), %	Reduction of distance from the leading company in terms of taxonomic indicator (Δh_j^μ), percentage points	Priority
1. Safe tourist service environment, points	44.42	4.98	4
2. Services focusing on local food traditions, points	42.14	7.26	2
3. Average time spent on online tour booking, min.	42.54	6.86	3
4. Quality and safety of tourist accommodation services, points	47.13	2.27	6
5. Compliance of advertising with the actual security state at the place of consumption, %	44.96	4.44	5
6. Compliance of the tourist's expectations with the actual services provided in terms of volume, %	33.11	16.29	1

Source: original data, resulting from own experience

The authors offer specific measures aimed at improving the quality of rural tourism services at the analyzed company:

(1)Constantly update information on travel safety in the context of overcoming the COVID-19 pandemic consequences, norms and regulations for the functioning of institutions for providing accommodation services at different levels of social contact to increase anti-epidemic resistance and create an image of a safe for recreation territory.

(2)Stimulate the participation of managers in professional online trainings on rural tourism, programs to improve technologies for providing services by local suppliers, information and advertising campaigns aimed at promoting recreation in domestic rural tourism locations with a focus on consumers who have reoriented their demand for domestic tourism.

(3)Carry out digital re-equipment of the operational quality control system of services.

(4)Maintain the established international and national security protocols for organizing travel, modern requirements for processing tourist documents.

(5)Implement the principles of "feedback" with the consumer in the work of managers, conduct exit polls, beta testing of consumers of rural tourism services.

(6)Introduce the monitoring system for complaints of tourists at the place of providing services in accordance with the contracts with suppliers of accommodation and catering services, under the program of agro gastronomic tours "Roads of Wine and Taste of Danube Bessarabia".

CONCLUSIONS

The study of the quality levels of tourist services according to the benchmarking technology, based on the methodology of taxonomic analysis, allows us to compare the quality of services provided by tour operators of the regional rural tourism markets in the context of overcoming the COVID-19 pandemic consequences and complements the developments of other authors to improve the quality of services in rural tourism [7], [12]. The results of our calculations and ranking of companies based on the algorithm of the combined taxonomy for ten travel companies, confirm the hypothesis that a travel service has a higher level of quality, if the degree of approximation of its quality model to the reference model, has a greater value of the taxonomic indicator. The benchmarking tools considered by the authors can complement the modern quality management of services in the field of rural tourism. Based on the results of calculation of the distances to the reference object, ranking tourist business companies, we can conclude that there are areas for improving the quality of travel services. In our opinion, the introduction of "feedback" technologies with the consumer in the activities of travel companies and the introduction of a monitoring system for complaints of tourists at the place of service provision, according to the contracts with tourists and suppliers of hotel and other services under the program of rural tourism tours, will increase the level of satisfaction of tourists, as well as eliminate the discrepancies between the expectations of tourists and the services actually provided in terms of volume and assortment. The results of the study conducted by business enterprises by themselves using the benchmarking method is the best way to create the measures to improve the quality of travel services. Approaches to the service quality benchmarking based on the unified taxonomy algorithm allow tour operator managers to focus their efforts on improving the safety of service consumption, operational quality control, and service characteristics of rural tourism tours offered for implementation.

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PROSPECTIVE WAYS OF DEVELOPMENT OF TOURIST AND RECREATIONAL POTENTIAL OF LVIV REGION, UKRAINE

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Abstract

Theoretical bases and methodical approaches to the study of the state of tourist and recreational potential of Lviv region are substantiated and the main tendencies of its changes for the future are determined. Many of the problems associated with the development of the tourism industry remain unexplored and need further elaboration. This testifies to the relevance and expediency of further research. The method of research of the state of tourist and recreational potential of Lviv region, which is based on the use of a number of general scientific methods, is described. The tendencies of development of tourist and recreational potential of Lviv region are substantiated. Wide range of different types of tourism is developing in the Lviv region now and therefore there is a well-developed network of enterprises that serve the tourism industry. The available strong tourist and recreational potential indicates that the development of the tourism industry has become one of the most priority economic directions of Lviv region. According to the results of the study, the relevant conclusions are given.

Key words: *tourism, tourist and recreational potential, inbound tourists, outbound tourists, domestic tourists*

INTRODUCTION

The global importance of the tourism industry is constantly growing, which is due to the importance of its role in the development of the economy and international relations of Ukraine, as well as in foreign exchange earnings to the budget. The mass development of tourism allows millions of people to expand their worldview, get acquainted with the history, heritage of world culture and traditions of foreign countries. Due to the correct economic and cultural policy, tourism is a factor of stability and strengthening of interstate ties and contributes to the formation of a positive image and prestige on the world stage of Ukraine in general and Lviv region in particular.

Lviv region occupies a significant place in the tourism industry of Ukraine and is one of the most promising tourist regions of our country. An important prerequisite for the development of tourism in the Lviv region is a strong resource base, which ensures the constant development of tourist infrastructure [5].

It has been one of the most attractive tourist areas of Ukraine. Various types of tourism are developing here now and, accordingly, a whole network of enterprises that serve the tourist infrastructure. The powerful potential of historical, cultural, architectural, socio-economic, and natural resources determines the priority of tourism development in the Lviv region.

Tourism as an important factor in the development of Lviv region contributes to the exit of the economy of both Lviv region and Ukraine as a whole from the crisis, as well as a stable and dynamic increase in revenues to local and national budgets [6].

A fundamental point in the study of the state of tourist and recreational potential of the region is its analysis as a system. We believe that the most important task facing the tourism industry is to continue the integration of Ukrainian tourism and recreation in the world by increasing the number of foreign tourists [9].

The transformation of Lviv region into a tourist zone with a European level of service and security will fundamentally change the face of both the region and the country.

MATERIALS AND METHODS

The purpose of our research was to analyze the state of tourist and recreational potential of the Lviv region and determine the prospects for its use. Based on this goal, the main task was to substantiate the trends of changes in the tourist and recreational potential of the Lviv region and to establish the most important factors influencing it.

The method of studying the state of the tourism industry of Lviv region involves the use of a number of general scientific methods (induction and deduction, computational, monographic, etc.). From the economic point of view, the resource base of the region is a set of factors of production (natural, labor, financial, production, etc.), which have quantitative and qualitative parameters that determine the possibility of their involvement in regional development programs. All available resources are a means of implementing development projects after their preliminary evaluation and analysis. The analysis of the resource base of the region includes an assessment of natural resource, economic, social, scientific and technical potential. It is necessary to take into account the territorial features of the location of resources and productive forces and their development. Tourist and recreational potential has a pronounced resource orientation, because it is the resources that determine its territorial organization, directions of specialization, tourist flows, the level of efficiency of tourist and recreational facilities [2].

For research of the effective development of tourist and recreational activity it will be most expedient to use the integrated system approach that allows us to explore:

-features of already existing natural and anthropogenic resources of a separate territory;

-functioning of tourist and recreational enterprises in a competitive environment;

-level of tourism infrastructure development;

-interaction with other systems (political, legal, economic, social, etc.).

RESULTS AND DISCUSSIONS

Lviv region is located in the west of Ukraine and is an extremely attractive area for tourists by geographical location, ecological situation, cultural and historical heritage.

The main feature of the economic and geographical position of Lviv region is its transit position and close location to the state borders of Ukraine with Poland, Hungary, Slovakia and Romania. It provides an opportunity for the development of business and cultural contacts with these countries.

Within the country, Lviv region borders with Ternopil, Rivne, Volyn, Ivano-Frankivsk and Zacarpattian regions. This allows you to explore and study the historical heritage of these areas. The most important of them are international and national highways: Lviv-Rava-Ruska, Lviv-Krakivets, Lviv-Shehyni, Lviv-Mukacheve, Lviv-Kyiv, Lviv-Uzhhorod, Lviv-Lutsk and Lviv-Khmelnytsky.

Lviv Railway covers railway routes of both international and national importance, the main of which are Lviv-Przemysl, Lviv-Chop, Lviv-Kyiv and Lviv-Odessa.

The presence of Lviv International Airport allows to carry out a large number of both international and domestic air transportation every day. In 2020, 877,700 passengers were transported through this airport, and 18,963 takeoffs and landings were made. The most popular and numerous international flights from Lviv were to Germany, Austria, Great Britain, Poland, the Czech Republic, Slovakia, Hungary, France, Spain, Italy, Israel, Turkey and a number of other countries. In addition, there is the possibility of domestic flights, the most common of which are: Lviv-Kyiv, Lviv-Kharkiv and Lviv-Odessa [11].

Lviv region is known as one of the best places in Ukraine for recreation and tourism. There are 400 territories and objects of the nature reserve fund in the region, in particular the state nature reserve "Roztochchya", 33 reserves, 240 natural monuments, 55 parks-monuments of garden and park art, 61 protected tracts. A significant area of rural tourism is the territory of the Ukrainian Carpathians, which is located in the south of Lviv region. The largest centers of cognitive tourism are Lviv and a number of ancient cities of the region with their historical and architectural monuments, such as Zhovkva, Drohobych, Gorodok, Sambir, Zolochiv, etc.

A special wealth of Galicia is the large reserves of mineral waters. In the Lviv region there are four deposits of medicinal mineral waters such as "Naftusya". on the basis of which there are medical resorts and sanatoriums in such cities as Morshyn, Nemyriv, Skhidnytsia, Truskavets, Shklo, etc [10].

Lviv region largely resembles an open-air museum, as there are more than 2,000 historical, architectural and cultural monuments on its territory. The architecture of Lviv has a mixture of Gothic and Baroque, Renaissance and Romanesque style, Rococo and Empire, modern eclecticism and constructivism. Lviv is a treasury of national ideas and culture, the economic, educational and cultural center of Western Ukraine. It has many museums, art galleries and theaters. A significant number of ancient churches have been preserved in the Lviv region. There are 1,235 religious buildings on its territory, of which 999 buildings are architectural monuments [4].

Table 1. Dynamics of the number of tourists and excursionists who were served by the subjects of tourist activity of Lviv region, persons

Index	2017	2018	2019	2019 in % to 2017
The total number of tourists	175,150	182,255	249,442	142.4
including: number of incoming tourists (foreign tourists)	6,042	7,617	7,929	131.2
number of outbound tourists (tourists-citizens of Ukraine who traveled abroad)	82,653	112,757	159,164	192.6
number of domestic tourists	86,455	61,881	82,349	95.3

Source: Generalized by authors based on [7; 8].

Analyzing the tourist flow during 2017-2019, it should be noted that the total number of tourists, including inbound and outbound, is growing, although the number of domestic tourists has slightly decreased [7; 8].

The available strong tourist potential indicates that the development of the tourism industry has become one of the most priority economic areas in the Lviv region. The analysis shows that in the structure of incoming tourists (foreign citizens) who visited the Lviv region in 2019, the largest share was occupied by tourists from Poland, due to the proximity of the state border with this country.

The vast majority of outbound tourists are characterized by the fact that the tourist trips of Ukrainian citizens are mostly due to the desire of people to rest and recuperate during their holidays in countries with favorable climatic conditions.

Therefore, in the structure of outbound tourists from the Lviv region, tourists who went to countries with powerful resorts with access to the sea coast had the largest share. The migration of outbound tourists was mainly related to their summer vacation.

We have identified the following main problems of development of tourist and recreational potential of Lviv region:

-economic and political situation in Ukraine (annexation of the Crimean peninsula, war in eastern Ukraine);

-ineffective state policy in the field of tourism and lack of state funding for the tourism industry;

-lack of clear planning the mechanism of development of perspective tourist territories and their financing;

-non-compliance of quality and level of service with European standards;

-unfavorable epidemiological situation caused by the pandemic of corona virus infection COVID-19;

-low qualification of specialists employed in the tourism;

-low competitiveness of historical and cultural heritage sites, caused by outdated material and technical base, neglected and dilapidated condition and lack of state funding;

-violation of the rules of use of natural resources, environmental protection and, as a consequence, unsatisfactory ecological situation, etc.

The issue of solving the problems of development of tourist and recreational potential of Lviv region is very important, because, thanks it, significant foreign exchange earnings are made to the budget, new jobs are created, which generally leads to improving the economic situation in Ukraine.

In the course of scientific research, we conducted a SWOT-analysis of the tourism industry of Lviv region (Table 2).

Table 2. SWOT-analysis of the tourism industry of Lviv region

Strengths	**Weaknesses**
– favorable socio-geographical position; – rich natural and recreational potential; – unique socio-historical heritage; – popularization of festival events as unique tourist and recreational products; – availability of regional tourism development programs; – increasing competition in the market of tourist services; – active position of the population on the development of the tourism industry.	– insufficient level of tourist infrastructure development; – low level of service provision in tourist facilities; – insufficient number of accommodation and catering facilities, disorderly condition of highways; – low level of advertising and public awareness of tourism programs in the region; – insufficient level of qualification of tourism workers; – lack of government programs to preserve and restore unique tourist attractions.
Opportunities	**Threats**
– use of geographical location to increase tourist flows; – use of natural potential for the development of rural, water, health and medical recreation; – involvement of objects of historical and cultural heritage in cognitive and entertaining tourist and recreational projects; – arrangement of accommodation and recreation facilities in places with tourist attractions; – arrangement of transport infrastructure to tourism facilities; – increase in the number of hotel facilities and other tourist accommodation facilities.	– reduction in the number of foreign tourists due to imperfect tourist infrastructure and low level of tourist services; – insufficient funding from the state budget for new tourism programs; – destruction of architectural monuments in case of their neglect; – reduction of tourist flows due to the low level of marketing of the tourist industry of the region; – excessive use of exhaustible natural and recreational resources.

Source: developed by the authors.

Ukraine has all the resources for the development of both domestic and international tourism. This is facilitated by the presence of a powerful tourist and recreational potential, a large number of historical, cultural and architectural monuments [3].

The lack of proper infrastructure remains a major problem. There is a need for high-quality repair of obsolete and construction of completely new competitive accommodation facilities. A large number of tourist facilities are located in rural areas, which are difficult to reach due to the lack or improper condition of roads. This can in some way scare away a large number of foreign tourists, so it is the problem of road repairs that needs to be urgently addressed.

There is also insufficient state funding for the construction of equipped stops for short-term recreation (gazebos, benches, etc.), mountain shelters, placement of tourist information signs and marking of routes and trails.

Some objects of cultural and historical heritage of Lviv region are in an abandoned or destroyed state. At the same time, the presence of these historic buildings is very important for the development of tourism. In addition, a significant problem is the insufficient funding of museums, and most of the total funding goes to pay for labor and utilities. The result is an outdated material and technical base of museums and almost no update. Abroad, the museum is a very important component of tourist and recreational potential, so there is a constant renewal of material and technical base, exhibition areas, reconstruction of historical and architectural monuments. All these factors actually contribute to the high popularity of foreign museums among tourists and, thanks to this, a significant income to the state budgets of foreign countries [1; 12].

Today the problem of household services for tourists in the Lviv region is acute. Unfortunately, the existing network of establishments that provide household services does not meet all the needs of the tourism industry due to:

-large concentration of tourist and recreational facilities in relatively small areas;

-remoteness of tourist and recreational facilities from district centers or large settlements, where the necessary facilities are located;

-insufficient quality of services provided by tourist and recreational infrastructure institutions and the appropriate level of qualification of tourism personal.

CONCLUSIONS

All this problems have been complicating the functioning of the tourism industry of Lviv region for a long time, so their elimination requires significant efforts. The solution of these problems depends not only on the weak material and technical base, but also on the state tourism policy.

The presence of a large number of different natural resources provides an opportunity to develop various types of tourism in the Lviv region, the main of which are: active (water, speleological, cycling), rural, cultural, healthcare and other types.

Each tourist and recreational territory for its stable functioning must specialize in certain types of tourism and types of recreational recreation. It is important to form them in such a way as to maintain a stable tourist demand throughout the year, avoiding the seasonality factor.

According to the results of scientific research, we have proposed the following main ways to solve the problems of development of tourist and recreational activities of the Lviv region:

-increase in financing of the tourism industry both through subsidies from the state and through attracting potential investors;

-improvement of the tourist infrastructure and the condition of the roads, especially in rural areas;

-improving the legislative and regulatory framework governing tourism;

-repair and restoration of historical and cultural heritage sites;

-improving the condition of tourist routes (increasing the number of equipped stops for short-term recreation, mountain shelters, placement of information and tourist signs, providing access to tourist facilities, etc.), which will increase the number of potential tourists;

-improving the quality and expanding the range of services in tourist facilities;

-increase in the number of tourist accommodation;

-providing a sufficient number of qualified personnel in tourism.

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PROSPECTS OF AGRARIAN SECTOR DEVELOPMENT OF LVIV REGION, UKRAINE

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Abstract

Theoretical bases and methodical approaches to the study of the state of the agrarian sector of Lviv region are substantiated and the directions of its development for the future are determined. Some issues related to the development of the agrarian sector need further elaboration. It indicates the relevance and feasibility of this research. The purpose and tasks of the method of research of the state of the agrarian sector of the Lviv region are defined and perspective tendencies of development are outlined. Agrarian sector of Ukraine having a production potential that significantly exceeds the needs of the domestic market, will contribute to the development of the national economy and its effective integration into the world economy. It will also have a positive effect on the growth of income of the rural population employed in agriculture, and in turn will provide a positive effect on the development of other sectors of the national economy. All the results of the study are presented in the form of relevant conclusions.

Key words: *agrarian sector, economic development, agro-industrial complex, economic efficiency, agricultural enterprises*

INTRODUCTION

At the current stage of economic development, the agrarian sector is one of the most important components of the economy of Lviv region in particular and Ukraine in general. Therefore, determining the directions of its further development is impossible without a thorough analysis of its current state, organizational and economic mechanism, which will further assess and develop the principles of implementation of these strategic directions.
A comprehensive study of theoretical and practical aspects of the functioning of the agrarian sector of Lviv region and the strategic directions of its development are substantiated.

MATERIALS AND METHODS

The purpose of our research is to analyze the state of the agrarian sector of Lviv region and substantiate the perspective ways of its development. Based on this goal, the main task was to substantiate trends in the functioning of the agrarian sector of Lviv region, as well as to establish the most important factors influencing it.
The issue of research of strategic directions of economic development of the agro-industrial complex and development of the mechanism of their realization has always been in sight of view of domestic economic science.
Theoretical and methodological and applied aspects of the study of strategic directions of economic development of the agrarian sector were in the sight of view of many domestic scientists such as Berezivskyy Z. P. and Berezivska O. Y. [2], Berezivskyy P. S. and Bryk G. V. [3], Gordiychuk A. I. [4], Luzan Yu. Ya. [5], Lupenko Yu. O., Sabluk P. T., Mesel-Veselyak V. Ya. and Fedorov M. M. [6], Malik M. Y. and Zayats V. M. [7], Prysazhnuk M. V., Zubets M. V., Sabluk P. T. and Mesel-Veselyak V. Ya. [8], Ulyanchenko O. V., Yevchuk L. A. and Gutorov I. V. [11].

RESULTS AND DISCUSSIONS

The agrarian sector of Ukraine, which is based on agriculture, is fundamental in the national economy. It formulates the main principles of food, economic, energy and environmental security, and develops technologically interconnected sectors of the national economy.

Entering the world economic space, strengthening the processes of globalization and trade liberalization requires adaptation to ever-changing conditions and further improvement of agricultural policy.

Agriculture of Ukraine, having a production potential that significantly exceeds the needs of the domestic market, will contribute to the development of the national economy and its effective integration into the world economic space. It will also have a positive effect on the growth of income of the rural population engaged in agriculture, and in turn will provide a multiplier effect on the development of other sectors of the national economy.

Decreased real cash inflows and solvency of agricultural producers at relatively high interest rates on short-term loans, almost completely reduced production, suspended investment processes, disrupted the balance of fixed and current assets, accelerated almost complete destruction and depreciation of material and technical base. This led to a sharp decline in production and to the displacement of domestic and foreign food markets of its own agricultural producers.

Significant lack of money supply in the absence of quality control by the state over the activities of banks, rapid growth of credit indebtedness of agricultural enterprises for the inability to pay at least the minimum wage to agricultural workers, creates both socio-economic and political tension in society.

All future ways of economic development of agriculture should be aimed at creating an efficient, socially adapted agricultural sector of the economy, which should meet the needs of the internal market and ensure the main world positions. This will be ensured on the basis of multifaceted and priority support of agrarian enterprises whose owners live in rural areas. It means that they combine the right to land with work on it, and as a result personal economic interests with its social responsibility to the whole community.

The crisis, which affected all sectors of the economy, had an extremely severe impact on the development of agricultural production in Ukraine. The reduction in the gross output of agriculture is becoming threatening. Due to the deepening disparity in prices for industrial and agricultural products, agricultural production is becoming very unprofitable. The destructive processes of resource potential in agriculture are deepening. The artificially formed separation of the agrarian economy from the financial system becomes extremely threatening, which almost completely deprives the organizational and economic structures of adequate conditions for functioning. Most small agricultural enterprises, in fact, are on the verge of financial collapse [4; 7].

Given that the economic crisis in agriculture is largely due to macroeconomic reasons, it is impossible to overcome them without state support. This is not about state intervention in a competitive market, but about balanced state regulation of the market itself. This will help improve the functioning of the market, which will increase economic efficiency and increase the welfare of the population.

To ensure the creation of an effective market environment, it is necessary to create a fundamentally new, independent of subjective factors, production infrastructure that would help free the producer of agricultural products from its uncharacteristic functions of marketing and service.

It is also necessary to create on a scientifically sound basis wholesale markets for agricultural products, improve the system of wholesale trade and the practice of holding auctions, exhibitions and fairs to promote Ukrainian products.

Table 1 shows data of the dynamics of agricultural products by categories of farms in the Lviv region. The analysis shows that there was an increase in production of agricultural products, including crop and livestock products, in almost all categories of farms in Lviv region, which is extremely positive for the functioning of the agricultural sector as a whole.

Table 1. Dynamics of agricultural production by categories of farms in Lviv region (at constant prices, million UAH)

Index	2017	2018	2019	2019 in % to 2017
Farms of all categories				
Agricultural products	22,029.3	22,818.7	23,004.4	104.4
including: crop products	14,926.9	15,522.3	15,967.9	107.0
livestock products	7,102.4	7,296.4	7,036.5	99.1
Enterprises				
Agricultural products	10,200.5	11,103.0	11,063.3	108.5
including: crop products	7,800.0	8,405.4	8,480.6	108.7
livestock products	2,400.5	2,697.6	2,582.7	107.6
Households				
Agricultural products	11,828.8	11,715.7	11,941.1	101.0
including: crop products	7,126.9	7,116.9	7,487.3	105.1
livestock products	4,701.9	4,598.8	4,453.8	94.7

Source: Generalized by authors based on [1; 9; 10].

Table 2. Share of Lviv region in general indicators of agriculture of Ukraine, %

Index	2017	2018	2019
Agricultural products			
Agricultural products	3.9	3.8	4.0
including: crop products	3.5	3.3	3.6
livestock products	5.2	5.2	5.2
Sowing areas			
Crops	2.5	2.4	2.4
including: cereals and legumes	2.0	2.0	2.1
sugar beet	5.0	4.2	4.5
soy	3.0	3.1	3.2
rapeseed	7.2	6.6	9.2
potato	7.2	7.2	7.2
vegetable crops	5.8	5.9	5.7
fodder crops	5.1	5.1	5.2
Crop production			
Cereals and legumes	2.3	2.1	2.3
Sugar beet	5.4	4.8	4.8
Sunflower	0.6	0.6	0.5
Soy	3.4	3.5	3.6
Rapeseed	8.0	7.5	10.3
Potato	7.6	7.5	7.6
Vegetable crops	5.5	5.4	5.4
Fodder crops	6.7	6.3	6.8
Fruit and berry crops	5.6	5.3	5.6
Number of farm animals			
Cattle	5.2	5.1	5.3
including: cows	5.6	5.4	5.8
Pigs	6.1	6.9	6.3
Sheep	1.2	1.2	1.2
Goats	4.1	4.1	4.1
Birds	4.2	4.3	4.2
Production of livestock products			
Implementation for slaughter of farm animals in live weight	5.5	5.6	5.5
Milk	5.1	5.0	5.2
Eggs	3.6	3.5	3.6
Wool	0.9	1.0	1.0

Source: Generalized by authors based on [1; 9; 10].

At the current stage of market relations the main position of the development strategy of enterprises of different organizational and legal forms of management in the agro-industrial complex of Lviv region is their cooperation for production, processing, storage and marketing of agricultural products, production facilities, sales network development and service [3; 5].

Processing of agricultural products should be based not only on the whole variety of forms of management, but also on different scales of concentration of production capacity. Preference should be given to ensuring the efficient use of large processing plants that have technological advantages and are attractive objects for investment, including from foreign sources. However, their actions do not necessarily create administrative barriers to the development of small and medium-sized processing enterprises, because their operation will contribute to the formation of a competitive environment. In turn, the formation of a powerful processing industry in rural areas will help create new jobs, which will successfully solve social problems [2; 8].

We analyzed in Table 2 share of Lviv region in the general indicators of agriculture of Ukraine. As we see in almost all indicators, the Lviv region occupies a significant share of agricultural production in the overall indicators for Ukraine.

During our research we have identified the main problems of development of the agrarian sector of Lviv region:

-uneven development of different forms of management with the simultaneous weakening of the positions of small and medium-sized agricultural producers through the creation of formally identical, but in practice not always equal in size and social burden economic conditions for different agricultural producers;

-there is no motivation for cooperation of small agricultural enterprises and their consolidation within territorial communities, which leads to a weakening of the economic development of these communities;

-lack of stability of competitive positions of domestic agricultural products in foreign markets, which occurred due to incomplete completion of the processes of adaptation to European requirements for quality and food safety;

-there are low rates of technical renewal of production;

-there are risks of increased production costs due to increasing levels of equipment wear, the use of obsolete and physically outdated technologies;

-loss of part of products due to imperfect logistics system, its storage and general infrastructure of the agricultural market;

-there is no motivation of agricultural producers to comply with environmental requirements;

-reduction of consumption of agricultural products, which is due to low solvency of the population;

-insufficient efficiency of self-organization and self-regulation of the market of agricultural products;

-lack of awareness of the majority of agricultural producers about market conditions and the conditions for doing business in the industry.

An important condition for efficient agricultural production is the availability of prompt and reliable information on prices in both domestic and global agricultural markets, compliance with domestic and international standards and standards, and the reliability of partners. This will encourage the creation of a network of structures that will assess the quality of agricultural products, provide information on the financial condition and reliability of partners.

Therefore, it is necessary to stimulate the creation and development of non-state agricultural trading houses, insurance companies, business centers, consulting firms for information and advisory services, technical and technological support of agricultural production and the provision of economic and financial activities.

A clear and effective system of information and consulting services in agro-industrial production will be the main means of rapid introduction of new production technologies, reducing the pressure of shadow and monopoly structures on agricultural producers, creating a favorable environment for market conditions, and as a result the main lever of civilized food market. New information technologies will be an essential tool for improving the management of agricultural production.

The exit of the agrarian economy from the crisis will be preceded by the mandatory establishment of conditions for full-fledged investment processes in the economy. Attracting a sufficient level of investment should be at the expense of both own funds of agricultural producers and involved. The investment regime should provide expanded reproduction of fixed assets [6; 11].

CONCLUSIONS

Further development of the agro-industrial complex in the current crisis situation objectively requires extensive use of foreign aid. The main task of its involvement should be to create conditions for overcoming acute crises, such as reducing the marketability of products, bankruptcy of many agricultural enterprises, almost complete destruction of the material and technical base of the industry, curtailment of breeding work etc.

The agro-industrial complex of Lviv region has all the necessary conditions for the widespread use of foreign investment. Such prerequisites are a favorable geographical location, climatic conditions for agriculture, soil, developed production and social infrastructures, availability of food and resource markets, skilled labor and more.

For the formation of an effective agricultural economy requires new effective mechanisms, methods, schemes, and levers for effective reform and further development of the agricultural sector. Some agricultural industries are suffering losses as a result of ignoring objective economic laws, the desire of certain political forces to lobby the interests of certain oligarchs. Without solving this problem, it is impossible to expect a significant increase in the competitiveness of agricultural products in attracting significant investments in agriculture, including foreign ones.

The situation that has developed in the agro-industrial complex of Lviv region requires the development of urgent measures to overcome the crisis and reasonable determination of strategic directions of agricultural policy, stop the economic downturn and increase production, domestic and foreign markets for agricultural products, carrying out socio-economic transformations.

We have substantiated the following main strategic directions for further development of the agrarian sector of Lviv region for the future:

- forecasting the development and sustainability of the agrarian sector through the development of various organizational and legal forms of management;
- improving the legal support for the functioning of the agrarian sector;
- guaranteeing food security by the state;
- development of programs for social protection of the rural population;
- promoting the development of rural settlements and the formation of the middle class in rural areas by providing employment to the rural population and increasing incomes;
- increasing the level of investment attractiveness of the agrarian sector and financial security of agricultural enterprises;
- increasing the competitiveness of domestic agricultural products;
- formation of market infrastructure and market environment in agriculture;
- increasing the share of participation of Lviv region in particular, and Ukraine in general, in providing the world market with agricultural products;
- rational use of agricultural lands;
- reduction of man-caused load of the agrarian sector on the environment.

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SOCIO-ECONOMIC AND MARKET POTENTIALS OF *CHRYSOPHYLLUM ALBIDUM* IN RAINFOREST AND DERIVED SAVANNA VEGETATION ZONES OF OSUN STATE, NIGERIA

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Abstract

This research to investigated the socio-economic and market potentials of Chrysophyllum albidum for the sustainability of the people, especially the rural dwellers. Nine and fifteen communities were purposely selected from rainforest and derived savanna zones for socio-economic and market potentials assessments, respectively. Two sets of semi-structured questionnaires (Household and Key informant questionnaire) were used to obtain information from the respondents. Majority of the respondents in both vegetation zones were mostly male and they are between the age of 41 to 50 years of age. A high percentage of C. albidum trees in both rainforest (66.7%) and derived savanna (93.3%) are found on the farmland. The result revealed that, 11.1% and 17.3% of the respondents in both rainforest and savanna zones respectively that owned C. albidum either on their farmlands or home gardens had no formal education. C. albidum fruits was being used for various purposes including food, nutritional supplement, income generation, medicinal, etc. Majority of the farmers sells C. albidum fruits by selling the whole tree on farmland for the marketers to harvest the fruits. Annual income generated from the sale of C. albidum fruits was between ₦ 8, 000 to ₦ 150, 000 in both rainforest and derived savanna vegetation zones, respectively. This research paper highlights the socio-economic and market potentials of Chrysophyllum albidum in the two vegetation zones of Osun State.

Key words: *socio-economic, market potentials, Chrysophyllum albidum, rainforest and derived savanna*

INTRODUCTION

Chrysophyllum albidum G. Don, commonly known as “Africa star apple” belongs to the Sapotaceae family. It is primarily a forest tree species, native to many parts of tropical Africa, widely distributed in West, Central, and East Africa for its edible fruits and various ethno-medical uses [11]. *C. albidum,* an indigenous plant is known by various tribal names in Nigeria as *agbalumo* (Yoruba), *Udara* (Ibo, Efik and Ibibo), *ehya* (Igala) and *agwaluma* (Hausa) [17]. Its fruits are harvested annually between December and April, which makes it a highly seasonal product [23]. The fleshy fruit pulp is suitable for jams and eaten especially as snack by both young and old [11]. The juice of the fruit has potentials as an ingredient of soft drinks and can be fermented for wine or other alcohol production [9]. *C. albidum* has been found to have nutritive value to provide nutrient supplements for children and women in rural communities [26] and high content of ascorbic acid (between 1,000 to 3,330 mg per 100 gm of edible fruit), which is about 100 times higher than that of oranges and 10 times higher than that of guava or cashew [6]. Commercially, *C. albidum* fruit is highly valued in Ghana and Nigeria and it is an excellent source of vitamins, irons, and raw materials to some manufacturing industries [14]. The market attractiveness of the species is derived from the sweet taste of the fruit pulp [8].

Despite the importance of *C. albidum* and other forest food tree species, their regeneration and improvement have been greatly neglected. *C. albidum* grows in the wild and if continues, there will be low probability of obtaining its much valued fruit on a sustainable basis [15]. In Nigeria, *C. albidum* is classified among the endangered tree species [18], with a high possibility of going into extinction in the near future except something is done to conserve the species or increase their population. The short shelf life of *C. albidum* fruit [14] as well as the lack of storage facilities poses a serious problem for its marketing. However, marketing of *C. albidum* has the prospect of providing a considerable income generating opportunity for rural people. From December 2005 to February 2006, the price of a basket of the fruits of *Chrysophyllum albidum* in Ghana ranged from about US$7 to US$17 [14]. In the humid lowland of Nigeria, the average value of production for 2007, the fruit of *C. albidum* was estimated at about US$16 million [19]. The general objective of this research is to analyze the socio-economic contributions and market potentials of *Chrysophyllum albidum* in the rainforest and derived savanna vegetation zones of Osun State, Nigeria.

MATERIALS AND METHODS

Study Area

Osun State has a many opportunities for agriculture development [4, 12, 22], but also for using other natural resources like the tropical rainforest and derived savanna zones [15].

The study was conducted in tropical rainforest and derived savanna vegetation zones of Osun State, Nigeria. From each vegetation zone, three LGAs (Atakumosa West, Ife North and Isokan) from tropical rainforest and five LGAs (Boripe, Iwo, Ejigbo, Ede North, Odo-Otin) from derived savanna were purposively selected and three communities with good concentration of *C. albidum* were purposively selected from each of the LGA. In each of the communities, five farming households who have *C. albidum* especially on their farms and home gardens were selected through snowball sampling technique. In addition, one key informant (farmer) was interviewed in each of the communities to gather information on the marketing. The GPS reading of the selected communities were overlaid to generated maps that show the distribution of the communities as shown in Figures 1 using QGIS software.

Data Collection

Data for this study were collected using two sets of semi-structured questionnaires. The first category of questionnaire (Household questionnaire), which was used to gather information (e.g. annual income from the sale of the fruits, percentage contribution of *C. albidum* to total annual income, yield of *C. albidum* per annum). The second set of questionnaire (Key informant questionnaire) was used to obtain data on fruit price (both at the market and farm gate), where the marketing takes place and people that are involved etc. The questionnaire was pre-tested before final administration to respondents. Thus, a total of 120 respondents were interviewed across the two vegetation zones in Osun State, Nigeria. The data were subsequently analyzed using descriptive statistics.

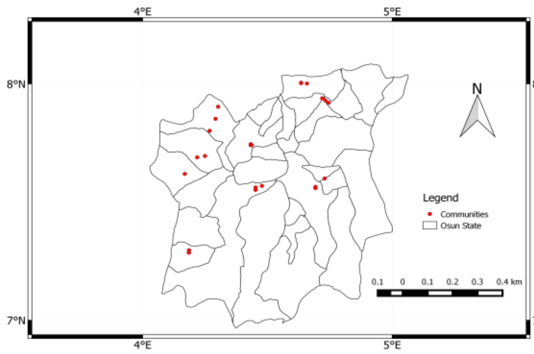

Fig. 1. Distribution of communities visited (red dots)
Source: Data Analysis.

RESULTS AND DISCUSSIONS

The research work covered a total of 24 communities. The results obtained in this study show that people that have *C. albidum* either on their farmlands or homes are mostly males, which is to be expected since the majority of respondents are males. They are married and their age ranged between 41 and 50 years (Table 1). This age range is active and will thus ensure active labour force for the domestication of the species as confirmed with the findings of Bolanle-Ojo and Onyekwelu [15], and their major occupation is farming, in both vegetation zones. The high percentage of middle aged (i.e. working-age adults) found in the two vegetation zones is an indication that they have high tendency to generate higher income from the sales of fruits, which is also similar to the view of Ajibefun *et. al.* [10].

The result (Table 1) revealed that, 11.1% and 17.3% of the respondents in both rainforest and savanna zones respectively that owned *C. albidum* either on their farmlands or home gardens had no formal education. Thus, respondents with no formal education are higher in the savanna than in rainforest ecosystem. In the rainforest zone, majority of the respondents have up to secondary school education (46.7%). The higher educational level of the respondents in the rainforest zone might have contributed to higher domestication level for the improvement on the production of *C. albidum* in the ecosystem. The low educational status observed among the farming populace is supported by earlier studies such as Adams *et. al.* [1] and Adhikari, *et. al.*[5]. Stoian [24] opined that education is one of the important human capitals, which plays important role in determining status in the society. Education is expected to contribute to people's ability to read and understand instructions and hence help them to adopt new technologies [16]. Prominent level of illiteracy in the savanna zone can lead to deforestation of the forest resources as it was noted by Adekunle *et. al.*, [3], which is the major threat factor of the species in the savanna ecosystem. Educational level may also affect future domestication of the forest fruit tree species, this is because it is easier to create awareness among educated people than among the non-educated [15].

Table 1. Demographic Information of Respondents

	Variants	Rainforest (n=45)		Savanna (n=75)	
		F	%	F	%
Age of Respondents	20-30 years	3	2.2	7	9.3
	31-40 years	10	22.1	13	17.3
	41-50 years	16	35.4	24	33.3
	51-60 years	15	33.1	17	22.6
	61-70 years	1	2.2	5	6.6
	71-80 years	0	0	7	9.2
	81-90 years	0	0	1	1.3
Highest Education Attained	No Formal Education	5	11.1	13	17.3
	Primary Education	18	40	46	61.3
	Secondary Education	21	46.5	15	20
	Tertiary Education	1	2.2	1	1.3

Source: Data Analysis.

The results on Figure 2 show that in both rainforest and derived savanna zones most of *C. albidum* trees are located on the farmlands. None of the respondents had been deliberately involved in planting of *C. albidum* trees.

Dominant reasons by the respondents for not planting the tree was the belief that if *C. albidum* tree is planted, they might experience early or immature death. The result on Figure 3 highlights the multipurpose uses of *Chrysophyllum albidum* in the study area.

The use categories of *C. albidum* in the study area were food, income and medicine. Food and medicine emerged as most dominant use categories among the respondents in both rainforest and savanna part of the study area.

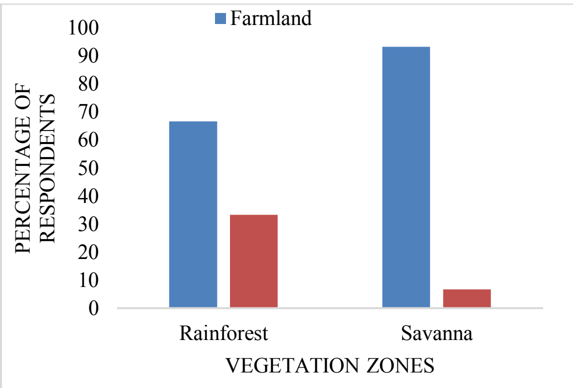

Fig. 2. Locations of *Chrysophyllum albidum* trees
Source: Data Analysis.

These findings confirmed previous studies that reported on the rich and diverse array of uses of *C. albidum* trees [7]. Besides these common uses, it was also mentioned by Houessou *et.al.*, [20], that *C. albidum* leaves were occasionally used for fodder and rotten or damaged fruits were used to feed pigs.

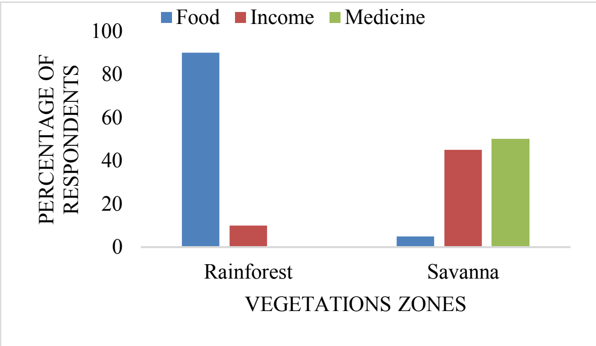

Fig. 3. Uses categories of *C. albidum*
Source: Data Analysis.

The number of trees owned by respondents across the vegetation zones is presented in Figure 4, In the rainforest zone, majority of the respondents (51.1%) had two trees of *C. albidum*, 37.8% had only one tree, 8.9% had three trees and 2.2% had four trees of *C. albidum*. Majority of the respondents (48%) in the derived savanna zone, had only one tree of *C. albidum*, 33.3% had two trees, 10.7% had three trees, 2.7% had five trees, 2.7% had six trees, 1.3% had eight trees, and 1.3% had ten trees.

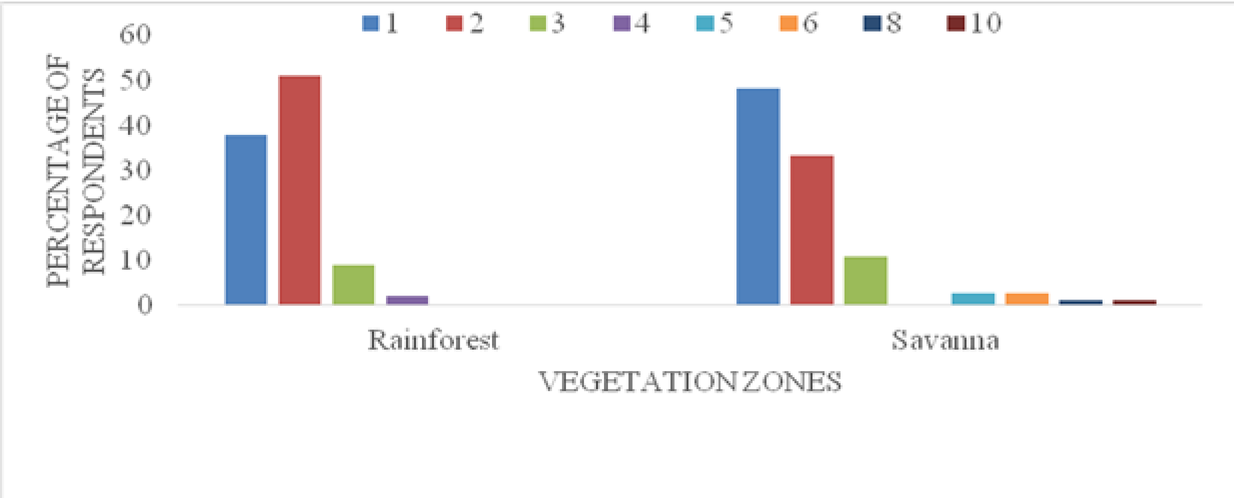

Fig. 4. Number of *C. albidum* trees owned by respondents in the study area
Source: Data Analysis.

The result obtained in this study show that all the respondents (100%) in both vegetation zones retained *C. albidum* tree, either on their farmlands and/or in their home gardens. Figure 5 shows that in the rainforest zone, majority of the respondents (57.8%) retained *C. albidum* tree for the purpose of food security and income, 40% retained *C. albidum* tree for food security, and only 2.2% retained *C. albidum* tree for food security, income and medicinal purposes. This shows that the people in the in rainforest zone have poor knowledge about the medicinal value of *C. albidum*. However, in the derived savanna zone, 2.7% of the respondents retained *C. albidum* tree for food security, 6.6% for income generation and 52% for medicinal, income, and food security purposes, and 38.7% for food security and income generation. In the rainforest zone, majority of the respondents (88.9%) sell the fruits while on the tree on farmland and the traders harvests the fruits thereafter while 11.1% periodically harvest the fruits from the trees and sell. All the respondents (100%) in the savanna sells the fruits by selling the entire fruits on the tree (Figure 6).

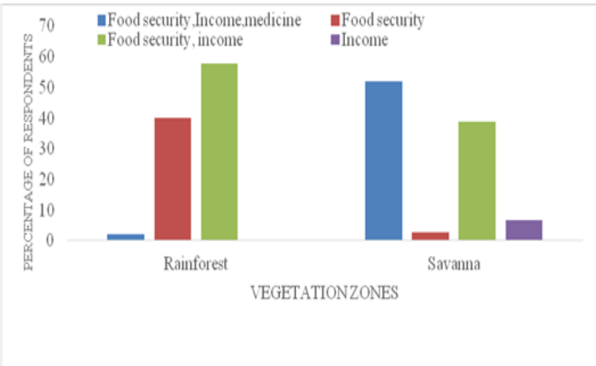

Fig. 5. Respondents reasons for retaining *C. albidum*
Source: Data Analysis.

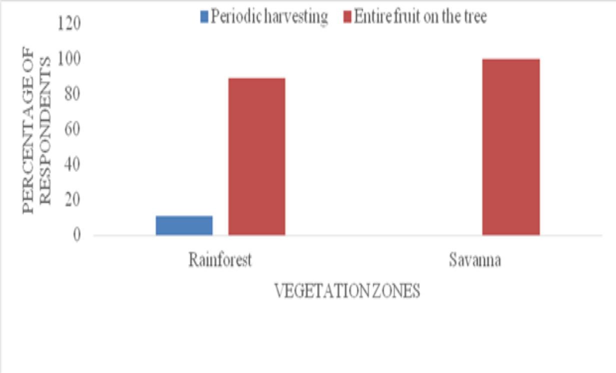

Fig. 6. Methods of sales of *C. albidum*
Source: Data Analysis.

Result in Table 2 study show that in the rainforest zone, majority (88.9%) of the respondents claimed that the cost/basket of *C. albidum* fruits at the farm gate ranged from ₦1,500 - ₦2,000 and 11.1% claimed that it was ₦1, 500 - ₦1,800 while 100% of the respondents claimed that at the market was ₦1,500 - ₦2,000. In the derived savanna zone, majority of the respondents (53.3%) and 46.7% claimed that the cost/basket of *C. albidum* fruits at the farm gate ranged from ₦1,500 - ₦2,000 *and* ₦1, 500 - ₦1,800 respectively.

Table 2. Cost of *C. albidum* fruits in rainforest and derived savanna zones

	Rainforest		Derived Savanna	
	Farmgate (%)	Market (%)	Farmgate (%)	Market (%)
₦ 1,500 - ₦ 1,800	11.1	0.0	46.7	0.0
₦ 1,500 - ₦ 2,000	88.9	100	53.3	93.4
₦ 1,500 - ₦ 2,500	0.0	0.0	0.0	6.6

Source: Data Analysis.

At the market, majority of the respondents (93.40%), 6.6% claimed that the cost/basket of *C. albidum* fruits ranged from ₦1,500 - ₦2,000, and ₦1,500 - ₦2,500 respectively.

The result in Figure 7 show the annual income generated by the respondents. Annual income generated from sale of *C. albidum* fruits ranged from ₦ 5,000 to ₦ 150,000 in the rainforest vegetation zone and ₦ 8,000 to ₦ 100,000 in the savanna vegetation zone. Generally, higher income was generated from the sale of the species by the marketers in rainforest marketers than derived savanna marketers as indicated in Figure 8. For example, majority of respondents (15.6%) in the rainforest zone realized ₦30,000 while only 2.2% of the respondents realized ₦150,000. In the derived savanna, majority of respondents (29.3%) earned ₦10,000 while 1.3% of the respondents realized ₦85,000. The mean annual income realized from the sales of *C. albidum* fruits were ₦22,955.56 and ₦21,813.33 for the rainforest and derived savanna zones respectively. Based on the fact that a high percentage of traders generated high annual income from the sale of the fruits, it can be opined that marketing of the fruits is rewarding business. Some other studies conducted in various parts of the world demonstrated that households utilize forest fruits due to their great subsistence role and cash income generation potentials [21]. The high annual income recorded in this study is supported by the study conducted in Kwara and Ekiti States by Adedayo [2] and Bada [13], who reported that large number of rural dwellers in Kwara and Ekiti States earn over N200,000.00 per annum from non-timber forest products marketing. Some researchers [25] have shown that NTFPs could contribute between 25 and 70% to rural household income.

The result in Figure 8 shows the percentage contribution of *C. albidum* to respondent's total annual income. Result shows that, majority of the respondents (97.8%) claimed that *C. albidum* contributes less than 20% to their total annual income and the remaining 2.2%, of the respondents claimed that *C. albidum* contributes 20-40%.

All the respondents (100%) in the derived savanna claimed that, *C. albidum* contributes less than 20% to their total annual income.

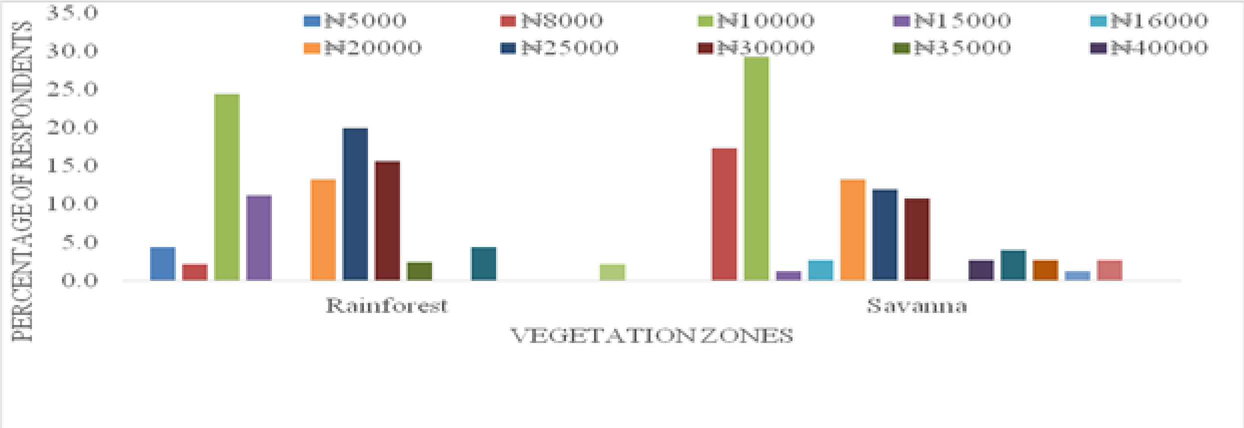

Fig. 7. Annual Income from the Sales of *C. albidum* fruits
Source: Data Analysis.

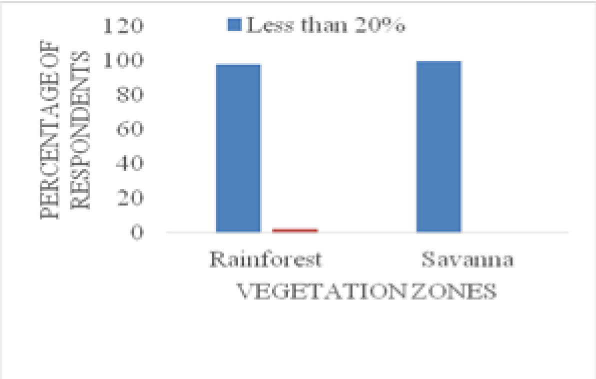

Fig. 8 Percentage contribution of *C. albidum* to the total annual income of the respondents
Source: Data Analysis.

CONCLUSIONS

Chrysophyllum albidum is a multipurpose tree species, which economically important to the two vegetation zones and thus contributes greatly to the socio-economic and sustain the life of the people in Osun State through the production, collection and marketing of its fruits. The people depend on them for medicinal, food and economic purposes which contribute to improve health, nutrition, food security and income to the local communities. Thus, it can serve as an alternative source of food during low production of agricultural products (such as fruits) and source of employment to generate income for unemployed people especially in the rural areas. However, farmers are willing to have more of this multipurpose tree species because it is economically viable, socially accepted, and environmentally sound when planted. There are indications that, there is a great demand for sweeter and bigger sized fruit and this can be done through tree improvement programme. Full domestication of this valuable fruit tree would be more beneficial and as a companion fruit for perennial crops in Agroforestry system which could have significant effects on food security and income generation by small scale farmers in Nigeria. Consequently, there is need for domestication of *C. albidum* in the study area.
Also, there should provision storage facilities to preserve the fruit from wastage and to generated higher income, especially during offseason period.
In addition, *C. albidum* is threatened by logging and deforestation in the study area when visited. Therefore, it is important to develop sustainable strategies for its conservation.

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WASTE MANAGEMENT IN AGRICULTURE

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Abstract

Waste of any kind, resulting from many human activities, is a very topical issue, both due to the increase in quantities and types (which through degradation and infestation pose a danger to the natural environment and the health of the population) and significant amounts of materials, raw materials, reusable materials and energy that can be recovered and put into the economic circuit. Waste is not only an environmental problem, but also an economic loss. The types of waste resulting from agriculture and forestry are: vegetable waste and waste from preparation; waste from manure; waste from forest holdings; used motor oils; used tires; plastic waste, including plastic packaging waste; waste from batteries and accumulators. In Romania, of the total amount of waste generated, most is vegetable waste and waste from preparation (over 90%), according to the National Institute of Statistics. Waste management must be carried out in waste recovery or disposal facilities. Thus, waste from agriculture can be managed by: recovery of organic substances - biogas plants, composting, recycling of plastic waste; recycling of scrap metal; incineration - in the case of hazardous waste (agrochemical waste, used oils); storage - in the case of waste that cannot be recovered. The EU legislation, more exactly the Waste Framework Directive creates the framework in which waste management has to implemented regarding prevention, preparation for reuse, recycling, recovery and disposals. The Directive has the duty to prevent the greatest possible generation of waste, to utilize the waste generated as a resource and to diminish to a minimum the amount of waste that reaches landfills. In this way, environmental pollution can be significantly reduced. After all, waste can be a problem or a resource only depending on how it is managed.

Key words: *waste, environment, pollution, management*

INTRODUCTION

Waste is represented by material residue resulting from a technological (or household) process of making a particular product, which can no longer be used directly in making that product. They can be substances, materials, objects, residues of raw materials from economic, household and consumer activities. Most human activities are also sources of waste production.

Waste is material considered worthless or useless. They should be eliminated as they endanger human health. Human contact with waste can occur either directly, through the accumulation of landfills near residential areas, or indirectly, through runoff into soil, groundwater or surface water and emission into the atmosphere.

With the end of the twentieth century, the population began to play an important role in the management of household waste by using recyclable materials, using methods of composting organic waste and by reducing the waste produced. Environmental laws have been implemented to protect the population and the environment from pollution generated by waste disposal. Due to the decrease in waste storage space and the controversy over the most appropriate method of disposal, the optimal solution seems to be the prevention of waste generation.

Europe generates very large amounts of waste: from agricultural activities, food and gardening waste, construction and demolition waste, mining waste, industrial waste, sludge, electrical and electronic equipment, old cars, batteries, plastic waste, paper, waste sanitary ware, textiles, etc. [2, 19]. On average, the Europeans produce about 500 kilograms of municipal waste per year. A higher part of this amount is recycled or turned into compost, while a smaller part ends up in landfills. The amount of waste depends on the production and mainly to the society consumption habits. For example, this quantity depends on the a large range of products entering the market, as well as on demographic changes (increase of the number of single-person households).

Many of the generated waste can be recycled and transformed into new products. This can be an effective way of waste managing [9, 10].

A current method used in waste management is artificial intelligence. Thus, artificial intelligence algorithms can be used to optimize the plastic waste management [1].

One of the great problems of society is that many people are not aware that their lives can be suffocated, affected by tons of waste that are not properly managed.

2020 has brought a new source of pollution, along with the COVID pandemic. Certain wastes begin to accumulate, in huge quantities, in nature. These are masks, gloves, visors and other personal protective equipment used by people around the world to protect their health. This equipment's, used until now mainly in the medical field, have become products of common use. It is very important to know how to dispose of them responsibly so that we can take care of ourselves and environment too [13].

In principle, the measures of recovery of waste, as well as the measures to avoid their formation, must be estimated the degree of environmental pollution. The environmental impact assessment model includes the fields of collection, transport, processing and production of by-products, distribution logistics, marketing, use and sanitation.

In order to achieve the purpose of the evaluation, i.e., to estimate the degree of reduction of environmental pollution through production, with the help of waste recovery, it is possible to make various comparisons. A decisive influence on the evaluation result is the choice and establishment of the limits of the researched system [20].

The quality of the environment is a fundamental factor for the health, economy and well-being of the population of each country. However, it faces several major challenges, not least those related to climate change, unsustainable consumption and production, and various forms of pollution [3, 4].

Agricultural waste consists of organic waste and waste such as plastic, mechanical waste, fences, pesticide waste, herbicides, raticides, contaminated packaging related to them, used oils and veterinary medicines. Spreading waste on the ground under strict conditions, anaerobic digestion and composting can be considered ways of managing them.

One of the objectives of waste management in agriculture is to break the link between economic growth and the environmental impact associated with waste generation.

Agricultural waste management covers all stages of an agricultural product's life cycle, from obtaining raw materials on farms, processing, distribution and consumption, before waste is taken over by waste operators. Thus, the prevention of the generation of large quantities of agricultural waste is an important tool not only for environmental protection in the context of waste management but also for reducing the pressure on natural resources.

Environmental pollution, which has spread its threat to the entire planet generates, develops and propagates one of the worst dangers facing modern civilization. Lately, a term associated with environment is the pollution that manifests as a continual aggression against itself integrity.

MATERIALS AND METHODS

The paper is a documentary study which intends to be a brief review of the issue of waste management in general and agricultural waste management in special, amid of the increasing public pressure on the environmental pollution crisis and the growing number of scientific evidence demonstrating the harmful impact on human health.

The responsibility for waste management in agriculture and animal husbandry lies with those who generate this waste,, mainly agricultural and forestry holdings. However, in Romania there is no distinct information regarding the operators that capitalize on waste resulting from agriculture and from animal husbandry activities.

RESULTS AND DISCUSSIONS

The concept of environment has the character of a complex but unitary system, consisting of a very large number of elements and links having a certain capacity for self-regulation and in which the factor the most active is represent by human communities. In recent decades, the global process of degradation of the environment factors of has had an increasingly worrying evolution, with the number of pollutants reaching figures that exceed any imagination.

Through their current activities, humans produce waste through their own existence. In addition, there are those from different industrial activities: clothing, furniture, detergents, cosmetics, household chemicals, etc. Most of wastes are not biodegradable and others are directly toxic. An additional source of pollution is outbreaks of coal, oil, gas, wood, which produce large quantities of smoke, ash, slag, gas. Another element pollutant consists of pathogenic bacteria that are circulated mainly in domestic waters.

From the point of view of nature and places of production, waste is classified as follows:

- *Waste from the mining industry* - are represented by fragments of rocks and poor ores. They are usually deposited at the mouth of the mine in undeveloped areas periodically exposed to erosion and washing by surface waters;
- *Waste from the energy and metallurgical industry* - can be slag, sludge, dust and ash. Waste from thermal power plants and non-ferrous metallurgy has a high content of heavy metals and a certain number of sulphates that can seriously pollute the environment;
- *Industrial waste* - generally comes from the manufacturing industry (textile, wood, food) and especially from metal processing;
- *Construction waste* - represents the materials from the demolition of constructions and from the remains of materials left from the civil and industrial construction sites;
- *Household waste* - are represented by paper, plastic, ceramic waste and bottles, rubble, food waste, vegetable waste, metals and dust, accumulated in the street areas from daily activities;
- *Radioactive waste* - are the result of industrial, medical and research activities. The largest quantities come from the activity of electricity production.
- *Agricultural waste* - consists of vegetable waste and waste from preparation; waste from manure; waste from forest holdings; used motor oils; used tires; plastic waste, including plastic packaging waste; waste from batteries and accumulators. Animal husbandry results in large amounts of manure.

Among the categories of pollutants, the chemically stable and highly toxic ones raise the biggest managerial problems. Heavy metals fall into this category. In order to substantiate the decisions regarding the management of areas contaminated with heavy metals, it is necessary to evaluate their effects, both on the components of natural capital and on the socio-ecological systems. The first step in this direction is to characterize their distribution in the compartments of these systems. In particular, if the effects of heavy metals on human populations in contaminated areas are to be assessed, their transfer routes from storage compartments to the human population must be characterized. One of the most important such transfer routes is through the consumption of plant and animal foods produced in the contaminated area.

The vast majority of waste can become hazardous in precarious storage or transport conditions. Thus, they can become explosive, oxidizing, flammable, irritating, toxic, carcinogenic, corrosive, infectious, mutagenic and radioactive and can emit toxic gases in contact with water, air or an acid.

Generally, due to the lack of facilities and poor operation, landfills are among the objectives recognized as generating impact and risk for the environment and public health.

The main forms of impact and risk determined by municipal landfills and industrial, in the order in which they are perceived by the population, are: landscape changes and visual discomfort; the air pollution; surface water pollution; changes in soil fertility and the composition of biocenoses on neighbouring lands.

Removing land for landfills from the natural or economic circuit is a process that can be considered temporary, but which in terms of the concept of sustainable development, extends over at least two generations if the summation periods are summed (1-3 years), exploitation (15-30 years), ecological restoration and post-monitoring (15-20 years).

In terms of biodiversity, a landfill means the removal of 30-300 species/ha from the affected area, without considering the microbiological population of the soil. In addition, the biocenoses in the vicinity of the deposit are changing, in plant associations species from polluted areas become dominant and some mammals, birds, insects leave the area, to the advantage of those who find their food in garbage, like rats.

Although the effects on flora and fauna are theoretically limited in time during the exploitation of the deposit, the ecological reconstruction achieved after the release of the area of technological tasks will not be able to restore the initial biological balance, the evolution of the bio system being irreversibly modified.

Waste, especially industrial waste, is a source of health risk due to its content in toxic substances such as heavy metals (lead, cadmium), pesticides, solvents, used oils, etc. The most difficult problem is hazardous materials (including toxic sludge, petroleum products, paint residues, metallurgical slag) that are stored in common with municipal solid waste. This situation can lead to flammable, explosive or corrosive mixtures and combinations; on the other hand, the presence of easily degradable household waste can facilitate the decomposition of complex hazardous components and reduce environmental pollution.

One downside is that many recyclable and useful materials are stored along with non-recyclable ones; being mixed and contaminated from a chemical and biological point of view, their recovery is difficult.

Agriculture is an important source of environmental pollution by: triggering and favouring soil degradation processes following the processes of erosion, salting, compaction; use of pesticides; excessive use of chemical fertilizers, etc. [15, 16, 17, 21].

The European Union is one of the largest food producers in the world. It uses modern agricultural production systems and has land suitable for agriculture. Productivity per hectare has increased considerably, due to the development of monocultures and irrigation systems, more efficient equipment and the use of a larger amount of chemicals, such as pesticides and fertilizers. At the same time, however, these modes of production have generated a greater amount of agricultural waste and higher environmental costs. The intensification of agricultural waste generation puts more pressure on the environment, resulting in higher nitrogen pollution and more CO_2 emissions, greater loss of biodiversity on agricultural land and greater contamination of soil, rivers and lakes. In addition, increasing the use of external factors to achieve higher yields in food production usually decreases the overall energy efficiency of the process.

Establishing the plant nutrition regime is a prerogative from the perspective of evaluating fertilizer doses to ensure the optimal plant nutrition and development [5, 14, 16].

In the organization of modern agriculture, a role very important is the arrangement works of land and, in particular, water management. But dams and irrigation canals do not change only the hydrological regime in that area, but and local ecological systems, through change edaphic factors. Both positive effects can occur (territorial extension of cultivated areas and uplift productivity) and negative (salting).

The amount of agricultural waste depends on the importance given to agriculture in each country and the type of agriculture. Most are organic residues, so they are biodegradable and can be converted by biological, physical or chemical processes into feed or fertilizer. Globally, their production is estimated at about 2 billion tons/year, the growth rate being about 6-7 times higher than that of urban and industrial waste combined.

In Romania, for the period 2014-2020, the objectives and targets regarding waste management in agriculture and animal husbandry activities provided in the legislation and in the National Strategy and the National Waste Management Plan were the following:

- Streamlining control over the storage of untreated waste from agriculture and animal husbandry (vegetable waste and animal manure);
- Encourage the recovery by aerobic and anaerobic processes of waste from agriculture, animal husbandry and forestry (vegetable waste and animal manure) [12].

When looking forward, global waste is expected to grow to 3.40 billion tonnes by 2050 (Figure 1), more than double population growth over the same period. Overall, there is a positive correlation between waste generation and income level [22].

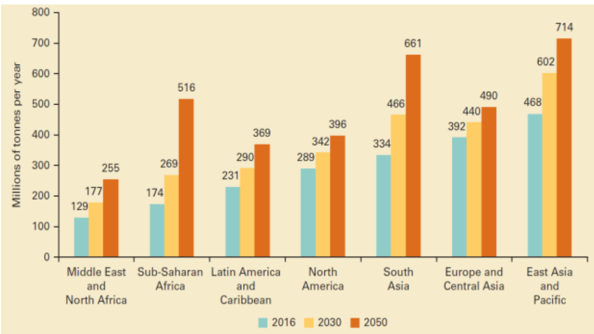

Fig. 1. Worldwide waste generation, by region (millions of tonnes/year)
Source: [22].

Figure 2 presents the weight of different economic activities and households waste generation in 2018. In the EU, from the total amount in 2018, constructions have a share of 35.9%, followed by mining and quarrying (26.6%), manufacturing (10.6%), waste and water services (9.8%) and households (8.2%); the rest of 9.1% waste is generated by other economic activities, especially by services (4.2%) and energy (3.4%).

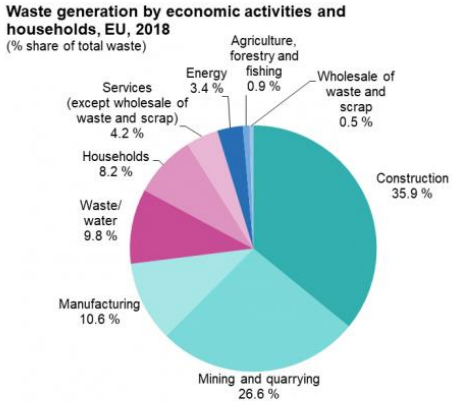

Fig. 2. Waste generation in Europe
Source: [7].

In order to get out of the vicious circle of a still linear economy, limit resource depletion and reduce waste generated, the concept of circular economy was launched at EU level, i.e., extending the life cycle of a product by reusing, repairing and recycling components, to achieve the ideal of "zero waste." This initiative is represented by the Waste Management Framework Directive, which requires of the Member States to meet certain waste recycling targets, namely 55% by 2025, 60% by 2030 and 65% by 2035 [8].

The problem must be solved, first of all, at the source. Manufacturers and traders must gradually reduce and then give up the production of disposable plastic packaging and invest primarily in reusable systems, in the joint effort to have a consumer experience that does not harm our health and the environment; at the same time, it must review the policies established by the associations with which it collaborates and ensure that they operate in accordance with their social and environmental values.

Waste recycling ensures the preservation of natural resources and the reduction of pollution. Waste contains materials or energy that can be reused. Only a tiny part of the waste can be reused as such, most of it being sorted and reintroduced into the processing industry. Thus, the following can be recycled: scrap metal, which currently accounts for 10% of world steel production; lead, by recovering from the 80 million batteries discharged annually from use, and from water / sewerage networks; precious metals from electronic equipment, by using advanced technologies;

plastics that can be melted and reused industrially; household waste, by collection by categories, in containers with precise destination. The most important markets for secondary materials resulting from waste are: paper; plastic; glass; metal; textiles; wood.

In Central and Western Europe are recycled between 30-40% of municipal waste: paper between 22-58% (in the first places being the Netherlands Germany and Norway), and glass between 22-70% (Switzerland, Holland, Germany, Austria, Belgium and Italy).

Bioconversion of organic waste is a process by which organic waste is transformed by aerobic or anaerobic bacteriological processes into products that can be used as agricultural fertilizers.

In Romania, the National Waste Management Strategy is developed by the Ministry of Environment and Water Management. Of all the European countries, Romania recycles only 1% of the entire volume of produced waste, the rest being thrown in the landfill. At the opposite pole is Belgium, which recycles 94%.

The options for sustainable waste management are: prevention of occurrence - by applying the "clean technologies" in activities that generate waste; reducing quantities - by applying the best practices in each field of waste generating activity; recovery - through reuse, material recycling and energy recovery; disposal - by incineration and storage.

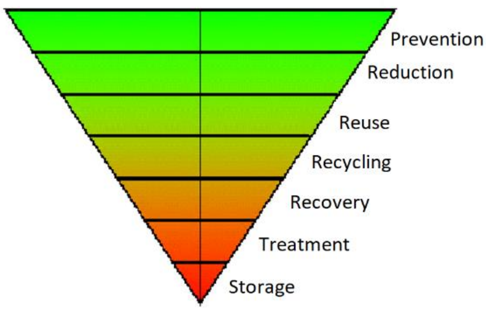

Fig. 3. Preferred waste management options
Source: [23].

Preferred waste management options are prevention, reduction, reuse, recycling, treatment and storage (Figure 3).

Integrated waste management requires: reducing the amount of waste produced; recycling (recovery) of waste in conditions of economic efficiency; composting of organic waste; waste incineration in conditions of minimal impact on the environment; controlled storage of waste.

Starting from the specific hierarchy of waste management, the waste whose formation cannot be avoided must be capitalized according to the possibilities. Waste recovery measures should be implemented where those to prevent the formation are not possible or were, for ecological or economic reasons, they would no longer be rational. With regard to waste disposal, the superiority of the recovery must be recognized, as long as this is technically possible and with some modest representation costs for the recovered materials, a sales market is available, respectively this market can be created.

Agricultural users and public decision-makers need to be aware of the risk associated with contamination with various chemicals in order to be able to estimate and subsequently prevent adverse effects and to set standards for their use.

Within the National Program of Waste Management, the statistics of agricultural waste can be found at Environmental Statistics section. The statistical research is carried out by survey, by the National Institute of Statistics, once every two years. The object of statistical research includes agricultural holdings with legal personality (about 1,000), and aims the collection of data and the realization of the estimation procedure regarding the generation, treatment and outsourcing of agricultural waste [12].

Efficient management of agricultural waste consists of minimizing waste production, recovery, recycling and reuse, including biodegradable waste, and promoting modern agricultural technologies. Undoubtedly, agricultural waste is a source of pollution, but well-managed waste can generate additional benefits, such as reduced consumption of natural resources, saving energy and financial resources. Transforming of the agricultural waste into reusable resources (raw material) is one of the main objectives of the green economy.

The recycling of agricultural waste is the process by which it is transformed into a secondary raw material for the manufacture of new products. The benefits of recycling are multiple, beneficial to communities, the environment, but also with a positive effect on the economy. In this regards, various agricultural wastes can be used in classical structures of lignocellulosic composites [6]: maize and cotton stalks, as agricultural waste, are used to manufacture agglomerated panels of medium density fibers; sunflower stalks have been used successfully to replace wood flour as a reinforcing element for polypropylene in the case of thermoplastic composites, as a potential raw material for replacing wood chips in the structure of PAL panels. The cereal straws (especially wheat and rice) can also be used for alternative panels of PAL and PFL, etc.

By reusing agricultural waste, financial savings can be achieved. For example, a company that dries fruit and produces plum jam, also produces agricultural waste as cherries and plums kernels pip. The average annual quantity of this type of agricultural waste is about 36 tons. However, these seeds contain a considerable amount of energy, so that the company can reuse them to produce the heat needed to dry the fruit. Thus, the company can save half of the natural gas used, which means about 17,000 m^3 / year, and the financial savings are around 120,000 lei / year [18].

The management of agricultural waste must be carried out without endangering human health and without harming the environment, in particular without creating a risk to air, water, soil, fauna or flora; without creating discomfort due to noise or odours and without adversely affecting the landscape or areas of special interest. From this point of view, the producers of agricultural waste and the owners of agricultural waste have the obligation to subject the waste that has not been recovered to a safe disposal operation, by observing the following measures: ensuring complete disposal of waste; use of the most sustainable techniques available and which do not involve excessive costs for waste disposal; locate and arrange the waste disposal facility in a space and under conditions established by the territorial authorities for environmental protection; disposal of agricultural waste only in authorized spaces for this purpose; etc.

Substances that persist in the environment and tend to accumulate at different levels structures related to a high potential for toxicity are of particular interest in the management of contaminated areas.

In accordance with Law no. 211/2011 (updated), "the agricultural waste producer or any waste holder has the obligation to carry out the treatment operations or to transfer these operations to an authorized economic operator carrying out waste treatment activities or to a public operator or private waste collection in accordance with legal provisions. Also, the economic operators that carry out waste collection and transport operations have the obligation to deliver and transport the waste only to installations authorized for carrying out the sorting, treatment, recycling and storage operations" [11].

An example of a company that deals with the provision of ecological services in Oltenia Region is ECO TOTAL SRL, established in 2008. The company aims to reduce the effects of pollution, supporting economic agents with integrated and flexible solutions for agricultural waste management and decontamination. It has a modern car fleet, properly equipped, according to the legislative norms in force, for the activities of collection, transport and storage of agricultural waste: authorized vans, equipment for their loading and unloading; capacities of over 100,000 litres of liquid waste storage. The company proposes integrated solutions with multiple advantages that lead to the reduction of time and internal resources allocated to environmental actions. It also has its own authorized storage spaces, with a storage area of over 1,000 square meters [18].

ECO TOTAL obtained the certification of the quality management system, environment and occupational health and safety: ISO 9001: 2008 - SR EN ISO 9001: 2008; ISO 14001:

2004 - SR EN ISO 14001: 2005; OHSAS 18001: 2007 - SR OHSAS 18001: 2008 [18].
The development of socio-economic systems and industrialization has a significant negative impact on components of ecological systems. In order to predict the effects of these pressures, the use of models is necessary as a decision support tool.

CONCLUSIONS

The best way to reduce the impact of waste on the environment is to prevent its occurrence.
The attitude towards waste production and management differs from country to country or even within the same state. In some countries, a hierarchy of preferential waste management options has been developed and adopted at four distinct levels: the prevention of waste production is preferable to recycling; recycling is preferable to incineration; incineration is preferable to storage; storage and control of the evolution of deposits is preferable to uncontrolled emissions.
Some measures to prevent the generation of agricultural waste is the following: efficient use of agricultural resources; promoting research and development in order to achieve agricultural raw materials and products through sustainable technologies and the distribution of research and development results; promoting the eco-design by systematically integrating environmental aspects into the projection of agricultural products, etc.
Integrated management of waste in the economic and social process, according to the concept of sustainable development is the effective support of material and energetic capitalization of the waste. Efficient waste management starts from the awareness of each person to respect the environment, by proceeding to a separate collection of waste, to its recycling and finally, to improve their own living conditions.

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SOME ASPECTS REGARDING THE FOOD STABILITY AND THE FACTORS THAT INFLUENCE IT

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Abstract

One of the specific features of food is perishability, and therefore it is very important to know and control the factors that influence their stability and the processes capable of producing qualitative changes and the possibilities of stabilizing them for as long as possible. The main factors which influencing the food stability are: enzymes, microorganisms and water content. The microorganisms and enzymes act on carbohydrates and lipids of the food and turn them through fermentation and putrefaction processes. As a result, the chemical composition of food undergoes changes and may appear the complete destruction of nutrients, the products becoming unfit for consumption. Increasing of the food product stability is necessary to eliminate the seasonal nature of consumption, to increase availability for consumers and to reduce losses of the perishable food. In this respect, is used some processes for the relative stabilization of food products properties, which involve various additional technological operations, as a result of which the products undergo physical, chemical and biochemical changes. Improving the food stability in safe conditions can be achieved by various processes which, in general, refer to the separation of microorganisms by physical processes; reducing or stop development of microorganisms; destruction by various means of microorganisms; combined methods. Technological processes are constantly evolving; more and more modern methods appear to extend the shelf life of a food. Notable examples in this regard are high pressure, radiations, ultra-short light pulses or magnetic field protocols. There are also microwave devices that have the same purpose - to preserve the nutritional properties of some food products for as long as possible.

Key words**:** *food products, stability, factors, processes*

INTRODUCTION

Food products are vital importance because it is the daily feed of people, providing the necessary energy and nutrients. Through their properties, food products can improve, maintain or on the contrary, can affect the consumer's health [7, 9, 12, 14].
The quality of food products is a particularly complex notion, which takes into account consumer safety, which has become a disqualifying competitive element for the market of these products. The quality of food products is determined and influenced by a series of factors that act both in the production process and in the process of product circulation, in all stages of the product trajectory, from identifying consumer requirements to satisfying them and assessing their satisfaction [2]. The dynamic character of food quality is determined by scientific progress on the one hand [8, 10, 11, 13] and on the other, by the growing demands of well-informed and educated consumers regarding the quality of products.
In the modern economy, one of the fundamental principles of food quality management is consumer orientation. This orientation has as essential objective the satisfaction of the needs and preferences of the consumers regarding the type and the assortments of the food products; food characteristics: organoleptic, physical, chemical, biological (nutritional, microbiological, toxicological), technological, aesthetic; the sources of provenance of the

food products and the technical processes used for their manufacture, etc. [1, 3, 6].

The main factors which influencing the food products stability are enzymes, microorganisms and the water content of those products. Enzymes are organic substances of a protein nature, secreted by the living cell and which act as biocatalysts (initiate and increase the speed of intra or extracellular chemical reactions thousands/million times). Characteristic of enzymes is the fact that they have specificity of action, in the sense that an enzyme catalyses only a certain reaction (degradation or association) and only for a certain substance that it recognizes chemically (substrate). Enzymes, found in raw materials or induced in the processing process, can act not only at the time of processing but also later.

Like any catalyst, enzymes are not consumed in the chemical reaction they catalyse. Their action is optimal at certain environmental parameters (temperature, pH), but like any protein they are thermolabile being denatured at high temperatures (over 100^0C) and long lasting [14].

With regard to microorganisms, a permanent control must be established over them, to block their multiplication mechanism by bacteriostatic means and use physical and chemical agents to destroy unwanted forms. Due to their chemical composition, food products have a favourable nutritional environment for the development of microorganisms, being an excellent source for energy procurement and the development of their metabolic activity. Temperature is an external factor that contributes greatly to the diversity and variability of microorganisms. Microorganisms that can inhabit in foodstuff are classified according to temperature, in: microorganisms with optimum at room temperature $20\text{-}30^0C$; microorganisms with optimum at human body temperature (37^0C), including pathogenic microorganisms; microorganisms with the optimum at the current coagulation temperature of protein substances (i.e., above 50^0C), called thermophilic microorganisms.

As regards microorganisms, both in the manufacturing process and in the storage and marketing of many food products, the most different species are involved, either with positive or negative action for the properties, respectively for the quality of the products [1, 4, 6]. In this sense, the microorganisms can be grouped in:

- Saprophytic microorganisms of culture, used for useful transformations of the foods and that are part of the current technologies in bakery, vinification, in the manufacture of cheeses, etc.
- Saprophytic degradation microorganisms (moulds, yeasts, bacteria), which cause undirected microbiological processes, which result in unwanted changes or even alterations of food;
- Conditioned pathogenic and pathogenic microorganisms, which through the toxins produced at the level of food (toxic type) or at the level of the human body (infectious type) cause serious diseases, sometimes fatal.

In order to prolong the consumption of some seasonal agricultural products, the companies in the field of food production proceeds to the application of some preservation techniques in order to maintain the qualitative level of the foods (nutritional value and sensory properties) for a longer period of time. In this way certain foods can be consumed at any time of the year. The basis of food preservation is the four biological principles: biosis, anabiosis, cenoanabiosis and abiosis [2, 14, 16].

Biosis is based on the ability of living organisms to counteract the harmful action of bioagents through the mechanism of natural immunity. For this, it is necessary to monitor the storage parameters (light, relative humidity, temperature, air circulation, microorganisms) at the optimal values necessary to maintain the quality level for as long as possible.

Anabiosis is based on slowing down the metabolic process of agricultural food product by applying special techniques (dehydration, increasing osmotic pressure, low temperatures, etc.).

Cenoanabiosis consists in creating optimal conditions for the development of certain

microorganisms (yeasts, lactic acid bacteria) which through their activity prevent the development of degradation processes of agricultural products.
Abiosis is based on the destruction or removal of microorganisms from the agricultural product through special methods (pasteurization, sterilization, use of food preservatives, etc.).

MATERIALS AND METHODS

This is a documentary study about the main elements of the notion of food stability and the factors that influence this property to ensure extend of the shelf life of food products, food safety and consumer protection. We considered this research useful given that the consumer protection has become a global issue. The European Commission emphasizes that the highest priority of the EU is to protect the health and safety of consumers and to ensure the fairness of the practices used in the food trade, through a series of deontological rules (codes), standards and recommendations.

RESULTS AND DISCUSSIONS

The stability of food products refers to their ability to retain over time the initial qualitative and quantitative characteristics and their resistance to handling and transport. This property is associated with the notion of perishability, because all foods change their initial characteristics over time. From this point of view, vegetables and fruits are grouped into four categories (Figure 1):
1. Excessively perishable: vegetables grown for the vegetative part (salad, parsley, dill, larch, etc.) and fruits with thin epidermis and very high respiration intensity (strawberries, raspberries, currants, etc.);
2. Very perishable: vegetables and fruits with thin epidermis (mushrooms, cucumbers, green onions, zucchini, cherries, sour cherries, apricots, peaches, etc.);
3. Perishable: vegetables and fruits resistant to storage and transport (cauliflower, melons, eggplants, apples, pears, grapes, etc.);
4. Less perishable: vegetables and fruits with a good ability to maintain quality and which are usually consumed more in winter (onions, carrots, winter radishes, beets, garlic, some varieties of apples, pears, quinces, etc.).
The main factors which influencing the food products stability are enzymes, microorganisms and the water content of those products.
In order to extend the shelf life of agricultural products, three factors must be taken into account: food processing conditions, packaging conditions and environmental conditions (Figure 2).

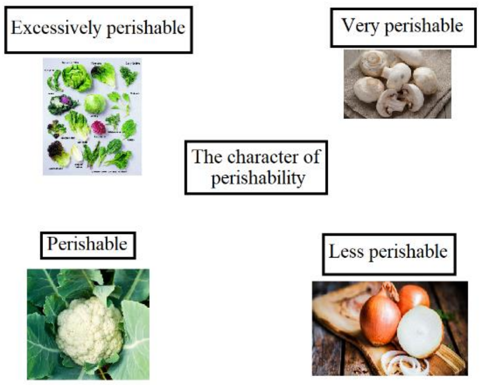

Fig. 1. The perishability character of fruits and vegetables
Source: [1].

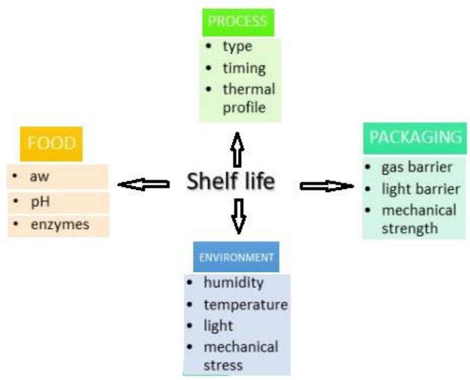

Fig. 2. The factors that influencing the prolongation of the shelf life of agricultural products
Source: [6].

Depending on the temperature at which they are active, the microorganisms can be classified into: psychrophiles, mesophiles and thermophiles. The minimum, optimal and maximum temperatures levels at which they activate are shown in Table 1.

Table 1. The minimum, optimal and maximum temperature levels (^{0}C) at which the microorganisms are activate

Group/ Temperature	Minimum	Optimum	Maximum
Psychrophiles	0	20-30	35-40
Mesophiles	15-20	30-40	≥45
Thermophiles	≥45	55-65	≥90

Source: [4].

The moulds are multiplied under natural conditions at low temperatures (10-20^{0}C); some prefer slightly higher temperatures, such as parasitic species that prefer human body temperature. Yeasts tolerate wider thermal variations. Cryophilic microorganisms generally grow around 0-10^{0}C.

Another external factor that can influence the activity of microorganisms is light. The orange and yellow radiation in the electromagnetic spectrum is indifferent, the green radiation is stimulating and the ultraviolet (UV) radiation is destructive to microorganisms. For this reason, decontamination is practiced with the UV lamps.

The pH level of food influences the activity of different types of microorganisms, taking into account the fact that most bacteria grow at a pH=6.5-7.5. When the pH value is outside these limits, development slows down and at a pH value of 8 it stagnates. On the other hand, yeasts and moulds prefer more acidic medium; some of them can develop even at a very low pH level (2-3). Among other external factors which influencing the activity of microorganisms can be listed: electricity, osmotic pressure, surface tension, ionizing radiation, etc. [4, 6, 14].

The microorganisms (bacteria, yeasts and moulds) and enzymes act on carbohydrates and lipids of the food and turn them through fermentation and putrefaction processes. As a result, the chemical composition of food undergoes changes and may appear the complete destruction of nutrients, the products becoming unfit for consumption.

Fermentation processes are produced by the enzymes of anaerobic microorganisms. These microorganisms produce chemical transformations mainly on carbohydrates, with the formation of a main product (in larger quantities) and by-products (in smaller quantities). The name of the fermentation comes from that of the resulting main product, so it can be: alcoholic (ethyl alcohol), acetic (acetic acid), lactic (lactic acid), butyric (butyric acid) etc. Each type of fermentation is related to the activity of specific enzymes.

Fermentation processes are accompanied by the release of energy or, as the case may be, by certain gases. A small part of the released energy is used by microorganisms, and the rest passes into the environment causing the heating of the substrate to cereals, fresh vegetables and fruits, fresh meat, etc. which, placed in piles, are heated or carbonized. The food industry directs the fermentative enzymatic processes through specific technological processes, in order to obtain products such as: alcohol, beer, citric acid, etc.

Alcoholic fermentation consists in the transformation of simple fermentative sugars (glucose, mannose, galactose, fructose, etc.) into ethyl alcohol and carbon dioxide. The bioagents that cause alcoholic fermentation and that produce in various proportions ethyl alcohol are: yeasts of the genus Saccharomyces, moulds (*Mucoraceae*, *Penicillium glaucum*), bacteria (*Bacillus aethylicus*), etc.

Alcoholic fermentation occurs during the storage of food products (fresh vegetables and fruits, jams, marmalades, syrups, juices, etc.) in conditions of improper storage, or as a result of improper preparation of products for storage (e.g., insufficient boiling, content insufficient sugar, etc.). In the food industry, alcoholic fermentation is directed through various technological processes that underlie the manufacture of wines, beer, alcohol, various bakery products, etc.

Acetic fermentation is produced by the enzymes of acetic bacteria and consists in the oxidation of alcohol contained in acetic acid products, the products acquiring a sour, pungent taste. As in the case of alcoholic fermentation, acetic fermentation too is the basis for obtaining food products. In most cases, however, it is an undesirable phenomenon, contributing to the depreciation of food stored in improper conditions (wine vinegar, beer spoilage, acidic dairy products, etc.). Favouring factors are oxygen and the temperature of 25-30^{0}C.

The lactic fermentation takes place under the action of lactic acid bacteria and consists in the transformation of carbohydrates (glucose, lactose, fructose, mannose, galactose, glycogen, etc.) from products into lactic acid.

Lactic bacteria are of two types:

1. True lactic bacteria (the genus *Termobacterium*, which includes *Bacillus lactis, B. helveticum, B. casei, B. yogurti*, etc., with the optimum activity at 30^{0}C);
2. False lactic bacteria (*Bacterium aerogenes*) producing gases (carbon dioxide and hydrogen), which degrade food products.

The lactic bacteria have an important role in the food industry, the favourable action of this fermentation being applied in a directed way to obtain many dairy products (yogurt, sour milk, cream, cheese) as well as to preserve vegetables by pickling, etc. The presence of lactic acid in a certain concentration in acidic dairy products or in pickled products prevents the development of spoilage microorganisms and especially those of putrefaction. However, these products cannot be stored for a long time, because the acidic environment favours the development of yeasts and moulds that consume lactic acid, the environment becoming alkaline and facilitating the development of putrefactive microflora.

Butyric fermentation takes place in the absence of air, under the action of butyric bacteria and consists in the transformation of sugars into butyric acid. Butyric bacteria are very widespread in nature (soil, dirty water, etc.) and grow intensely at temperatures between 35 and 40^{0}C. Butyric fermentation occurs during the improper storage of pickled products, cheeses, milk, etc., which acquire a bitter taste and unpleasant odour. Cheeses with buttery bloating are recognized by their strongly swollen shell, soft consistency, sweet taste and strong odour of butyric acid. The milk attacked by the butyric bacteria acquires a bitter taste [1, 4].

Putrefaction is a microbiological process caused by putrefactive bacteria (aerobic and anaerobic) and less often by the action of mould. The main aerobic (and optionally anaerobic) putrefaction bacteria are: *Bacillus mesentericus, B. proteus, B. fluorescens, B. subtilis, E. coli* and among the anaerobic putrefactive bacteria are mentioned: *Bacterium putrificus, B. sporogenes* and *Clostridium perfringens*. The development of these bacteria is favoured by high temperature and high humidity [5].

Putrefactive bacteria mainly attack protein substances causing profound amino acid transformations. As a result of these transformations, various aliphatic acids (oxyacids, polybasic acids), aromatic acids, amines, ptomaines, phenols, mercaptans, various gases (CO_2, NH_3, H_2S, CH_4) appear in different products. Many of these substances are toxic or very toxic: putrescein, cadaverine, indole, scatole, mercaptans, amines (histamine, tyramine, etc.) [4].

All rotting food has a repulsive odour and is unfit for consumption. Fish is very sensitive to the onset of putrefaction processes, because the mucus that covers the body of the fish easily fixes microorganisms, constituting an environment conducive to their development. Bacteria can also penetrate more easily into the muscle tissue of fish that is less dense than warm-blooded animals and contains less connective tissue. Rotten eggs have a cloudy, opaque or coloured content in red, green or black. The foul smell of sauerkraut indicates an advanced process of putrefaction.

Mouldy foods came from a form of microbiological spoilage of these. Biological agents are mould whose colonies specifically stain (by species) the infected surface of the products, in white, yellow, green, brown and black. The action of moulds consists in the hydrolysis of polysaccharides (to ensure their nutrition), proteins, lipids, as well as in various chemical and biochemical transformations (oxidations, fermentations, etc.). Mouldy foods contain mycotoxins and as such are eliminated from human consumption [1, 6].

Moulding process occurs on products with high-water content (cheese, vegetables, fruits, etc.) or even on products with a lower humidity but kept in a humid environment. For example, bread moulding occurs when it is stored in conditions of relative air humidity above 80%; the mould develops on the surface of the bread, then penetrates inside through the cracks of the crust, making it unfit for consumption. Sausages kept in high humidity conditions are covered with mould, which also penetrates inside the product if it has air gaps. The eggs mould in an environment with a humidity of over 85%, acquiring the appearance of a stained egg and the smell of mould. Cheeses usually mould under the shell, especially if it is cracked. In some cheeses, moulding is not a defect, as it is controlled by the use of noble moulds during ripening (*Penicillium roqueforti* in Roquefort cheese and *Penicillium camemberti* in Camembert cheese).

The stability of food products is a feature intrinsically linked to the variation of their water content. Either by reducing the water content (dehydration), or by binding it to the food by salt or carbohydrates, it is possible to influence the way in which certain microorganisms grow, improving the tolerance to food storage. Another role of water is to form the texture of food following interactions with proteins, polyglucides, lipids and mineral salts.

Water influences directly the quality of products (in food products, water it is found in free or bound form). Having the role of dissolving other chemicals in its mass, water is a nutrient necessary for the activity of bacterial enzymes. Therefore, the water content of food is monitored and specified in standards, as an essential element on which are established the conditions and duration of food storage. Also, the water content influences the consumer's perception of some characteristics of the products, such as freshness.

The water content respective dry matter content is an indicator of quality, especially for products in which the correction of humidity to optimal values is possible and necessary, such as: cereals, cheeses, meat products, sugar products, etc. The water activity (*aw*) specific to a food varies according to its moisture content, so that for different foods, the same aw value corresponds to some different humidity values (Figure 3).

Above a certain minimum value of *aw*, the metabolism of various microbial species ceases. This minimum value is a characteristic of the species and depends on the ability of the microbial cytoplasm to retain a greater or lesser amount of water: when the amount of water retained by the cytoplasm of the microbial cell is higher, the limit value characteristic of the species is small.

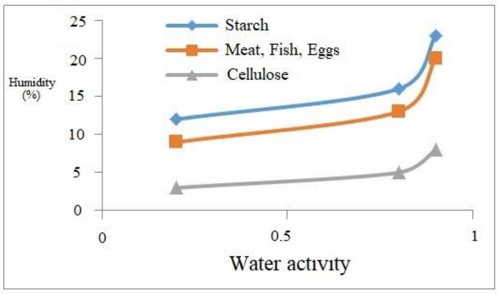

Fig. 3. The relationship between humidity and water activity
Source: [14].

In general, it is considered that microorganisms stop multiplying at aw = 0.7. The *aw* value of 0.7 at a temperature of 20^0C varies for different foods, depending on the humidity, as follows: for powdered milk it is reached at 7% humidity, for lean meat and dehydrated fish at 10% humidity and for beans and soybeans at 9-13% [1].

A wide variety of foods are slightly degradable: meat products, dairy products butter, cheese, fats and oils, confectionery and bakery products, etc. The modern methods of prolonging the stability of food (especially of slightly degradable products) include thermic and athermic methods.

The main *athermic* methods for improving food stability are given below:

1. Food preservation through high pressure - destruction of vegetative forms of microorganisms under the action of high pressures (4,000-10,000 Bar). The high pressures have the following effects: inactivation of some enzymes due to denaturation of their proteins part; modifying the tertiary and quaternary structure of proteins, increasing digestibility and their susceptibility to protease attack; changing the melting point of fats; intensifying the aroma of some food products by disorganizing some

cellular organs that release proteolytic enzymes that act on proteins with the formation of taste substances, etc. [16].

2. Food preservation through magnetic field. The oscillating and static magnetic field exerts a lethal effect on microorganisms due to the following damaging actions: at the level of cell membranes; on DNA and altered DNA synthesis; changing the flow of ions (Ca2 +) through the membrane.

The advantages of this method are the following: it preserves the sensorial and nutritional quality of the food product; the food products can be treated in flexible plastic packaging. In addition, the application of the magnetic field is not dangerous for operator.

3. Preservation with ultra-short light pulses - products of laser generators or lamps (flash). It destroys microorganisms on the inner surface of packaging, leading to an extension of shelf life of food, especially when refrigerated or frozen storage is practiced.

Use of the ultra-short pulses of light has been extended on the replacement of thermal sterilization of fruit juices, beneficial effects being obtained in the case of cherry juice, where the shelf life has been considerably increased. Other achievements in this area are increasing the shelf life of chilled tomatoes to about 30 days, keeping the fresh appearance of bread for more than 15 days or purifying water and liquid foods [15].

4. Preservation by high voltage pulsating electric field. It is applied to liquid foods, the effect manifesting itself in the cell membrane. The process has no negative effects on nutritional value and sensorial properties of treated food products.

5. Food irradiation is used in several countries to prolong stability and prolong shelf life. From this point of view, the irradiation method is applied to food for the following reasons: to destroy microorganisms in vegetables and spices, to prevent sprouting and germination of potatoes, onions and garlic, to kill or sterilize harmful insects from cereals, nuts and vegetables, to delay the ripening and ripening of fruits and vegetables, etc.

Irradiated foods must follow strict labelling guidelines, which vary by country. Testing should be performed using an appropriate method for the product to obtain reliable results.

The main *thermic* methods for improving food stability are [16]:

1. Preservation by ohmic heating. It is applies to more or less viscous liquids food products, with a certain solid/liquid ratio. This procedure is falls as a UHT system and the lethal effect on microorganisms is due to heat and electricity.

2. Preservation by heating with radio waves. It is a dielectric heating process, with concomitant pasteurization and freezing by continuous flow of meat compositions, intended for obtaining meat products with a diameter of up to 50 mm. The characteristics of the field from where they are: λ = 10-100 mm, frequency 3-30 MHz (short radio waves).

3. Preservation with infrared radiation, which can be with λ = 0.75-2.5μ (short), λ = 2.5-25μ (medium), λ = 25-750μ (large). They are used in the meat industry, for drying cereals, lactose, baking bread, biscuits and pastry.

4. Preservation with antiseptic substances (Table 2).

Table 2. Examples of slightly degradable food products and antiseptics used in the food industry to increase food stability

Antiseptic	Type of food	Dose
Ascorbic acid, sorbates	meat products	200 mg/kg
	margarine, butter	1,000 mg/kg
	cheese	500 mg/kg
	fats and oils	500 mg/kg
	fruit juices, syrups	1,000 mg/kg
	dried or frozen fruits	200 mg/kg
	bakery products	1,000 mg/kg
	confectionery products	500 mg/kg
	wine	1,000 mg/kg
Benzoic acid and its salts	caviar, mayonnaise	1,000 mg/kg
	canned fish	300-500 mg/kg
	fruit salads	100 mg/kg
	olives	100 mg/kg
Sulphites and sulphates	jams	25 mg/kg
	dehydrated fruits	60 mg/kg
	tomato sauce	100 mg/kg
	fruit concentrates	200 mg/kg
	potato flakes	400 mg/kg

Source: [16].

Antiseptics are substances that stop the development and action of microorganisms (bacteriostatic substances) or destroy them (bactericidal substances), depending on the concentration and species of the microorganism. The main factors that influencing the action of antiseptics are: concentration of substances, duration of contact, temperature, species and number of microorganisms in the substrate, the stage of development of microorganisms, the chemical composition of the medium culture and its pH [16].

Numerous studies have been conducted on the use of microwaves to improve food stability [17-20]. Thus, equipment and installations were made for the pasteurization and sterilization of food liquids, but also of meat and meat products, fruits and vegetable, canned fruits, ready to eat foods, bakery and pastry products, etc. Microwaves can reduce microbial flora, bacteria, moulds and other microorganisms harmful to food, by the thermal effect achieved, the food being passed through a microwave field.

Use of modern methods and techniques for preserving and prolonging the shelf life of food allows ensuring optimal conditions for storage, transport and distribution of food, with minimal losses of nutrients. At the same time, there are low consumptions of energy and auxiliary materials, compared to other conservation technologies, an undeniable advantage in terms of economic implications.

CONCLUSIONS

From the end of the technological process, food products maintain their physico-chemical, sensory and microbiological properties for a certain period of time, specific to each product and only under certain environmental conditions (temperature, relative humidity, light and other radiation, air circulation, microorganisms), after which changes in quality slower or faster, in negative sense, culminating with the alteration of the products. Foods have a lifespan that depends on their nature, chemical composition, preservation method, technological process, packaging, storage conditions, handling and transport.

The stability of food products refers to their ability to retain over time the initial qualitative and quantitative characteristics and their resistance to handling and transport. Improving the food products stability is an important element in ensuring their quality. The main factors that influence the food products stability are internal factors (pathogenic microorganisms) and external factors (temperature, humidity, chemical compounds in the structure of the package, etc.). For each food product is experimentally established the minimum quality assurance period, under prescribed conditions (temperature, relative air humidity, etc.).

The modern methods of prolonging the stability of food products include thermic methods (e.g. ohmic heating, heating with radio waves, use of antiseptic substances, etc.) and athermic methods (e.g. high pressure, magnetic field, ultra-short light pulses, etc).

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BEHAVIOR OF SOME GM AND CONVENTIONAL MAIZE HYBRIDS UNDER DROUGHT AND HEAT CONDITIONS

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Abstract

Since 2007, the GM maize event MON 810 (resistant to insects Lepidopteran) is authorized for cultivation in Romania, but since 2016 the farmers have given up cultivating it for various reasons. In this study, the main agronomic parameters of genetically modified (GM) maize hybrid (MON 810 - trade name: DKC 5784 YG) and of two conventional maize hybrids (Deliciul verii and F 376) were compared under drought and heat conditions during two years at Agricultural Research and Development Station (ARDS) Șimnic. The hybrid affected statistically significant (P≤0.05) all evaluated parameters. Similarly, climatic conditions (year) significant influenced all evaluated parameters with the exception of the days to tasseling. The GM hybrid confirmed ability to protect itself against the Ostrinia nubilalis (ECB) and the drought, and its average grain yield was higher by 1.33 - 1.69 t/ha in comparison with conventional maize hybrids. The results showed a higher level of attack on conventional maize hybrids in extremely dry year 2012 compared to 2013. Thus, adopting GM maize crops can effectively address the drought stress and its consequences for sustainable maize crop production in the dry Oltenia region.

Key words: *attack frequency, drought, ECB, GM maize hybrid (MON 810)*

INTRODUCTION

Maize or corn (*Zea mays* L.) is the most important annual cereal crop for food and industry. It ranks first in the world, with an annual production estimated at 1,148 billion tons cultivated on 197 million hectares. In Romania, maize is one of the strategic cereal crops for internal and foreign market [19] and the annual production is estimated at 17,432 million tons cultivated on 2,678 million hectares [8].
MON 810 maize resistant to *Ostrinia nubilalis* is authorized for cultivation in the European Union since 2007, but is currently grown only in Spain and Portugal. In Romania, MON 810 has not been cultivated since 2016, farmers giving up for various reasons [16, 32].
The grain yield of maize depends on the genetic potential of the cultivar used, the field management practices, the soil and agro-climatic factors [27].
Many factors contribute to maize low yields, among which drought and heat [4, 17, 20, 25] and Lepidopteran stem borers [1, 30, 31]. The attack of these pests is favorably influenced by dry and warm weather [21].
The European corn borer (*Ostrinia nubilalis*, *ECB*) is a Lepidopteran stem borer affecting the growing maize plants and causing damage and yield loss of 60.87% and 41.27% for white and yellow maize, respectively [1].
In the last decade, *ECB* represent one of the most dangerous maize pests in many countries, including the central and western region of Romania [9, 10], Czech Republic [14], Serbia [22] and Croatia [23].
A possible cause for area increasing of *ECB* can be climate changes such as increasing of the temperature [9, 15].
In Romania, due to *Ostrinia nubilalis attacks*, the yield losses were 1.3% in Dobrogea, 8.5% in Transilvania, 10.5% in the South of Moldova, 11.7% in Bărăgan and 17.7% in the West Plain [9].
To combat the problem of yield loss in areas affected by stem borers, use of GM maize is an available option suggested by many researchers [2, 3, 28].

The genetic potential, tolerance of drought, agronomic parameters and benefits of GM maize hybrids are little known in many regions. On the other hand, conventional maize hybrids are able to provide high grain yield and tolerance of drought, but they need efficient protection against pests, and pathogens, usually by chemical pesticides. Consequently, it is necessary to identify and develop strategies for every maize growing area of reducing the damage caused by drought and pests.

Therefore, the aim of our field study was to compare some agronomic parameters of conventional maize hybrids with the GM maize hybrid under severe drought stress.

MATERIALS AND METHODS

The field experiments were carried out in the 2012 and 2013 in the field of the Agricultural Research and Development Station (ARDS) Şimnic – Craiova (geographic coordinates: $44^{0}19'$ N, $23^{0}48'$ E and altitude of 182 m). This station is located in the central part of Oltenia (south- western Romania).

The climate was extremely dry in 2012 and dry in 2013. The highest average air temperatures were recorded in 2012 (21.08ºC) while the total rainfalls were the lowest in the 2013 year (246.0 mm). In 2012 the average monthly precipitations and temperatures in the months June, July and August were higher compared to the average in 2013 or to the multiannual average (Table 1). This led the maize plants to suffer, because of the lack of water during the both vegetation periods.

The factors studied were: i) Factor A – three maize hybrids (GM hybrid and two conventional hybrids) and ii) Factor B - two climatic conditions, respectively two years (2012 and 2013).

The GM maize hybrid - MON 810 (trade name: DKC 5784 YG, Monsanto Company) is a semi-late hybrid (FAO 400) resistant against Lepidopteran insects (*ECB*).

Conventional maize hybrids, Deliciul verii (ARDS Turda) are a sweet early hybrid and F 376 (NARDI Fundulea) is a semi-late yellow hybrid.

The agronomical parameters: phenological phases (days to tasseling, days to silking, days to maturity), plant height leaf area, grain yield, frequency of the attack and length of the stalk tunnels were evaluated.

Maize grain yield was calculated based on the adjustment to grain moisture content of 15.5%.

The attack frequency was calculated according to the formula:

$$F = n \times 100/N$$

where: n = number of attacked plants and N = total number of evaluated plants.

During the harvest period, the length of the stem tunnels was determined by splitting five plants/plot.

The results obtained were subjected to statistical analysis.

Table 1. Monthly mean temperature and total rainfall during studied period, ARDS Simnic

Parameter		IV	V	VI	VII	VIII	Vegetation period
Rainfall (mm)	2012	79.3	130.0	28.0	13.5	-	250.8
	2013	56.0	55.0	88.0	20.0	27.0	246.0
	Multiannual average	50.8	65.8	72.1	83.6	47.3	319.6
Temperature (^{0}C)	2012	13.7	17.9	21.8	26.6	25.4	21.08
	2013	14.5	19.4	21.3	23.4	24.5	20.62
	Multiannual average	12.1	17.7	21.6	23.8	22.2	19.48

Source: Own processing based on data from Weather Station Craiova.

The ANOVA test analysis was performer, while the significance of differences between means values was determined using the Duncan's multiple range tests (P≤0.05).

RESULTS AND DISCUSSIONS

ANOVA results

Analysis of variance was conducted to determine the effect of hybrid (H) and year (Y), and interactions among these factors - hybrid x year (H x Y) (Table 2).

The main effects of hybrid were significant ($P \leq 0.05$ level) for all studied parameters (days to tasseling, days to silking, days to maturity, leaf area, plant height, grain yield, frequency of the attack and length of the stalk tunnels). The effect of year was also, significant for all studied parameters, except days to tasseling.

The H x Y interaction was significant only for plant height, grain yield and frequency of the attack. Significant H x Y interaction indicated that hybrids under different year behaved differently for the expression of parameters of interest.

Table 2. Source of variation (SOV), degrees of freedom (DF), mean squares (MS) and significance of studied parameters

SOV	DF	MS			
		DT	DS	DM	LA
Hybrid (H)	2	446.05*	601.05*	468.22*	0.109*
Year (Y)	1	4.50^{ns}	150.22*	9.39*	0.006*
Interaction (H x Y)	2	2.16^{ns}	5.05^{ns}	0.22^{ns}	0.003^{ns}
Error	12	1.05	6.05	1.72	0.0003
SOV	**DF**	**MS**			
		PH	**GY**	**FA**	**TL**
Hybrid (H)	2	8,145.21*	4.75*	67.67*	171.58*
Year (Y)	1	12,116.06*	23.38*	19.32*	5.89*
Interaction (H x Y)	2	1,380.06*	0.69*	4.94*	1.62^{ns}
Error	12	20.04	0.06	0.71	1.23

DT = days to tasseling; DS = days to silking; DM = days to maturity LA = leaf area; PH = plant height; GY = grain yield; FA = attack frequency; TL = tunnel length;
*: significant and ns: non-significant in 5% probability level, by F test
Source: Own calculation.

Phenology and plant growth

ANOVA results showed that, in the case of tasseling (DT), only the hybrid effect was significant, but for silking (DS) and maturity (DM) both hybrid and year effects were significant ($P \leq 0.05$) (Tables 2 and 3).

The conventional maize Deliciul verii flowered earliest because it is an early hybrid.

The GM maize and F 376 hybrids recorded the highest number of days to tasseling (72.7 and 71.8 days, respectively).

Days to silking of hybrids ranged between 59.7 to 82.7 days and the mean day to silking in the studied period was 73.2 days. Maximum days to silking were observed in GM maize hybrid and in F376 in 2012 (73.0 days).

Maximum days to maturity were observed in F376 (110.2 days) and in 2013 (104.7 days).

In the central part of Oltenia, only two out of ten years are favorable to agricultural crops. Here, drought and heat are the most important abiotic factors that reduces maize yield, depending on the constrainer length, its intensity and crop stage. Thus, the identification of hybrids with tolerance of drought and high yield potential, coupled with wide adaptability, is an important task for maize or others crops breeding program [4, 6, 25].

Field experiments conducted over two consecutive crop-growing seasons revealed that severe drought stress (especially during the flowering, pollination and grain-filling stages) had a strong effect on maize growth and development.

Significant differences were observed between the GM and conventional maize for all evaluated parameters. These significant differences between hybrids for growth and development agree with previous research reported by [29]. He found that water deficit reduced leaf area as much as 33% and plant height by 15%, depending on leaf number and timing of water deficit.

According to [24], four consecutive days of severe wilting during silking and pollination can reduce maize yield by 40-50%.

The plant height and leaf area were significantly influenced by year and hybrid, but H x Y interaction effect was non-significant (Tables 2 and 4).

The mean leaf area in the studied period was 0.35 cm^2 and the mean plant height was 177.2 cm. The higher values, for both parameters, recorded for GM maize and F376 hybrids in 2013 year.

Climatically conditions during 2012 year (in the vegetative period), comparative to 2013, reduced leaf area by -14.9% in GM maize and by -13.3% in F376, and increased by +5.3% in Deliciul verii.

Plant height was reduced by -30.4% in GM maize, by -11.9% in Deliciul verii and by -29.0% in F376 (Table 6).

Table 3. The average of days to tasseling (DT), days to silking (DS) and days to maturity (DM)

Parameter	Hybrid (H)	Year (Y)		Average per hybrid
		2012	2013	
DT (days)	GM maize	73.0	72.3	72.7 a
	Deliciul verii	57.3	57.3	57.3 b
	F 376	73.0	70.7	71.8 a
	Average per year	67.8	66.8	67.3
DS (days)	GM maize	82.7	75.0	78.8 a
	Deliciul verii	63.7	59.7	61.7 b
	F 376	82.0	76.3	79.2 a
	Average per year	76.1 a	70.3 b	73.2
DM (days)	GM maize	107.0	108.7	108.0 b
	Deliciul verii	93.3	94.3	93.8 c
	F 376	109.3	111.0	110.2 a
	Average per year	103.2 b	104.7 a	104.0

Indicator	LSD test	H	Y	H x Y
DT	5%	1.29	1.05	1.82
DS	5%	3.09	2.53	4.38
DM	5%	1.65	1.34	2.33

Means followed by different letters in each column are significantly different from each other at 5% level of significance

Source: Own calculation.

Yield of grains

The results showed significant difference ($P \leq 0.05$) in the grain yield for the hybrid, the year and for the H x Y interaction (Tables 2 and 5).

The average grain yield for all hybrids and the studied period amounted to 2.67 t/ha.

The 2013 average yield (3.81 t/ha) was significantly higher than the 2012 yield (1.53 t/ha).

The GM maize hybrid had a significantly higher average yield (3.68 t/ha) than the conventional maize hybrids (1.99 and 2.35 t/ha, respectively), the highest value being obtained in 2013 (5.05 t/ha).

Reduction of grain yield in 2012, comparative to 2013 was of 35.7% in GM maize hybrid, of 54.7% in Deliciul verii and of 71.2% in F376 (Table 6). The grain yield of GM maize hybrid was least affected by severe drought stress conditions as compared to conventional maize hybrid.

According to [26], losses caused by the pest range from 250-1000 kg/ha, depending on the degree of infestation, the year and the grain yield average.

Table 4. The average leaf area (LA) and plant height (PH)

Parameter	Hybrid (H)	Year (Y)		Average per hybrid
		2012	2013	
LA (cm^2)	GM maize	0.40	0.47	0.43 a
	Deliciul verii	0.20	0.19	0.19 b
	F 376	0.39	0.45	0.42 a
	Average per year	0.33 b	0.37 a	0.35
PH (cm)	GM maize	164.8 b	236.8 a	200.8 a
	Deliciul verii	126.2 d	143.2 c	134.7 b
	F 376	162.7 b	229.3 a	196.0 a
	Average per year	151.2 b	203.1 a	177.2

Indicator	LSD test	H	Y	H x Y
LA	5%	0.023	0.019	0.031
PH	5%	5.62	4.60	7.96

Means followed by different letters in each column are significantly different from each other at 5% level of significance.
Source: Own calculation.

Table 5. The average grain yield (GY), frequency of the attack (FA) and tunnel length (TL)

Parameter	Hybrid (H)	Year (Y)		Average per hybrid
		2012	2013	
GY (t/ha)	GM maize	2.31 d	5.05 a	3.68 a
	Deliciul verii	1.24 e	2.74 c	1.99 c
	F 376	1.05 e	3.65 b	2.35 b
	Average per year	1.53 b	3.81 a	2.67
FA (%)	GM maize	0	0	0
	Deliciul verii	7.72 a	4.33 b	6.03 a
	F 376	7.00 a	4.17 b	5.58 a
	Average per year	4.91 a	2.83 b	3.87
TL (cm)	GM maize	0	0	0
	Deliciul verii	10.3	8.90	9.60 a
	F 376	9.90	7.90	8.90 a
	Average per year	6.70 a	5.60 b	6.16

Indicator	LSD test	H	Y	H x Y
GY	5%	0.30	0.24	0.41
FA	5%	1.07	0.86	1.50
TL	5%	1.37	1.10	1.90

Means followed by different letters in each column are significantly different from each other at 5% level of significance.
Source: Own calculation.

Table 6. Reduction/increase (%) in 2012 (extremely dry) comparative to 2013 (dry) for evaluated parameters

Hybrid	DT	DS	DM	LA	PH	GY	FA	TL
GM maize	+1.0	+10.2	-1.6	-14.9	-30.4	-35.7	-	-
Deliciul verii	0	-10.1	-1.1	+5.3	-11.9	-54.7	+78.2	+15.7
F376	+3.2	+7.5	-1.5	-13.3	-29.0	-71.2	+67.9	+25.3

DT = days to tasseling; DS = days to silking; DM = days to maturity LA = leaf area; PH = plant height; GY = grain yield; FA = attack frequency; TL = tunnel length
Source: Own calculation.

Resistance to European corn borer

The *ECB* tunneling and attack frequency were significantly influenced by the year and the hybrid. The H x Y interaction was significant only for attack frequency (Tables 2 and 5).

The GM hybrid plants were not infested by the *ECB* (attack 0%), confirmed its ability to protect itself against *ECB*.

The average attack frequency of *ECB* (*O nubilalis)* for the period 2012-2013 was 3.87%. The 2012 average attack frequency

(4.91%) was significantly higher than the 2013 average. The highest average attack frequency was obtained in 2012 at both conventional maize hybrids (7.72% and 7.0%, respectively).

Similarly, significant differences were also observed in tunnel length between hybrids and years, but not in the H x Y interaction.

The average tunnel length in the studied period was 6.16 cm. The highest average length was obtained in 2012 (6.70 cm).

Photo 1. *Ostrinia nubilalis* - different types of tunnels in the maize stalk
Source: Project ADER 6.1.2.

For the attack frequency of *ECB* and tunnel length at conventional maize hybrids, was observed an increase of the values from 2012 compared to 2013, by +15.7%... +25.3% and by +78.2%... +67.9%, respectively.

Also, the present study demonstrated the efficacy of MON 810 in controlling the *ECB* in Oltenia area. The biological efficacy of GM maize (MON 810) on the reduction of the attack caused by *ECB* was reported in other study [5, 14, 30, 31].

The frequency of attack on conventional maize hybrids has been influenced by years of study. Higher pest pressure was registered in year 2012. A possible explication of this was because in June and July of 2013, at ARDS Șimnic, the abundant rain and the temperatures slightly below the multiannual average (-0.3^{0}C and -0.4^{0}C, respectively) limited the flight of *O. nubilalis* butterflies, their oviposition and incubation, therefore the attack frequency was lower compared to 2012. Similarly in Croatia, climatic conditions in 2012 increased the *ECB*'s potential to damage maize [23].

[9] found that at NARDI Fundulea, the increase in attack intensity is due the climatic conditions from the end of June or beginning of July, favorable for larva development, from emergence until they enter in plant stalks.

[12] reported that the differences between years for level of attack, were significant, but between genotype (GM maize and conventional) maize were non-significant.

[11] considers that sensitivity of a plant species to the attack of pests results not only from its genetic properties, but also from growth conditions for pests.

Also, the reduction of plant height by water and heat stress can affect the level of infestation with *ECB*, because adults are attracted to the taller plants in an area during the first generation egg-laying period [28].

[7] reported an attack frequency of *ECB* between 9% and 60.5%, depending on the hybrid, in the RDCFCSS Dăbuleni area, and [13] reported an average attack frequency of 51.27% at Horia, Arad County.

The stalk tunnel length is a character typically used to quantify *ECB* damage, and it is negatively correlated with grain yield, although is unknown the genetic mechanism responsible of that relationship [18].

CONCLUSIONS

Field experiments conducted over two consecutive crop-growing seasons revealed that severe drought stress had a strong effect on maize growth and development. Significant differences were observed between the tested maize hybrid (GM and conventional maize) for all evaluated parameters. Also, the climatically conditions of years of study, significantly affected the all evaluated parameters, except days to tasseling.

The present study demonstrated the efficacy of MON810 in controlling the *ECB* in central part of Oltenia, Romania.

Climatic conditions from summer period, registered at ARDS Simnic were favorable for *ECB* larva development in conventional maize hybrids.

The grain yield of GM maize hybrid was least affected by drought stress conditions as compared to conventional maize hybrids.
Thus, adopting GM maize crops can effectively address the drought stress and its consequences, for sustainable maize crop production in the dry Oltenia region.

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GROSS MARGIN ANALYSIS OF SELECTED VEGETABLES GROWN UNDER PROTECTED AND OPEN FIELD CULTIVATION IN LEYTE, PHILIPPINES

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Abstract

Growing vegetables has been a problem during the wet season in Leyte island, Philippines, because of intense rain affecting the growth and quality of produced vegetables. Using protected cultivation has been identified as one of the promising solutions in dealing with this problem. Several experimental trials under protected and open field cultivation have been conducted to evaluate the applicability and profitability of protected cultivation under Leyte island conditions. Gross margin analysis was used to measure and compare the profitability of selected high value vegetables like tomato, sweet pepper, and lettuce grown under protected cultivation compared to the conventional practice in open field cultivation. Results show that vegetables planted under protected cultivation employing different production practices are more profitable than vegetables grown under open field cultivation. This suggests that protected cultivation will help vegetable farmers increase their production and profitability, particularly during the wet season.

Key words: *profitability analysis, high-value vegetables, protected cropping, rural Philippines*

INTRODUCTION

The vegetable industry is a dynamic and sizeable agricultural subsector in the Philippine economy. In terms of production, Philippine Statistics Authority (PSA) (2016) reported that 5.1 million tons of vegetables are produced in 544,000 hectares of land in the country in 2015 [13]. The annual average growth rate of vegetable production only constitutes 3% from 2010-2015. In 2014-2015, net returns and net profit-cost ratio per hectare from the production decreased from 2.22 million pesos to 2.08 million pesos and 18.01 to 17.75, respectively, which are still generally lower than the net returns of other crops such as rice and corn [13].

Vegetables play an essential role in the Philippine economy. However, growing vegetables has been a problem during the wet season due to heavy winds and rain, leading to the inability of the farmers to satisfy demand for vegetables [1, 3, 6]. Vegetable production in the country can be enhanced by exploring new farm technologies and improving farm skills [4]. One of the feasible approaches to address this problem is through the use of a protected cropping system and integrated cropping management system [12]. Using a protected production system, previous study found that the average yields of selected vegetables grown under protected structure were relatively higher than vegetables planted in the conventional method [6, 12].

Growth in agricultural can be sustained not just by input growth but with technological development [21]. Protected cultivation is the most contemporary approach to produce horticultural crops in a modified and controlled environment. It manipulates production factors such as light, soil, water, temperature, humidity, etc., to attain maximum productivity and even allows a regular supply of vegetables during off-season [18]. This is also used to protect the plants from adverse climatic conditions, including protecting insect pests and diseases. This technology can further help farmers produce safe and high-quality vegetables as well as gain higher income. Protected cultivation has spread worldwide for the last decades [18, 22, 23, 24].

Previous research results showed that crops under protective structures have higher yields on average than those grown in the open field [6, 16]. This study will add further evidence of the profitability of protected vegetable cultivation under Leyte conditions. Leyte island is vulnerable to extreme weather events [11, 17, 19]; hence, finding practical approaches to continue production is vital in keeping the vegetable supply chain. This study aims to compare the production of selected vegetables grown under protected cultivation and in the open field using gross margin analysis. The results of this study would be beneficial to improve the year-round production system of vegetables in Leyte. Vegetable farmers will be able to improve their yields with protected cultivation by producing during off-season and capture higher prices, thus enhancing their profitability. This study will be helpful to policymakers for the formulation of projects, programs, or policies necessary for the development of the vegetable sector.

MATERIALS AND METHODS

Study Sites

The selected study sites were the experimental area of the Department of Horticulture in Visayas State University (VSU) for the comparison of protected and open field setup. This located in 10 kilometers north of Baybay City, Leyte. Map 1 shows the location of the study. The Visayas State University has an experimental area devoted to field trials of agricultural technologies [20].

Data Collection

Data on production receipts and total variable costs were gathered through face-to-face interviews using a prepared and pre-tested questionnaire. Information about production inputs like direct inputs, labor and overhead costs; and revenues were collected in the experimental site. In addition, an interview with one (1) on-field horticulturist and one (1) focus group discussion with farm workers were done to obtain information about the potential yield changes from protected and open field cultivation. This method of obtaining information is called Delphi technique. This technique is widely accepted as a means for consensus-building method to gather data or information from persons in their domain of expertise especially in case of limited data [10].

Map 1. Location of vegetable experimental site
Source: [8].

Gross Margin Analysis

Gross margin analysis has been used in previous studies to initially assess the potential of intervention before a full economic analysis is done [1, 15]. Gross margin is the firm's total revenue minus the cost of goods sold or the variable inputs used to produce the outputs sold. The total revenue comprises the sales from the marketable and non-marketable yield of crops. The variable cost includes direct inputs such as seeds, fertilizers, pesticides, material cost; labor cost; and overhead cost such as rent of machines. The gross margin per enterprise for each type of cultivation was compared. Values were converted to per m^2 to compare both cultivations systematically. The gross margin is derived using the following calculations:

$$\text{Gross margin} = \text{Gross returns} - \text{Total variable cost}$$

where gross returns is computed by multiplying the total production by prevailing farm gate prices [14].

RESULTS AND DISCUSSIONS

Gross margin analysis of tomatoes grown under protective structure and open-field with different organic amendments

Tomato is highly sensitive to pest and disease attacks which can reduce productivity to a considerable extent, particularly bacterial wilt caused by *Ralstonia solanacearum* [2]. Photo 1 shows the field trial to evaluate the effects of waste cabbage residues, *Chromola enaodorataa* (a weed species) and forest leaf litter as soil organic amendments on disease occurrence and yield performance of tomato grown under protective and open-field cultivation. The total area planted for all four treatments is 200 m^2. These organic amendments were added to the soil at the rate of 15 kg/10 m^2 plot area with 3 replications. Figure 2 shows the experimental setup of tomatoes grown under protected and open field cultivation. Gorme et al. (2017) discussed in details about the experimental of these organic amendments [9].

Photo 1. Tomato plants grown under protective structure (A) and in open field (B)
Source: [9].

To determine the profitability of these organic amendments, the gross margin analysis was conducted. The variable costs include all material and labor inputs incurred in carrying out the different trials planted in a total area of 200m^2 area. Each treatment has a total plot size of 30m^2. Table 1 shows the gross margin analysis of protected cultivation and open field disaggregated by treatments.

The total revenue was computed by multiplying the total quantity of harvested tomato fruits by the average farm gate of tomato in Leyte.

Results show that tomatoes planted under protected structure yields eight times higher gross margin than those planted in the open field. Between treatments, tomatoes planted in soil with cabbage waste have the highest gross margin in both types of cultivation. This result coheres with previous study findings that cabbage farm residues can generally minimize bacterial wilt disease and increase yield in tomato [2].

Table 1. Gross margins of tomato production with different organic soil amendments

Items	Organic Amendments			
	Forest Leaf Litters	Cabbage Waste	*Chromolaena odorata*	Control
PROTECTED CULTIVATION				
Yield (kg/30m^2)	79.88	102.00	76.85	73.90
Price/kg (PHP)	34.02	34.02	34.02	34.02
A. Gross Returns (PHP)	2,717.52	3,470.04	2,614.44	2,514.08
Materials	686.04	956.04	606.04	556.04
Labor	890.28	841.85	938.68	648.28
B. Variable Cost (PHP)	1,576.32	1,797.89	1,544.72	1,204.32
C. Gross Margin (A-B) per 30m^2 (PHP)	**1,141.20**	**1,672.15**	**1.069.72**	**1,309.76**
Gross margin per hectare (PHP)	**313,830.57**	**459,842.48**	**294,173.40**	**360,184.68**
OPEN FIELD				
Yield (kg/30m^2)	47.95	58.50	46.63	43.80
Price/kg (PHP)	34.02	34.02	34.02	34.02
A. Gross Returns (PHP)	1,631.26	1,990.17	1,586.35	1,490.08
Materials	686.04	956.04	606.04	556.04
Labor	867.59	819.16	915.99	625.59
B. Variable Cost (PHP)	1,553.63	1,775.20	1,522.03	1,181.63
C. Gross Margin (A-B) per 30m^2 (PHP)	**77.63**	**214.97**	**64.32**	**308.44**
Gross Margin per hectare (PHP)	**21,347.55**	**59,116.33**	**17,688.29**	**84,822.23**

Note: PHP = Philippine peso (currency)
Source: Authors calculation based on the experimental data and survey data, 2017.

Tomatoes grown in the soil medium without organic amendments have a higher gross margin than those with forest leaf litters and *Chromolaena odorata.* This is because adding organic amendments requires additional labor and materials compared to the traditional way of growing tomatoes. On a per hectare analysis, the cabbage waste amendments under protected structure yield a gross margin of PHP 459,842 per hectare compared to open field cultivation with an estimated gross margin of only PHP 59,116 per hectare (Table 1).

Gross margin analysis of sweet pepper grown under protective structure and open-field

Sweet pepper production has been limited due to pest infestation throughout the country [5]. These pests reduced the yield and quality of the fruits. Sweet pepper pests include insects, mites, pathogens, and nematodes. Among these, mites, specifically broad mites and insects like the fruit worm, fruit fly, and sucking species, are common [5]. The high cost of chemicals (insecticides) to be used as a repellant for insect infestation led to the development of organic concoctions like the vermitea. The use of vermitea as fertilizer and repellant against insect pests is one of the organic options that small farmers can easily adopt [5].

In this study, vermitea was tested to know if it can minimize insect infestation on sweet pepper. Photo 2 shows the experimental setup of pepper grown under protected and open field cultivation. The treatment application was done by spraying the test plants early in the morning or late in the afternoon using the recommended rates of application of each treatment.

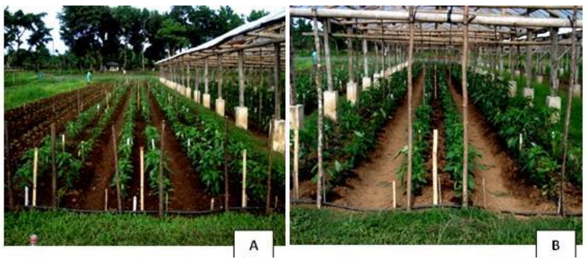

Photo 2. Comparison of sweet pepper grown in open field (A) and in protective structure (B)
Source: [5].

The gross return of sweet pepper was calculated by multiplying the total yield of sweet pepper with the selling price of PHP 100.00 per kilogram (Table 2). The material cost includes all necessary inputs in growing sweet pepper. For the treatments, all the necessary ingredients in preparing the brewed and ordinary vermitea including water were quantified and given monetary value. The labor input includes all the activities from sowing seeds, harrowing bed preparation, transplanting, weeding, harvesting, and all other activities with a given rate of PHP 150.00 per man-day. The revenue and variable cost was computed from planting sweet pepper in a 200 m^2 with 4 treatments and three replications. The average plot size for every treatment application is about 30m^2. Results show that a positive gross margin can be observed in all the treatments under the protected cultivation (Table 2).

Table 2. Gross margins of sweet pepper production with different kinds of insecticides.

Items	Insecticides			
	Tap Water	Ordinary Vermitea	Brewed Vermitea	Insecticide (Oschin)
PROTECTED CULTIVATION				
Yield (kg/30m^2)	19.70	24.10	19.70	37.50
Price/kg (PHP)	100	100	100	100
A. Gross Returns (PHP)	1,970	2,410	1,970	3,750
Materials	382.55	727.55	432.15	627.55
Labor	638.25	638.25	638.25	638.25
B. Variable Cost (PHP)	1,020.80	1,365.80	1,070.40	1,265.80
C. Gross Margin (A-B) per 30m^2 (PHP)	**949.20**	**1,044.20**	**899.60**	**2,484.20**
Gross Margin per hectare (PHP)	**261,029.31**	**287,154.31**	**247,389.31**	**638,154.31**
OPEN FIELD				
Yield (kg/30m^2)	12.00	11.60	13.40	12.20
Price/kg (PHP)	100	100	100	100
A. Gross Returns (PHP)	1,200	1,160	1,340	1,220
Materials	380.55	727.55	432.15	627.55
Labor	525.76	525.76	525.76	525.76
B. Variable Cost (PHP)	906.31	1,253.51	957.91	1,153.31
C. Gross Margin (A-B) per 30m^2 (PHP)	**293.69**	**-93.31**	**382.09**	**66.69**
Gross Margin per hectare (PHP)	**80,765.44**	**-25,659.56**	**105,075.44**	**18,340.44**

Source: Authors calculation based on the experimental data and survey data, 2017.

In the open field, a negative gross margin can be observed in the sweet pepper treated with ordinary vermicast (PHP -93.31) as a control to pest infestation. The treatment sprayed with insecticide has the highest gross margin of PHP 2,484.20 in the protected structure and the brewed vermitea (PHP 382.09) in the open field. However, the treatment with insecticide (PHP 66.69) yields the least positive gross margin in the open field and the brewed vermitea has the lowest amount of gross margin in the protected structure (PHP 899.60).

It was observed that plants grown under the protective structure were generally more vigorous, have darker and broader leaves, and w2ere mostly taller than sweet pepper grown in open field cultivation [5]. In addition, the fruiting period of sweet pepper grown under protected structure lasted for fourteen weeks, and those planted in the open-field lasted only for ten weeks. This contributed to the relatively enormous difference in gross margin between protected cultivation and open field cultivation.

Gross margin analysis of lettuce grown under protective structure and open-field

Growing leafy vegetables like lettuce (*Lactuca sativa* L.) requires intensive care and management practices. One such practice is the method of raising vegetable seedlings. Seedling production is a vital farm operation to consider since it is the critical stage that highly affects the yield of the crops [7]. An experiment exploring different methods of raising seedlings is specified in the following treatments and disaggregated between the types of cultivation. Photo 3 shows the growth performance of lettuce grown in the open field and under protected structure.

Photo 3. Performance of lettuce in the open field (A) and under protective structure (tunnel type).
Source: [7].

The gross return for lettuce was computed based on the farm gate selling price of PHP 80.00 per kilogram. It can be noticed in Table 3 that the lettuce grown under the protected structure yields better than those grown in the open field regardless of the methods of raising seedlings. In terms of the management practice in raising seedlings, T_3 or the seeds sown in seedling trays then transplanted to the field results in a higher gross margin in the open field (PHP 12,683.50) and under the net-tunnel structure (PHP 9,808.10).

Table 3. Gross margin analysis of lettuce production with different methods of raising seedlings

Items	Raising Seedlings			
	T_1	T_2	T_3	T_4
PROTECTED CULTIVATION				
Yield (kg/30m^2)	108.96	122.88	165.12	104.64
Price/kg (PHP)	80	80	80	80
A. Gross Returns (PHP)	8,716.80	9,830.40	13,209.60	8,371.20
Materials	1,861.50	1,501.50	1,561.50	1,201.5
Labor	1,960.00	1,870.00	1,840.00	1,900.00
B. Variable Cost (PHP)	3,821.50	3,371.50	3,401.50	3,101.50
C. Gross Margin (A-B) per 30m^2 (PHP)	**4,895.30**	**6,458.90**	**9,808.10**	**5,269.70**
Gross Margin per hectare (PHP)	**636,389.0**	**839,657.0**	**1,275,053.0**	**685,061.0**
OPEN FIELD				
Yield (kg/30m^2)	98.40	104.64	202.56	91.20
Price/kg (PHP)	80	80	80	80
A. Gross Returns (PHP)	7,872.00	8,371.20	16,204.80	7,296.00
Materials	1,861.50	1,501.50	1,561.50	1,201.50
Labor	2,080.00	2,020.00	1,960.00	2,080.00
B. Variable Cost (PHP)	3,941.50	3,521.50	3,521.50	3,281.50
C. Gross Margin (A-B) per 30m^2 (PHP)	**3,930.50**	**4,849.70**	**12,683.30**	**4,014.50**
Gross Margin per hectare (PHP)	**510,965.0**	**630,461.0**	**1,648,829.0**	**521,885.0**

Note: T_1- Seed sown in seedbox, then pricked to seedling trays then transplant, T_2- Seeds sown in seedbox, then transplant to the field, T_3- Seeds sown in seedling trays, then transplanted, T_4- Seeds sown directly to the field.
Source: Authors calculation based on the experimental data and survey data, 2017.

Comparing the gross margins under the two types of cultivations shows that T_1, T_2, and T_4 yield higher profit under protected cultivation and only T_3 yield a bigger profit in the open field. This implies that lettuce with seeds sown in seedling trays before transplanted to the field performs better in the open field than in the protected structure. Further experiments from horticulture experts will be needed to confirm this result.

CONCLUSIONS

Gross margin analysis has been conducted to investigate whether it is profitable to grow vegetable crops under protected structure as compared to the conventional method of growing vegetables. Gross margin analysis of selected vegetable crops experimented under different cropping practices were conducted. With gross margin as a measure of profitability, we only consider the variable costs incurred in the production. This analysis excludes the cost of the structure. Results show that vegetables grown under protected cultivation yield higher production, translating to higher profit than open field cultivation. This suggests that cultivation under protected structure will enhance the production and as well profitability of vegetable farmers. Tomato, sweet pepper, and lettuce cultivated under protected structures have higher gross margins as compared to open field cultivation.

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EFFECTS OF COVID-19 ON SMALL-SCALE AGRIBUSINESS IN ENUGU STATE, NIGERIA

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Abstract

COVID-19 is one of the deadliest infectious disease that has affected mankind in recent time. The disease affected both public and private businesses. Thus, it has impacted negatively on the economy of many nations in the world. This study examined the effect of COVID-19 pandemic on the small-scale agribusiness sector in Enugu State, Nigeria. Data used for the study were collected from randomly selected 397 agripreneurs via a structured questionnaire. Descriptive statistics and logistic regression were used for the data analysis. The results revealed that the production, marketing, supply and demand of agricultural produce drastically declined significantly due to the outbreak of the corona virus. The study further showed that COVID-19 has led to disruptions in rural agribusiness in Enugu state Nigeria by reducing the profitability of agribusinesses through channels such as high cost of seeds, credit sales, produce not harvested due to the pandemic, and unavailability of seeds. The coping strategies adopted by the agripreneurs to lower the effect of COVID-19 pandemic on their business were selling at home, paying their way to the selected market, selling on credit, reduction in prices, further processing of the product and engaging in lower scale sales. The study recommends provision of financial, input, technology and marketing support to the agripreneur by the government and nongovernmental organisations to ease the effects of COVID-19 on their business. These will encourage agripreneurs to maintaining a steady supply of agricultural produce and make moderate profits and also reduce hardship to the citizens.

Key words: *agribusiness, Covid-19 pandemic, lockdown, Nigeria, profitability*

INTRODUCTION

Since the turn of the last century, the world has had series of infectious and viral diseases with fatal consequences. The Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS), Ebola, Malaria, Lassa fever among other deadly diseases have posed great challenges to global health. Nigeria and its constituent states have their own share of these maladies but none of these diseases has held the world to ransom as Corona virus (COVID-19). COVID-19 is one of the deadliest infectious/contagious disease that has ravaged the nations of the world. Globally, COVID-19 has affected nations' economy, peoples' health, culture and social activities [8, 13, 14]. It is defined as an illness caused by a novel coronavirus called respiratory syndrome coronavirus II [7]. According to World Health Organization (WHO), coronavirus is largely family of viruses that are known to cause illness ranging from common cold to more severe diseases that affect the entire human body. This illness can have tremendous effect on economies as presently being witnessed and as such can affect the agricultural sector. The effect of COVID-19 in Nigeria if not timely contained could affect the entire population within a short period. The rural dwellers whom their mainstay of the economy is agriculture are among the most vulnerable group as they have limited or no access to protective equipment and health care facilities.

COVID-19 has become an economic crisis in Nigeria and has affected the low-income agribusiness communities that are the major domestic production hub in Nigeria. However, the economic effects are on the wellbeing of families of these production communities. The virus has affected both public and private businesses as a result of restrictions in movement and movement of commodities which aides in the production, marketing and distribution of essential commodities [12]. Agricultural food distribution covers the activities of moving agricultural product from the producer to the consumer. These activities involve the planning, organizing, directing and handling of the produce in such a way as to satisfy intermediaries and consumers [4]. However, numerous interconnected activities are involved in doing this, such as production and harvesting, grading, packing and packaging, transport, storage, provision of market information [10]. These processes were severely disrupted due to COVID-19 pandemic.

With COVID-19 spreading to all parts of the country, the supply side of agricultural raw materials are heavily affected as the major imports from outside the country reduced tremendously during the lockdown and thus affected agricultural production [12]. The macroeconomic effects of COVID-19 have resulted in shutting down of the supply chain in most states. These disruptions due to closure of state borders by the government has resulted in a sharp decrease in the supply of agricultural raw materials, increase in the price and the demand of these commodities by consumers and agribusiness firms. The coronavirus has brought about a huge increase in the price of agricultural raw materials used in production in the country.

Also, from the supply side, the immediate exposure to the economic effects of COVID-19 is trade restrictions, supply shortages as well as price hikes. The restrictions on trade have affected the businesses and also has increased the poverty levels due to increase in the prices [5]. This also has resulted in the decrease in the demand for agro raw materials transported to and within the State. It is with clear understanding that most of the haulage services have cancelled orders due to border closures and restrictions on human movement by the federal government and also these have affected the availability and ultimately the prices of the traded agro commodities. Suppliers of these agribusiness commodities used in agricultural production are now forced to increase the prices of their products due to the uncertainties caused by the COVID-19 pandemic. Agribusiness firms have lost substantial income due to the outbreak of the disease as a result of the reduced demand of agribusiness raw materials and labour thus this has also translated into negative economic impact affecting the already most vulnerable population. The fear and the concern about COVID-19 is growing consequently, many agribusiness firms have put in place measures to ensure that the virus does not spread further among their employees and customers which, however, affected their business activities.

In view of the foregoing, this study aims at examining the economic effect of COVID-19 on small-scale agribusiness firms in Enugu state, Nigeria. Specifically, the study investigated the effect of COVID-19 pandemic on crop/food production of agribusiness, the effects of COVID-19 on agribusiness marketing, the effect of the pandemic on agribusiness profitability, as well as examined the coping strategies of small-scale agribusiness amidst the Coronavirus pandemic in Enugu State, Nigeria. The remainder of the study includes the methodology section, presentation and analysis of results as well as conclusions with relevant policy recommendations.

MATERIALS AND METHODS

The study was conducted in Enugu State, Nigeria. The state has seventeen local government areas (LGAs), shares border with Abia and Imo State to the South, Ebonyi State to the East, Benue State to the Northeast, Kogi State to the Northwest and Anambra State to the West [1]. It is located between Latitudes $5^0$55'N and $7^0$08'N of the equator and longitudes $6^0$55' E and $7^0$08' E of the Greenwich meridian [1]. Enugu state has a population of 3,257,298 people and a landmass of 71,161 square kilometres [2]. The larger proportion of the population lives in rural areas who mostly engaged in agricultural activities.

The study employed a survey research design. A well-structured questionnaire was used to elicit information from 397 randomly selected respondents (agripreneurs) who engaged in small scale agribusinesses. Number of respondents selected from each local government area (LGA) were based on agripreneur participation level. One hundred and thirty-three (133) respondents were randomly selected from Igboetiti LGA, one hundred and sixteen respondents were randomly selected from Igboeze South LGA, while one hundred and forty-eight respondents were randomly selected from Nsukka LGA. Thus, 33.50% of the respondents were residents in Igboetiti LGA while 29.22% and 37.28% were from Igboeze South and Nsukka local government areas, respectively.

Table 1. Sampling procedure

Local government area	Number of respondents	Percentage
Igboetiti	133	33.50
Igboeze South	116	29.22
Nsukka	148	37.28

Source: Field Survey, 2021.

The study elicited information from participants in agribusiness in Nsukka, Igboetiti and Igboeze South local government areas from January to February, 2021. Twelve research assistants who were trained and well familiar with the three LGAs selected assisted in the data collection. Due to the nature of the pandemic, the researchers and the assistants wore facemask, had hand sanitizers and also wore hand gloves which were regularly removed and disposed. The questionnaire had two sections (section A and section B). Section A captured information about the respondents while section B, which was divided into four clusters centred on the objectives of the study. Clusters one, two and three were structured in Likert format to capture the extent that COVID-19 affected crop/food production of agribusiness, the extent COVID-19 affected marketing of agribusiness and the extent COVID-19 affected profitability of agribusiness. Cluster four was structured to allow the respondents to state their coping strategies to reduce the effect of COVID-19 on their agribusiness.

The data were analysed using descriptive statistics such as mean, standard deviation, frequency, percentage and Likert rating scale. Inferential statistics, logistic regression, was also used as a means of data analysis. The entire analysis was done using STATA 15 software.

A four-points Likert scale was used to analysis the effects of COVID-19 on crop/food production of agribusiness and the effect of COVID-19 on agribusiness marketing. The nature of the questionnaire items for the first two objectives which were Likert scaled implied that decision for the result can only be done based on real limit means. By this method, means of 1 to 1.4 = very low extent (VLE), 1.5 to 2.4 = low extent (LE), 2.5 to 3.4 = high extent (HE) and finally 3.5 and above = very high extent (VHE).

To investigate the causal pathways through which the pandemic has affected agribusinesses (proxied by the extent or severity of profit losses) in the study area, the study used the logistic regression model. The logistic regression was used due to its simplicity and seemingly advantages over the Probit model. Also, it was used basically because the dependent variable; extent of profit declines associated with the pandemic was used in the model as a dummy variable having two categories 0 and 1. Those who reported very low extent and low extent on profit declines were coded as 0, while those who reported high extent and very high extent were coded 1. The use of the logistic for handling this kind of relationships is prevalent in literature such as [3, 6].

The model was fitted thus:

$$L_i = \ln((P_1 - P_2)/1 - P_1 - P_2)) = X_i'\beta + \mu$$

where:

L_i = Logit

$P_1 - P_2$= Probability of success; High extent of profit decline.

$1 - P_1 - P_2$ = Probability of failure; low extent of profit decline.

X_i (X_{1-6}) are vector of covariates.

X_1= cost of seeds as a result of the pandemic.

X_2= respondent’s level of education.

X_3= age of the respondent.

X_4= gender.
X_5= credit sales.
X_6= products not harvested as a result of the pandemic.
X_7= unavailability of seeds.
β is an unknown vector of regression coefficients.
μ is the error term.

RESULTS AND DISCUSSIONS

Demographic characteristics of the respondents

Table 2 presented the demographic features of the respondents. From the Table, it could be seen that most of the respondents were male (60.45%) and married (78.84%). These imply that married males were mostly engaged in small-scale agribusiness activities. Majority of the respondents were aged 40 and above which suggests that the agripreneurs were advanced in age who are, however, still within their economic active age. Considering the drudgery nature of agriculture which requires energy and quality of farm labour, age of the agripreneurs is a vital factor for effective maximization of available scarce resources for increased production and outputs [9, 11]. The educational status of the respondent revealed that majority had only secondary school education or its equivalent. This shows a low level of literacy among the agripreneurs which could affect their decision making.

Table 2. Frequencies and Percentages for the Personal Information of the Respondents

Response Options	Frequencies	Percentages
Gender of respondents		
Male	240	60.45
Female	157	39.55
Marital status of respondents		
Single	60	15.11
Married	313	78.84
Divorced/separated	5	1.26
Widowed	19	4.79
Age of respondents		
Below 30 years	27	6.80
30 to 39 years	96	24.18
40 to 49 years	157	39.55
50 years and above	117	29.47
Highest completed education of respondents		
Secondary education or equivalent	289	72.80
NCE/OND	83	20.91
HND/B.Sc. and above	25	6.30

Source: Field Survey, 2021.

The effects of COVID-19 on crop/food production of agribusiness

Table 3 showed the results of Likert mean, standard deviation (SD) and decision on the effect of COVID-19 on crop/food production of agribusiness. From the table, the respondents indicated that the quantity produced reduced greatly ($\overline{X} = 3.16$) and sales were negatively affected because of the lockdown ($\overline{X} = 3.51$). However, the respondents indicated that some of their produce were not harvested ($\overline{X} = 2.07$) because of COVID-19 lockdown (movement restriction). The mean score of 3.26 showed that the pandemic highly affected planting during the period. Furthermore, the mean value of 3.52 indicated that to a very high extent cost of seeds for planting went up as a result of COVID-19 pandemic. The result also indicated that seed for planting were to a high extent ($\overline{X} = 3.23$) not available for agripreneurs to buy in the market. Conclusively, the cluster mean of 3.12 indicated that to a high extent COVID-19 has affected agribusinesses. These results imply that COVID-19 had a great effect on agribusiness activities through reduction in production and loss in output due to inability to harvest produce. Due to movement restriction imposed by the pandemic during the lockdown, there was scarcity of seeds for planting and other agricultural input which led to an inflation in the agricultural inputs cost. These greatly affected the 2020 planting season which could increase the food insecurity level if immediate and appropriate measures are not taken. The impact of COVID-19 was thus felt on all aspect of agriculture, especially small-scale agribusiness.

Table 3. Effects of COVID-19 on Crop/Food Production of Agribusiness

Questionnaire Items	Mean	SD	Decision
Quantity produced reduced	3.16	1.06	HE
Some of your produce were not harvested because of lockdown	2.07	1.10	LE
Sales were negatively affected because of lockdown	3.51	0.88	VHE
Planting were affected because of lockdown	3.26	1.01	HE
The cost of seeds for planting went up because of COVID-19	3.52	0.86	VHE
Seeds for planting were not available to buy in the market	3.23	1.02	HE
Cluster summary	3.12	0.54	HE

Source: Field Survey, 2021.

The effects of COVID-19 on agribusiness marketing

Table 4 showed the results of Likert mean, standard deviation (SD) and decision for the highlighted effects of COVID-19 on agribusiness marketing. As shown in the table, the respondents indicated that loan borrowed for their business to a high extent ($\overline{X} = 3.19$) were not used for production purpose due to movement restriction, instead were used for consumption purpose. Similarly, the mean value of 3.23 indicated that their profit to a high extent declined due to low market participation among the agripreneurs. Also, with a mean score of 3.96, the study indicated that sales reduced to a very high extent and this was not surprising as the respondents indicated that markets were to a high extent ($\overline{X} = 2.99$) not open for their goods during the pandemic. In addition, the mean value of 3.88 indicated that the cost of marketing to a very high extent increased because of increased cost of transportation. Furthermore, the respondents indicated that non-durability of their goods to a high extent ($\overline{X} = 3.35$) led to spoilage and waste of their produce. Lastly, the cluster summary with a mean score of 3.43 indicated that COVID-19 to a high extent affected marketing of agribusiness. These results imply that rapid spread of the viral disease affected the various sectors involved in the supply and distribution channels of food. Thus, the disruption caused by COVID-19 affected the marketing aspect of agribusiness as producers and consumers were on the look-out to avoid contracting the disease.

Table 4. Effects of COVID-19 on Marketing of Agribusiness

Questionnaire Items	Mean	SD	Decision
Loan borrowed were not used	3.19	1.03	HE
Profit declined	3.23	1.00	HE
Sales reduced	3.96	0.29	HE
Markets were not available	2.99	1.16	HE
Increase in cost of marketing because of increased in cost of transportation	3.88	0.49	VHE
None durability of the goods led to waste	3.35	1.16	HE
Cluster summary	3.43	0.40	HE

Source: Field Survey, 2021.

The effects of COVID-19 pandemic on agribusiness profitability

Table 5 shows the logistic regression estimates used to examined the effect of COVID-19 pandemic on agribusiness profitability among the small-scale agripreneurs. This was discussed based on the marginal effects for simplicity purposes. However, from the available result, education, respondent age, and gender did not influence profitability during the Covid 19 period under study. However, other variables such as cost of seeds, credit sales, products not harvested due to the pandemic, and unavailability of seeds significantly reduced the agribusiness profits during the period of the pandemic understudy. From the result of the marginal effect, cost of seeds, credit sales, inability to harvest products, and unavailability of seeds significantly increased the reduction of profits by the respondents during the period of the pandemic understudy.

Table 5. Effects of COVID-19 pandemic on agribusiness profitability

	Logit	Marginal effect
Cost of Seeds	2.312**	0.099**
	(0.730)	(0.0294)
Education	1.472	0.0627
	(1.509)	(0.0637)
Age	-0.0695	-0.0030
	(0.277)	(0.0118)
Gender	0.667	0.0284
	(0.534)	(0.0224)
Credit Sales	3.067***	0.131***
	(0.901)	(0.0362)
Products Not Harvested	1.956*	0.0408*
	(0.443)	(0.0183)
Unavailability of Seeds	3.120***	0.1330***
	(0.426)	(0.0089)
Constant	-13.82***	
	(2.666)	
R2	0.0000	
AIC	136.5	
BIC	180.4	
F	22.4543	
N	397	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Field Survey, 2021.

The results showed that with a unit increase in the cost of seeds during the pandemic, profits declined significantly by 9%. The result implies that increase in the cost of seed increased the severity in profit declines in the study area. This large cost of seed with the corresponding decline in profit could be attributed to the following reasons. Firstly, due to the pandemic, many cities were on lockdown. This situation led to farmers inability to access seeds, and as a consequent led to an increase in cost of purchase as demand overwhelms the supply. Secondly, due to the increasing cost of input, prices in the market for commodities are bound to rise, and with a general fall in the incomes of employees, especially private sector employees which account for the large chunk of the labour force, sales declined significantly due to low income. The result from the descriptive statistics also affirms the reduction in the volume of sales.

In addition, those who sold on credit were likely to experience loss in profits by 13%. Also, one of the coping strategies used by the farmers in order to increase sales was selling on credit, which led to further losses in profitability. This is intuitively so because, unlike the advanced societies, selling on credit are highly risky options which does not usually yield expected results due to factors such as lack of repayment, time of repayment and the economic environment which also affects the former.

Also, in terms of the severity of the respondents' inability to harvest farm produce, profits decline significantly by 4%. The failure to harvest all farm produce significantly led to profit losses in agribusiness firms. With reduced harvest, the availability of goods for sales reduced significantly which led to reduced sales and hence, profits.

For the degree of severity in the unavailability of seeds, profit declined by 13%. The unavailability of seeds also led to significant increases in the severity of profit loses due to the pandemic. Usually, one of the major problems that affect farming and agricultural production generally in developing countries is the lack of farm inputs. This lack of farm inputs leads to increases in the prices of available inputs and reductions in the scale of production hence reducing profitability. [16] found in Kenya that agricultural inputs significantly influenced agricultural productivity. [15] have stated that "agricultural growth necessary for economic transformation comes from expanded input use, especially of modern inputs—like improved seed, fertilizers and other agrochemicals, machinery, and irrigation—that embody improved technologies" which Sub-Saharan Africa Countries lag behind especially when compared to the rest of the globe. Hence, it is expected that with productivity affected due to this, profit would be affected. And from our results, this variable exerts higher influence on profits compared to the others.

Coping strategies adopted by agripreneurs to ameliorate the effect of COVID-19 on their business

The result presented in Table 6 depicted the coping strategies adopted by those in agribusiness to ameliorate the effect of COVID-19 on their business.

The result revealed that 94.71% of the respondents adopted home sale. This result implies that selling from home was widely adopted and ranked first by the agripreneur to ameliorate the effect of COVID-19 on their business.

This was due to the movement restriction during lockdown period which prevented them from accessing the market. Although, the respondents reported that selling at home did not give the required sales but assisted them to an extent. More than half (54.91%) of the respondents indicated that they adopted paid their way to the selected market as a coping strategy.

More so, only 37.78% of the respondents adopted selling on credit as their coping strategy. The agripreneurs, however, complaints of low rate and late repayment by some of their customers who took their commodities on credit. Sixty one percent of the respondents reduced their prices to ensure they sold their goods. This was done to attract more customers to avoid spoilage of their produce due to its perishable nature. Furthermore, only 29.97% of the respondents mentioned that they further process their product to increase its lifespan. Going further, 73.55% of the respondents mentioned that they engaged in lower scale sales to ensure they remain in business to avoid losing their customers to competitors.

Table 6. Coping Strategies for the Effect of COVID-19 on Agribusiness

Items	Response Options	Frequencies	Percentages
Selling in their homes	Yes	376	94.71
	No	21	5.29
Paying their way to the selected market	Yes	218	54.91
	No	179	45.09
Selling on credit	Yes	150	37.78
	No	247	62.22
Reduction in prices	Yes	153	61.46
	No	244	38.54
Further processing of the product (like drying of cocoyam	Yes	119	29.97
	No	278	70.03
Engaging in lower scale sales	Yes	292	73.55
	No	105	26.45

Source: Field Survey, 2021.

CONCLUSIONS

The Covid 19 pandemic has remained an economic, political and social shock to the world, with all countries trying to recover from its effect. This study analysed the effect of coronavirus on agribusinesses in Enugu State, Nigeria. The result of this study showed that the pandemic has influenced the economic status of majority of the respondents, who were business owners in the agricultural sector. Thus, coronavirus outbreak had indeed affected small scale agribusiness. This was clearly revealed as individuals and businesses were not allowed to engage in any form of business activities in the market place due to the government-imposed lockdown which although necessary had led to reduced economic status for individuals and businesses. Major results of the study showed that COVID-19 severely affected different segments of agribusiness which include production and marketing which thus affected their profitability. Channels such as the cost of seeds, credit sales, products not harvested due to the pandemic, and unavailability of seeds were significant areas through which the pandemic affected agribusinesses in the state. The coping strategies adopted by the agripreneurs to lower the effect of COVID-19 pandemic on their business were selling at home, paying their way to the selected market, selling on credit, reduction in prices, further processing of the product and engaging in lower scale sales.

From the fore-going, it was recommended that Nigerian government needs to give the health sector and the agricultural sectors serious priority, as the two sectors are very vital to ensuring food security, improved human capital development and sustainability in an economy. The current pandemic effect can be minimized if appropriate policies is geared towards absorbing its effect on agribusinesses. Therefore, the agripreneurs need financial supports from the government and nongovernmental organisations to ease the effects of COVID-19 on their business. Consequently, there is need for enhanced social and economic policies that will absorb the effect of the coronavirus in communities in order to reduce its impact on agribusinesses and most especially on well-being of the members of the society. Activities in agribusinesses can increase and be sustained by developing online technologies that both the large, medium and small-scale agribusinesses can afford. Also, agricultural innovation technologies that are tailored towards online activities such as e-marketing channels and logistics will reduce movement and face to face businesses interaction which will contribute to containing and reducing the spread of the virus. These will encourage producers and agribusiness owners to not only be in business but also make moderate profits. Furthermore, since the outbreak of the current COVID-19 has affected production, the use and adoption of technologies will also go a long way to bridge the gap in the production, marketing and movement of commodities from one area to another. This will go a long way to maintaining a steady supply of agricultural produce and reduce hardship to the citizens.

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RURAL HOUSEHOLD IN THE PROCESS OF MODERNIZATION-DEVELOPMENT OF THE ROMANIAN RURAL AREA

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Abstract

The goal of this paper was to establish a causal relationship between the socio-economic modernization level and the development level of the Romanian rural area, as main point of modernization of the rural household. The starting point in establishing this causal relationship was the development of a theoretical model for the assessment of the modernization and socio-economic development level of the rural area in terms of rural household modernization potential. The output of these models was 3 composite indices that were analysed both as independent indices, in dynamics, and in relation to the other indices, as well as to the dimensions and indicators related to each index. The main hypothesis of the research was the existence of an intrinsic link between the modernization degree and the socio-economic development of the rural area, thus the integration of modernization elements entailing development and implicitly, at rural household level, the continuous improvement of the quality of life and welfare of the rural population. The rural household was considered an important component of the Romanian rural space, being the driving engine that makes all the subsystems of the rural space work.

Key words: *rural household, rural area, sustainable rural development*

INTRODUCTION

The main economic activity in the Romanian rural area is agriculture, while the non-agricultural economy (industry, services, tourism, etc.) has a small share in the Romanian countryside [4]. The farming practice is generally of subsistence or semi-subsistence type, generating a much lower standard of living of the rural inhabitants compared to urban residents. This farming practice became a defining characteristic for the Romanian rural space [1], [8]. Yet the social function of subsistence and semi-subsistence household farms should not be neglected, as, through the farming activity, rural inhabitants can meet their food needs in the situation of insufficient money income. These agricultural holdings also had a social buffer role in the periods of crisis [11]. The rural household, in most cases, coincides with the peasant household farm/individual farm (small, subsistence farm), and due to the low diversification of the Romanian rural economy, the development of rural area is strongly correlated with the viability of agricultural structures [3], [5]. "In the future, the rural household has the mission to preserve the authentic national values of rural areas, in the context of modernizing and streamlining the activities carried out, in a traditional but profitable way" [10].

MATERIALS AND METHODS

Once the theoretical matrices regarding the investigated phenomena have been conceptualised [2], [6], the next stage is the collection of data from statistical sources and the creation of databases (SPSS and Excel). Each indicator of the model will go through the normalization stage, according to the following formula:

$$In = (X - Xmin)/(Xmax - Xmin),$$

where:
In – value of normalized indicator;
X – current value of indicator;
Xmin – minimum value of indicator;
Xmax – maximum value of indicator.
For each normalized indicator, each analysed entity is ordered in the range 0-1, where the

lowest value receives 0, and the highest value receives 1.
For each dimension the size index will be calculated, according to the formula:

Id= (Ind1+Ind2+....Indn)/n

where:
Id – size index
Ind1, Ind2 .... Indn – normalised indicators
n – number of selected indicators.
The final index is calculated according to the following formula:

Ig=(Id1+Id2.....+Idn)/n

where:
Ig – global index;
Id1 ....Idn – size index
n – number of dimensions related to the model.
Each indicator will have equal weights within the dimension, and each dimension has equal weights in the global index. The values of indices of modernization and socio-economic development of the rural area are available for the period 2007-2018, and the values of index of rural household modernization refer to the years 2007, 2013 and 2016, when the Farm Structure Survey was carried out.

RESULTS AND DISCUSSIONS

The rural socio-economic development index

The rural socio-economic development index, in the present research work, aims to capture the rural development phenomenon at county level, as an evolutionary process in the post-accession period. For a most clear picture of rural development in the territory, we considered both the composite index (which made it possible to establish a hierarchy, a typology of counties by their rural development), and the component dimensions to be able to identify the factors that influence the rural development level.
As strange as it may seem, the rural socio-economic development index had a downward trend in the period 2007-2018, which was not expected from the beginning, considering the investments made in the rural area in the post-accession period. The main causes of this phenomenon could be the following:
- development punctuality, focused on road, technical, educational or sanitary infrastructure, targeting certain (agricultural or non-agricultural) businesses, yet without generating social and economic development at community level.
- development selectivity – certain rural communities have benefited from the increase of the rural development level, these being peri-urban communities; some communities (mainly those remote from the urban centers, isolated communities) have experienced devolvement processes (demographic decline, disappearance of social and economic activities, loss of local traditions).
Thus, in terms of development, there are two types of rural communities: the first type includes the favoured communities, specific to the areas in the proximity of cities, suffering from “wild suburbanization” [7] with a spectacular increase, in statistical terms, of the technical and economic development level, yet with the loss of specific rural identity; the second type includes the great majority of rural settlements characterised by demographic, social and economic underdevelopment. There are few examples of communities that have managed to develop economically with minimum cultural, economic and environmental losses.
Depending on the rurality level, the rural socio-economic development index (RDI) is higher as the rurality level decreases: thus, the predominantly urban counties have the highest values (2.04), followed by the intermediate rural counties (1.57) and next by the predominantly rural counties (1.38). The index has a decreasing trend in all these categories.
The variations of the rural socio-economic development index, at macro-regional level, in the period 2007-2018, reveal an increasing trend only in Macro-region 1 (from 1.59 to 1.72); the remaining macro-regions had declining trends, the strongest decline being in Macro-region 3 (from 1.69 to 1.39).
At the level of development regions, the region București-Ilfov ranks first in terms of

the index value (2.04), followed by the region Nord-Vest (1.73), the region Centru (1.71), the region Vest (1.56), the region Nord-Est (1.49); the regions Sud (1.30) and Sud-Est (1.14) rank on the last positions in this hierarchy. At county level, the hierarchy begins with the county Timiş (2.09), Ilfov (2.04), Maramureş (2.03), Suceava (1.94), Braşov (1.93) and ends up with Olt (0.83), Teleorman (0.87), Buzău (0.97).

Table 1. Evolution of the Rural Socio-Economic Development Index - at macro-regional and regional level, in the period 2007-2018

	2007	2010	2013	2016	2018
TOTAL	***1.58***	***1.56***	***1.46***	***1.48***	***1.48***
MACRO-REGION ONE	1.59	1.71	1.60	1.63	1.72
Region NORD-VEST	1.52	1.71	1.57	1.64	1.73
Region CENTRU	1.66	1.70	1.63	1.62	1.71
MACRO-REGION TWO	1.61	1.56	1.45	1.48	1.40
Region NORD-EST	1.71	1.59	1.54	1.51	1.49
Region SUD-EST	1.50	1.54	1.37	1.45	1.31
MACRO-REGION THREE	1.69	1.54	1.43	1.43	1.39
Region SUD-MUNTENIA	1.61	1.47	1.34	1.33	1.30
Region BUCURESTI – ILFOV	2.23	2.02	1.99	2.10	2.04
MACRO-REGION FOUR	1.44	1.40	1.30	1.33	1.32
Region SUD-VEST OLTENIA	1.35	1.21	1.18	1.18	1.14
Region VEST	1.57	1.64	1.46	1.52	1.56

Source: author's own calculations based on NIS tempo online data [9].

As the territorial unit to which we refer gets smaller, there is a higher discrepancy according to the development index: if the gap is 0.40 at macro-region level, it increases to 0.90 at development region level, to reach 1.26 at county level.

The ranking of counties by rural development level reveals the following structure:

-Counties with a good development level: Timiş, Ilfov, Maramureş, Suceava, Braşov, Sibiu;

-Counties with acceptable development level: Bistrița-Năsăud, Cluj, Alba, Mureş, Satu-Mare, Iași, Bihor;

-Counties with medium development level: Harghita, Prahova, Bacău, Arad, Constanța, Vrancea, Dâmbovița, Neamț, Gorj, Călărași, Sălaj, Covasna, Hunedoara, Argeș;

-Counties with low development level: Tulcea, Ialomița, Galați, Brăila, Caraș-Severin; Dolj, Botoșani, Mehedinți, Vaslui;

-Counties with very low development level: Vâlcea, Giurgiu, Buzău, Teleorman, Olt.

Rural socio-economic modernization index

The rural socio-economic modernization index aims to capture the rural modernization phenomenon at county level, as evolutionary process in the post-accession period. Rural modernization is different from rural development, as development is the last stage in the modernization process, which implies deep and long-lasting changes in the technological, economic and ecological field, with implications in the entire social and cultural system.

In the investigated period, the rural socio-economic modernization index had quite a stable trend. When the value of modernization index is analysed, we could say that there was no accentuated dynamics of the modernization process; if the analysis is performed at the level of dimension, indicator, we can notice some important changes. Thus, in terms of the index size, there is a significant depreciation of the demographic and social dimensions, while the economic dimension is maintained constant, and only the ecological dimension significantly increases.

Depending on the degree of rurality, the modernization index had an increasing trend in the predominantly urban areas (from 1.13 in the year 2007 to 1.45 in 2018) following the increase of the attractiveness of these areas for the younger population; there was a slightly downward trend in the intermediate areas (from 1.60 in the year 2007 to 1.56 in 2018) and in the predominantly rural areas (from 1.55 in 2007 to 1.49 in 2018).

Table 2. Evolution of the Rural Socio-Economic Modernization Index - at macro-regional and regional level, in the period 2007-2018

	2007	2010	2013	2016	2018
Total	1.56	1.50	1.42	1.60	1.51
At macro-regional level					
Macro-region 1	1.55	1.53	1.47	1.68	1.62
Macro-region 2	1.60	1.51	1.49	1.54	1.40
Macro-region 3	1.53	1.46	1.31	1.58	1.51
Macro-region 4	1.56	1.47	1.39	1.58	1.54
At regional level					
Region Nord-Vest	1.41	1.40	1.34	1.56	1.48
Region Centru	1.68	1.67	1.60	1.80	1.76
Region Nord-Est	1.50	1.44	1.45	1.53	1.34
Region Sud-Est	1.70	1.59	1.52	1.56	1.46
Region Sud	1.58	1.50	1.35	1.59	1.51
Region București-Ilfov	1.13	1.19	0.96	1.55	1.45
Region Sud-Vest	1.53	1.45	1.31	1.54	1.44
Region Vest	1.61	1.49	1.49	1.63	1.66

Source: author's own calculations based on NIS tempo online data [9].

The variation of the Rural Modernization Index (RMI) at macro-regional level, in the period 2007-2018, reveals a significant decrease in Macro-region 2 (from 1.60 in 2007 to 1.40 in 2018), a slight decrease in Macro-regions 3 (from 1.53 in 2007 to 1.51 in 2018) and 4 (from 1.56 in 2007 to 1.54 in 2018).

By development regions, the hierarchy based on RMI index was the following: region Centru (1.76), region Vest (1.66), region Sud (1.51), region Nord-Vest (1.48), region Sud-Est (1.46), region București-Ilfov (1.45), region Sud-Vest (1.44) and region Nord-Est (1.34).

At county level, the following counties ranked first: Brașov (1.96), Harghita (1.90), Sibiu (1.86), Timiș (1.82) and Cluj (1.81); at the opposite pole, we can find the counties Satu Mare (1.09), Botoșani (1.13), Neamț (1.18), Bacău (1.19), Vaslui (1.31).

The classification of counties by rural modernization level revealed the following structure:

-Counties with a good modernization level (12.20%): Brașov, Harghita, Sibiu, Timiș, Cluj;

-Counties with an acceptable modernization level (14.63%): Ialomița, Bistrița-Năsăud, Hunedoara, Arad, Covasna, Suceava;

-Counties with a medium modernization level (41.46%): Vâlcea, Brăila, Mureș, Iași, Teleorman, Alba, Constanța, Giurgiu, Argeș, Sălaj, Buzău, Bihor, Dâmbovița, Olt, Călărași, Caraș-Severin, Ilfov;

-Counties with a low modernization level (21.95%): Mehedinți, Prahova, Tulcea, Dolj, Galați, Vrancea, Gorj, Maramureș;

-Counties with a very low modernization level (9.76%): Bacău, Neamț, Botoșani, Satu-Mare.

In the investigated period, the gap between the counties with the highest socio-economic modernization level and the lowest modernization level narrowed from 1.37 in 2007 to 0.86 in 2018. The share of counties with acceptable modernization level decreased (from 48.78% to 14.63%); at the same time, the share of counties with low and very low modernization level increased (from 9.76% to 31.71%), the same situation being noticed in the case of counties with medium modernization level (the share of which increased from 31.71% to 41.46%). These modifications reveal a demographic and social restructuring in the rural area: even though there is a narrowing gap between counties, a shift from the top of the ranking to the bottom can be noticed.

The rural household socio-economic modernization index

The modernization of rural households is an important step in supporting rural area viability. The working hypothesis, in this context, is the following: the higher the modernization degree of rural households, the higher the attractiveness of rural areas.

The rural household modernization index (RHMI) has as main research subject the agricultural household farm that largely overlaps the rural household. In the period 2007-2016, RHMI followed a downward trend, which confirms the negative effect of a discontinuous modernization process. According to the degree of rurality, the rural household modernization index had an upward trend only in the predominantly urban areas (from 1.76 in the year 2007 to 1.87 in 2016), with the highest depreciation in the predominantly rural areas (from 1.39 in 2007 to 0.98 in 2018). This process reveals that the Romanian rural area behaves differently depending on the proximity of large cities (see counties județele Timiș, Ilfov, Cluj, Sibiu, Constanța, Brașov), and the rural households in the proximity of cities have an easier access to utilities, education, social services and more attractive jobs.

Table 3. Evolution of rural household socio-economic modernization index, in the period 2007-2016

	2007	2013	2016
Macro-region 1	1.49	1.25	1.15
Macro-region 2	1.28	1.01	0.95
Macro-region 3	1.31	1.05	1.08
Macro-region 4	1.45	1.20	1.06
Region Nord-Vest	1.37	1.19	1.07
Region Centru	1.61	1.31	1.22
Region Nord-Est	1.11	0.85	0.82
Region Sud-Est	1.45	1.17	1.08
Region Sud	1.24	0.96	0.96
Region București-Ilfov	1.76	1.69	1.87
Region Sud-Vest	1.33	1.05	.92
Region Vest	1.60	1.39	1.25
Predominantly urban	1.76	1.69	1.87
Intermediate	1.34	1.17	1.14
Predominantly rural	1.39	1.08	0.98
Total	1.38	1.13	1.06

Source: author's own calculations based on NIS tempo online data [9].

The variation of the rural household modernization index, at macro-regional level, in the period 2007-2018, reveals a downward trend in all macro-regions, the most pronounced decline being noticed in Macro-region 4 (from 1.45 in 2007 to 1.06 in 2018), which led to its downgrading in the macro-regional ranking.

Across regions, the only development region with an upward trend was the region București-Ilfov (+6.25%); the region Sud-Vest lies at the opposite pole, with -30.77%. By the value of rural modernization index, the hierarchy of regions was the following: region București-Ilfov (1.87), region Vest (1.25), region Centru (1.22), region Sud-Est (1.08), region Nord-Vest (1.07), region Sud (0.96), region Sud-Vest (0.92) and region Nord-Est (0.82).

The classification of counties by the level of rural household modernization reveals the following structure:

-Counties with a good level of rural household modernization: Constanța, Brașov, Ilfov;

-Counties with an acceptable level of rural household modernization: Sibiu, Timiș;

-Counties with a medium level of rural household modernization: Sălaj, Teleorman, Bistrița-Năsăud, Covasna, Ialomița, Gorj, Maramureș, Brăila, Arad, Cluj, Tulcea;

-Counties with a low level of rural household modernization: Mehedinți, Prahova, Călărași; Botoșani, Dâmbovița, Iași, Alba, Mureș, Satu Mare, Galați, Hunedoara, Harghita, Dolj; Argeș, Caraș-Severin;

-Counties with a very low level of rural household modernization: Buzău, Bacău, Bihor, Olt, Giurgiu, Vrancea, Vâlcea, Suceava, Vaslui, Neamț.

In the investigated period, the gap between the counties with the highest modernization level of households and the counties with the lowest modernization level of households increased from 1.08 in 2007 to 1.30 in 2016. The share of counties with an acceptable level of rural household modernization decreased from 24.39% to 4.88%; at the same time, the share of counties with a low and very low modernization level of households increased from 43.90% to 60.98%, and in the case of those with medium modernization level from 21.95% to 26.83%. Thus, we can notice an increase in the gap between counties and a translation from the top of the ranking to the bottom, highlighting the increase of disparities between counties in terms of rural household modernization.

The relationship between the rural household modernization and the modernization and socio-economic development of the Romanian rural area

Modernization is a defining process for the rural areas; an ongoing process for rural areas, it succeeded in certain areas, through continuous accumulations to generate the emergence of elements specific to rural development. The gradual transition from modernization to development is slow, and characteristic to certain limited areas. On the other hand, rural modernization entails a beneficial process on the rural household: while at the beginning of the period, in the year 2007, the link was weak, it intensified over time, to reach a significant correlation between the Rural Modernization Index and the Rural Household Modernization Index (+0.364*).

The strongest link is with rural development, the increase of living standard being the main determinant for rural household modernization. The elements of rural development (demographic, social and economic dimensions) had a favourable impact on household modernization; according to the relational analysis, there is a strongly significant correlation between the Rural Development Index and the Rural Household Modernization Index (+0.589**). In other words, there is a direct causal relationship between the modernization – socio-economic development phenomena in the rural area and the rural agricultural household modernization.

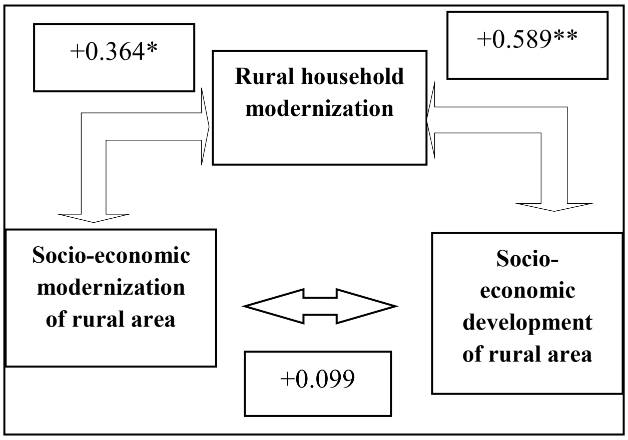

Fig. 1. The causal relationship between the rural household modernization and the modernization and socio-economic development of the Romanian rural area
Source: author's own calculations based on NIS tempo online data [9].

From the endogenous relational analysis (rural development – own dimensions) the following findings emerged: the demographic dimension is the most important in the period 2007-2018, being the main factor in the rural development process. For instance, there are significant direct relationships between rural development and the natural increase of the population (+0.535**). The second factor with significant influence is materialized in the economic activities: from a significant correlation in 2007 (0.396*) to a strongly significant correlation in the period 2007-2018 (0.651** in 2018). The development process focuses on the agricultural activities – significant correlations with the share of animal production (+0.529**), with the number of tractors/100 ha (+0.408**). The social dimension has a decreasing trend in the investigated period, from a strongly significant influence (0.549**) to a low influence (0.216 in 2018). The ecological dimension has an oscillating trend, but the specific element of sustainable development had a significant correlation: the amount of natural fertilizers / 100 ha agricultural land (+0.685**).

To sum up, in the period 2007-2018, rural development was a complex process, depending on demographic factors and phenomena (mainly the natural increase of the population), on farming activities (share of animal production and number of tractors/100 hectares) and on pro-environmental behaviour (use of natural fertilizers/100 hectares).

The endogenous statistical analysis of rural modernization, in the same period, reveals the particular importance of the social trend dimension, with increases of all the incorporated factors, which in their entirety have a significantly strong connection with the modernization phenomenon throughout the period (from a value of Pearson correlation of 0.473** in 2007 to 0.701** in 2018).

The demographic dimension increased significantly in the investigated period, from a weak correlation (0.140 in 2007) to a significant correlation, to reach a value of Pearson correlation of 0.489** in 2018. The ecological dimension had a significant influence throughout the investigated period yet under decline: from 0.529 (2007) to 0.471 at the end of the period. There is a lower importance of the economic dimension on the modernization index in the analysed period.

In conclusion, the rural modernization process depends on social factors/phenomena, followed by demographic and ecological factors. In the analysed period, we can speak about social modernization, in statistical terms, in the first place.

The rural household modernization process was noticeable in demographic terms, specific to the living space, as well as in economic terms. If we analyse the relationships that exist between the **Rural Household Modernization Index** and its dimensions, we can notice that the strongest and relatively constant relationships are with the demographic criterion (+0.601**) and the economic criterion (+0,692**), throughout the analysed period.

The dwelling modernization criterion has also a significantly strong influence on the rural household modernization index, this increasing in the analysed period, from a significant influence in 2007 (+0.371*) to a strongly significant influence (+0.601**).

The relational matrix is characterised by:

- Direct links with the rural household modernization phenomenon: significant relationship with the following indicators: living space per person (+0.419**), share of new dwellings (+0.535**), amount of natural gas supplied to the population (+0.458**), UAA per household farm (+0.553**);
- Significant relationship with indicators: amount of drinking water supplied to the population (+0.389*) and LLU per household farm (+0.319*);
- Indirect (inverse) relationship with the number of household farms (-0,650**);
- Weak relationship with the number of persons who work on the household farm (+0.257), number of days worked / person on the agricultural household farm (+0.298).

CONCLUSIONS

The compound socio-economic indices of household modernization and Romanian rural area socio-economic modernization and development (RDI, RMI, RHMI) had a decreasing trend, in the period 2007-2018; the main factors that influenced the evolution of phenomena were the following:

-increasing gap between rural communities in terms of modernization and socio-economic development of rural area and of rural household modernization in Romania;

-shift of counties in the lower part of the ranking regarding the modernization of the Romanian rural household modernization and rural socio-economic modernization;

-increased appreciation of modernization and socio-economic development, mainly in peri-urban areas

-another cause, yet not tested, is the absence of data at county level on the non-agricultural economy, as the main economic indicators mainly refer on agriculture. Thus, the depreciation of economic indicators is strongly linked to the agricultural activity, yet significant depreciations are noticed in the case of demographic and social indicators.

The peri-urban rural areas have a more diversified economy, with a mixed economy (agriculture, industry and services), and their agriculture is adapted to the demand of sales markets.

The rural household is adapted to its environment, it is not a competitive household, it continues to represent a refuge and a buffer in the face of changes and economic crises. Its basic activity is still agriculture, which generates low and unreliable incomes, but at the same time ensures the survival of rural household on short term.

The evolution of the socio-economic development and modernization of the Romanian rural area over time has not led to rural household consolidation, it has rather led to the perpetuation of the subsistence status in most rural areas of the country. The rural household is at risk of disappearing due to the lack of attractiveness of rural areas, the young population leaves the countryside, preferring to go to town or abroad for a better living, while the elderly people remain in the village, and there are no other young family members to take over the farming activity. Until this demographic decline does not stop, the rural household is at risk of not being able to support the existence of some rural communities.

There is a strong direct link between the modernization process, the rural socio-economic development respectively and the process of rural household modernization, which tends to intensify. The evolution of the importance of dimensions related to the analysed processes (modernization, development of rural areas, rural household modernization respectively) reveals the following situations:

- The rural socio-economic development process largely depends on the demographic, economic and ecological phenomena.
- The rural socio-economic modernization process depends on social and demographic phenomena: the link with the social dimension was strongly significant and growing throughout the investigated period; the link with the demographic dimension had an increasing evolution, from a weak link at the beginning of the investigated period to a strong link at the end of the period; the link with the ecological dimension is strongly significant throughout the period; the link with the economic dimension is losing importance.
- Rural household modernization was materialised at three levels: the link with the demographic and economic dimensions was strongly significant and relatively constant; the link with dwelling modernization also has a strongly significant influence on the rural household modernization index, this increasing in the investigated period, from a strong influence in 2007 to a significantly strong influence in 2018.

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STUDY ABOUT THE MAIN TYPES OF CONFLICTS WHICH APPEAR ON THE RURAL COMMUNITIES IN THE SOUTH MUNTENIA DEVELOPMENT REGION AND THE INFLUENCE OF THE RESIDENTS EDUCATION LEVEL ON THEIR SOLUTION

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Abstract

Among the inhabitants of rural communities in the South-Muntenia Development Region, the occurrence of conflicts is an inherent reality of life... The main purpose of this scientific research is to identify the main types of conflicts faced by the inhabitants of the study area and the causes of their occurrence, as well as to determine the influence of the level of education of the population on conflict management. The following sociological methods were used to collect the working information and research them: questionnaire method, comparative analysis method and Hi-square test method. The research revealed that the most common types of conflicts in the population of the study area are family and work conflicts. Thus, it is revealed that family conflicts, by their degree of complexity due to the strong subjective specificity that characterizes them, do not spare individuals regardless of their level of schooling. Also, in the rural communities of the study area there is a discrete relationship of direct proportionality between the number of the most frequent types of conflicts in which the respondents are involved and their level of education, in the sense that people who have a maximum level of professional education of secondary/vocational level are more likely to become party to a conflict - regardless of its type.

Key words: *conflict, rural community, education*

INTRODUCTION

At the level of the population of rural communities in the South-Muntenia Development Region, similarly to the situation of the populations of other human communities, the emergence and management of conflict relations is an inevitable aspect in the development of everyday social relations [4].

The social, economic or personal relations between the inhabitants of these settlements are not infrequently vitiated by conflicts between different people [1].

The causes of conflicts are many and varied, and they are caused by material shortcomings, differences in the educational level of members of rural communities, a permanent imbalance between the interests and needs of the inhabitants of the areas concerned, pressure from administrative factors, ethnocentric attitudes of members of rural communities, etc. [9].

In essence, these communities are characterized by an important conservative vocation, their life being guided by the need to respect local traditions and customs, to consider and respect the precepts of Christian morality and the need to maintain a community spirit among the inhabitants [8].

A new aspect that influences the life and habits of rural people is the new intensive technologies for growing fruits and vegetables that involve the use of plant protection products that have a high potential for pollution [15]. The use of insecticides can sometimes cause conflicts between neighbors, especially between beekeepers and fruit and vegetable growers [12].

It is precisely these characteristics, which differentiate rural communities from urban ones, that have ensured the continuity of these human communities' existence over time, while they remain sheltered from the influences of multiculturalism, modernism and, more recently, globalism. Instead, these influences have been and are rapidly being assimilated by urban communities [8].

Conflicts, through their destructive capacity, can lead to the alteration of the particularities that distinguish rural communities from other human entities [2].

The most serious effect of increased conflict among rural communities would be to weaken their social cohesion [3]. For example, the conflicts related with land limits, inheritance and succession have a negative effect on the concentration of agricultural land in Romania [11].

In view of the need to protect the characteristics that give uniqueness to rural communities, the study and analysis of the causes of the most common types of disputes and the influence of the level of education of individuals on the way they are managed becomes a topic of interest for researches taking place in these human communities [13].

MATERIALS AND METHODS

In order to achieve the objectives of this study, quantitative and qualitative methods of sociological analysis were used, such as the questionnaire (survey) method, the comparative analysis method, and the identification of measurable frequencies using the Hi-Square Test. [5].

In order to identify the most common types of conflicts in rural communities in the South-Muntenia Development Region and to determine the influence of the level of education of individuals on the way they manage conflicts, it was necessary to conduct a sociological survey on a representative sample of 700 respondents belonging to rural communities in each county of the South-Muntenia Development Region. The questionnaire involved a diverse target audience, made up of farmers, villagers and village intellectuals.

Sociological research aims to identify and analyze the real situation in the territory under analysis [5].

The questionnaire was systematized and constructed in such a way that the data collected through it could provide information that would give an overview of the most common types of conflict among the rural communities under analysis, as well as sufficiently conclusive data on the influence that the level of education of the members of these communities has on the way they manage conflict [10]. An important factor that negatively affects the level of education of the rural population is the depopulation of villages, which leads to the closure of rural schools and the increase in the distance that young people have to travel to school [7].

The sociological research also sought to observe the degree of conflict in the rural communities under study, with respondents being asked about the number and type of conflicts they had, as well as how they were resolved. Thus, the questions outlined in the questionnaire were designed to verify the research hypotheses, so respondents were asked to provide answers on the types of conflicts listed in the survey form, as well as on the level of schooling they had [6].

By interviewing different groups of rural inhabitants in the study area, differences of opinion and choice were crystallized in relation to the different socio-economic categories from which they come. The questions used are constructed to obtain point responses, which were technically used in the comparative analysis, as well as in the application with statistical value, through which measurable frequencies are examined (Hi-square test) [14].

RESULTS AND DISCUSSIONS

Respondents were asked to answer the question *What types of conflicts do you most often face?* With this important indicator of analysis of the study theme, the aim was to identify the main types of conflicts faced by the rural population in the South-Muntenia Development Region. To this end, all 700 respondents were questioned on this topic, and they were given the opportunity to choose one of the five types of conflict pre-defined in the questionnaire. Thus, 324 people indicated that they are most often involved in family conflicts, representing 46% of the total number of respondents; 154 respondents indicated that they are most often involved in labour conflicts, representing 22% of the total number of respondents; 48 respondents opted for administrative and fiscal conflicts, representing 7%, and 14 people indicated that they are most often involved in criminal conflicts, representing a very low percentage of 2%. An important percentage is also represented by those who said that they most often become party to other types of civil disputes, 160 of them, representing 23% of the total number of respondents (Fig. 1).

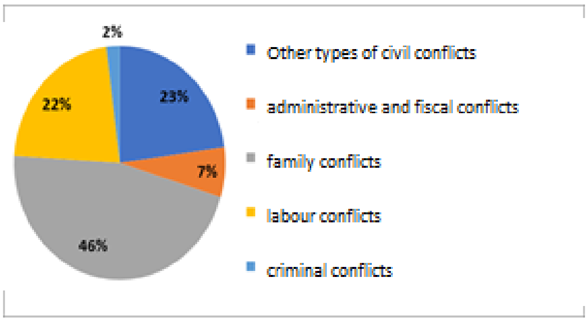

Fig. 1. Situation of the most common types of conflicts in the study area
Source: Own determination.

Comparing the data on the most common types of conflict among rural communities in the South-Muntenia Development Region to the gender of the respondents, it appears that out of the 324 reported family conflicts, 198 are female and 126 male. In other words, 61% of family conflicts are reported by women and only 39% by men. These results are not surprising, as it is well known that women are more sensitive and interested in family relationships. Also, of the 154 cases of labour disputes reported by the questionnaire, 99 belong to male respondents and only 55 to female respondents. Percentage-wise, 64% of the respondents who said that they most often face work conflicts are men and only 36% of those respondents are women. This indicates a greater propensity for males to develop conflictual relationships at work. With regard to administrative and fiscal conflicts, of the 48 such conflicts, 34 were among male respondents (71%) and 14 among female respondents (29%) (Table 1).

This substantial difference in numbers can be explained by the patriarchal nature of the relationship between rural dwellers and the state authorities, with men being the ones most often responsible for taking the necessary steps to ensure that the rights and interests of the family/people are protected in their relations with the public authorities.

Table 1. Ratio of the most common types of conflict to the sex of respondents

Main types of conflicts respondents most often face	Female	Male	Total
other types of civil conflict	53	107	160
administrative and fiscal conflicts	14	34	48
family conflicts	198	126	324
labour disputes	55	99	154
criminal conflicts	14		14
Total	334	366	700

Source: Own calculation.

In terms of the level of education of the respondents who made this sociological research possible, in relation to the total number of 700 individuals, 328 of them are high school/vocational school graduates, representing 47% of those surveyed; 153 individuals are secondary school graduates, representing 22%; 113 respondents are primary school graduates, representing 16%; 93 individuals are university graduates, representing 13%, and 13 individuals are postgraduate graduates, representing only 2% of the total number of respondents (Fig. 2).

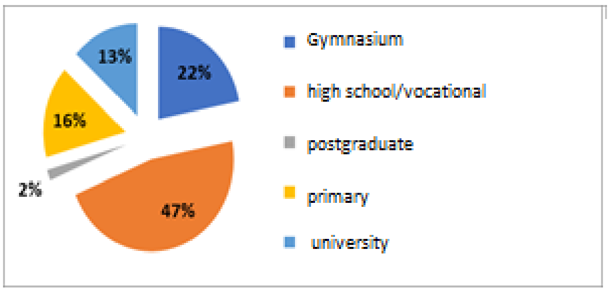

Fig. 2. Ratio of respondents by level of education
Source: Own determination.

In order to be able to obtain data and thus to be able to generate conclusions regarding the existence or non-existence of a link (influence) between the respondents' level of education and the causes of the most common conflicts among the rural communities in the study area, based on the results obtained by questioning the 700 respondents, we will report the number of types of conflicts declared as most common among the respondents at their level of education.

Thus, out of the 324 conflicts in the field of family relations declared as the most common among respondents, 66 conflicts were involving respondents with only primary education, which represents 20% of the number of conflicts in the field of family relations; 73 conflicts involved people with secondary education, which represents 23%; 152 conflicts were developed by high school/vocational school graduates, representing 47%; 26 conflicts involved university graduates, representing 8%; and only 7 conflicts involved postgraduates, representing only 2%.

Of the 154 work conflicts, 7 conflicts were developed by respondents with only primary school education, representing 5% of the number of work conflicts; 25 conflicts involved secondary school graduates, representing 16%; 88 conflicts were developed by respondents with secondary school/vocational school education, representing 57%, and 34 conflicts were developed by respondents with university education, representing 22%.

Of the 48 administrative and tax law conflicts, 14 conflicts involved secondary school graduates, accounting for 29%, and 34 conflicts involved high school/vocational school graduates, accounting for 71%.

Of the 160 other conflicts of a civil nature, 40 conflicts involved respondents with only primary education, representing 25% of the number of conflicts; 41 conflicts involved respondents with only secondary education, representing 25%; 40 conflicts were developed by respondents with a high school/vocational school education, accounting for 25%; 33 conflicts involved respondents with a university education, accounting for 21%, and respondents with a postgraduate education were involved in only 6 conflicts, accounting for only 4% of the total number of other types of civil conflicts (Table 2).

Table 2. Structure of respondents' opinions on the types of conflicts they encountered according to their educational background

What types of conflicts do you face?								
By level of education								
Level of education	U.M.	gymnasium	high school /vocational	postgraduate	primary	univ.	Total	
		No.	No.	No.	No.	No.	No.	%
other types of civil conflict	No.	41	40	6	40	33	**160**	**23**
administrative and fiscal conflicts	No.	14	34				**48**	**7**
family conflicts	No.	73	152	7	66	26	**324**	**46**
labour disputes	No.	25	88		7	34	**154**	**22**
criminal conflicts			14				**14**	**2**
TOTAL	No.	**153**	**328**	**13**	**313**	**93**	**700**	**-**
	%	**22%**	**47%**	**2%**	**16%**	**13%**	**-**	**100**

Source: Own calculation.

By statistically testing the sample structure (Chi-Square = 113.58***; Critical Value = 32.00 at a probability of p>0.01), it is observed that there is a significant association between the aspects analyzed, and from the analysis of R (standardized residual) very significant differences are observed, allowing us to conclude that, in most cases, the types of conflicts in which the respondents were involved are influenced by the level of their studies. We observe that there is an association between the type of conflicts and the respondents' level of education (Pearson's C = 0.37; Cramer's V = 0.23), so that the legal nature of the processes in which the respondents were involved was influenced by their level of education.

Table 3. Structure of respondents' opinions on the types of conflicts they have encountered according to their educational background

Percentage deviations				
gymnasium	**high school /vocational**	**Post-graduate**	**primary**	**Univ.**
17.24%	-46.65%	101.92%	54.87%	55.24%
33.44%	51.17%	-100.00%	-100.00%	-100.00%
3.08%	0.12%	16.33%	26.19%	-39.60%
-25.73%	21.95%	-100.00%	-71.84%	66.18%
-100.00%	113.41%	-100.00%	-100.00%	-100.00%

Source: Own calculation.

Table 4. Structure of respondents' opinions on the types of conflicts they have encountered according to their educational background

Standardized Residue					
Type of conflict	**gymnasium**	**high school /vocational**	**postgraduate**	**primary**	**univ.**
civil	1.02	-4.04	1.76	2.79	2.55
Admin./fiscal	1.08	2.43	-0.94	-2.78	-2.53
family	0.26	0.01	0.40	1.89	-2.60
work	-1.49	1.86	-1.69	-3.58	2.99
criminal	-1.75	2.90	-0.51	-1.50	-1.36
Calculated Chi-Square =	**113.58*** **	**Critical Value (Theoretical) =**	5.81	$p > 0.1$(*) $p > 0.05$(**) **$p > 0.01$(***)**	
			26.30		
Degree of freedom (df) =	16		**32.00**		
Cramer's V =	0.23	Pearson's C =	0.37		

Source: Own calculation.

CONCLUSIONS

From the statistical data highlighted in the previous chapter, the following working conclusions can be drawn:

a)Respondents who have completed university and postgraduate studies are less likely to become party to conflicts of a criminal nature, labour conflicts, as well as administrative and fiscal conflicts (conflicts with various state authorities);

b)family conflicts, by their degree of complexity due to the strong subjective specificity that characterizes them, do not exempt individuals regardless of their level of schooling. In other words, problems of a family nature can occur in any family, irrespective of its members' level of education, even in rural societies - which are still characterized by a strong conservative spirit, which manifests itself at all levels, including family life;

c)however, it is found that in the rural communities of the study area there is a discrete relationship of direct proportionality between the number of the most frequent types of conflict in which respondents are involved and their level of education, in the sense that people who have a maximum level of secondary/vocational education are more likely to become party to a conflict - regardless of its type. One possible reason for this could also be due to the environment in which these people live/work, whose individuals often have only a basic level of school/vocational training or no school education at all.

Interesting to note are also the responses regarding the variant of criminal conflicts, with all 14 of these responses coming from female respondents. This raises the question of the causes that lead female residents of rural communities to experience such conflicts.

However, the level of education of the rural population is not in itself a determining factor in the development of a pacifist or conflictual attitude at the individual level, but it can be a differentiating factor between different categories of populations. Since the needs, rights and interests of individuals are very diverse and of varying importance to people, their fulfilment and protection often transcend the social level conferred by education, sometimes even taking the place of good skills.

The level of education is an indicator that has implications on the quality of life of a community and is particularly important for the social differentiation of its members. The results of the sociological survey conducted in rural communities in the South-Muntenia Development Region reinforce the statistical data known so far on the level of education of the inhabitants of rural communities, which in general provide an overview of the current level of schooling of the inhabitants of these areas.

The data collected and analyzed above are of particular importance for the social perspectives that could be implemented through coherent public policies at the level of the rural communities under research, since the absolute majority of these types of conflicts can also be resolved through alternative dispute resolution procedures, among which the mediation procedure stands out. Thus, family disputes (with the strict exception of divorce/marriage breakdown), labour disputes, most other types of civil disputes, criminal disputes that can be subject to reconciliation of the parties or to the procedure for withdrawal of the preliminary complaint, as well as the settlement of the civil side of all criminal disputes - can be subject to mediation. In addition, some administrative and fiscal disputes may also be subject to mediation. According to the results of the sociological survey presented above, all types of disputes that can be settled by mediation account for at least 90% of the total volume of disputes with which respondents in the study area stated that they are most frequently confronted.

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STUDY ABOUT THE DEGREE OF KNOWLEDGE OF THE MEDIATION PROCEDURE AMONG THE RESIDENTS OF RURAL COMMUNITIES IN THE SOUTH MUNTENIA DEVELOPMENT REGION, ROMANIA

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Abstract

Interhuman relations have experienced many moments of peace, which have favored the emergence of progress, but also moments of unrest, which have led to the emergence of tense phases. It was therefore necessary to develop measures and procedures to bring people to the table for dialogue and cooperation. The mediation procedure is a special feature of the amicable dispute settlement procedures that are alternatives to state justice. Mediation involves processes based on the parties' openness to dialogue, their mutual trust in each other and their willingness to make concessions in order to reach a mutually acceptable and lasting agreement. The main purpose of the present research is to provide a clear view on the current state of implementation of the mediation concept among the inhabitants of rural communities in the South-Muntenia Development Region. The following sociological methods were used to obtain the working information and to research them: questionnaire method, comparative analysis method and Hi-square test method. The sociological research revealed that there is still a low level of knowledge of the mediation procedure among the rural population in the study area. Interestingly, the number of men who know about the mediation procedure is significantly higher than the number of women, but the interest in the procedure is high among those who said they knew and had even used mediation by the time of the research.

Key words*: *mediation, amicable settlement, rural

INTRODUCTION

In the course of time, rural communities have not been spared the vicissitudes of history, not infrequently falling victim to conflagrations. However, their cultural foundation, religious discipline and spirit of community have ensured their continued existence to this day [13].
Even if the rural population in Romania has decreased in recent years, it can be seen that, unfortunately, the number of conflicts has not had the same decreasing trend [12].
Social peace was best cultivated in the consciousness and spirit of the villagers. They have come to understand that peace for themselves and their environment is a precious gift and a guarantee for the continuity of their lives. The level of education and the number of conflicts that appear in the analyzed area negatively influence the socio-economic development potential of the communities in these rural areas [6].

Mediation is a procedure not yet sufficiently settled in the Romanian public consciousness. However, the approach of rural communities to mediation and its role in rural society appears to be attractive to study. As is well known, rural communities are still characterized by a high degree of traditionalism, with religious life and respect for the norms of Christian morality still very much in evidence. Mediation is designed precisely to bring people together, to encourage them to adopt the path of peace rather than that of discord [1].
At European level, mediation is regulated by directives and recommendations, and over the last 20 years the Member States have adapted their national legislation to the Community legislative context. As mediation is not yet regulated by European regulation, the Member States have been free to choose the way in which the mediation procedure is to be legislated for in their national laws. This has led to a variety of situations, ranging from states that have made mediation compulsory

in certain areas to states that have considered that mediation is and should remain a strictly optional procedure [1].

In Romania, mediation is regulated by Law No 192/2006, which has been amended and supplemented many times during its 15 years of existence. At present, the law on mediation is a legal act that can be improved [2].

In domestic law, mediation is recognized as an optional procedure, with the parties to a dispute having the right to use the procedure both before and after a court case is brought [8].

The procedure is conducted by a specifically qualified professional, called a mediator, who has the obligation to help the parties reach a common agreement on the settlement of their dispute in conditions of impartiality and confidentiality [9].

With increased attention from European bodies, mediation is emerging as an alternative to the traditional procedure of settling disputes through the courts, but also as an effective tool within the reach of justice [4].

Mediation involves the initiation of processes based on the parties' openness to dialogue, on the reconfiguration of their mutual trust and on their willingness to make concessions in order to reach a mutually acceptable and sustainable common agreement [11].

Compared to the classic procedure of judicial appeal, the advantages of mediation are clearly in favor of the parties involved in the procedure, the outcome of the mediation process being a win-win for all parties involved in the procedure [10].

As far as the process of assimilation of mediation by the inhabitants of rural communities is concerned, they have to adapt their existence to the demands of the permanent process of modernization of human society, in which the realities of social and economic life are governed by the principles of market economy, competition and the degree of assimilation of the newest and most efficient social and economic measures [7]. Of course, such an improvement should not lead to a perversion of the specificity of rural communities, as this specificity ensures the uniqueness and charm of these communities [6].

MATERIALS AND METHODS

In order to achieve the aim of the scientific research, which was to determine the degree of knowledge of the mediation procedure among rural communities in the reference region, it was necessary to use a series of quantitative and qualitative sociological analysis methods, such as: the sociological questionnaire method, the comparative analysis method, and the identification of measurable frequencies using the Hi-square test [5].

In order to ascertain the degree of knowledge and assimilation of the mediation procedure among the rural population, as well as to identify the level to which the rural communities in the study area have reached regarding the exercise of this alternative procedure to the court, it was necessary to carry out a sociological survey applied on a representative sample of 700 respondents belonging to rural communities in each county of the South-Muntenia Development Region. The questionnaire was designed to target a diverse audience, made up of farmers, villagers and village intellectuals.

Sociological research aims to identify and analyze the real situation in the territory under investigation [3].

The questionnaire was systematized and constructed in such a way that the data collected through it could provide information that would give a clear picture of the level of knowledge of the mediation procedure, as well as of the degree of use of this procedure for the management of conflict situations among members of rural communities in the mountains.

Therefore, the questions included in the questionnaire form aimed at verifying and validating the research hypotheses, so the interviewed villagers were asked to provide answers regarding their level of knowledge on the mediation procedure, including by providing answers on the use or non-use of this procedure up to the time of the survey. By interviewing different groups of rural residents in the study area, differences in opinion and choice were crystallized in relation to the different socio-economic categories from which they come. The questions used are constructed to obtain point responses, which were technically used in the comparative analysis, as well as in the application with statistical value, through which measurable frequencies are examined (Hi-square test) [14].

RESULTS AND DISCUSSIONS

In order to quantify the social impact that the mediation procedure has on rural communities in the South-Muntenia Development Region, we started by identifying the level of knowledge of the mediation procedure among the inhabitants of this geographical area. Thus, the sociological survey aimed to identify and analyze the answers that respondents gave to the question *"How well do you know the conflict mediation procedure?* Respondents were asked to give one of four possible answers: *very well known, known, a little known* and *unknown*.

Thus, of the 700 people interviewed, 33 said that they were very familiar with the mediation procedure, representing only 4% of the total number of people interviewed.

Of the 33 respondents, 20 are women (61%) and 13 are men (39%). A total of 222 respondents said that they were familiar with the mediation procedure, representing 32%; of these, 102 respondents were women (46%) and 120 respondents were men (54%). A total of 313 respondents said that they were not very familiar with the mediation procedure, representing 45% of the total number of respondents.

Of these, 133 respondents are women (42%) and 180 respondents are men (52%). Also, out of the total number of respondents, 132 respondents said that they were not familiar with the mediation procedure, representing 19%. Of these, 79 respondents are female (60%) and 53 respondents are male (40%) (Table 1).

Table 1. Level of knowledge of the mediation procedure by gender of respondents

Level of knowledge of the mediation procedure	**Female**	**Male**	**Total**
well-known	20	13	33
popular	102	120	222
little known	133	180	313
unknown	79	53	132
Total	**334**	**366**	**700**

Source: Own calculation.

With regard to the educational level of the respondents, of the 33 respondents who said that they are very familiar with the mediation procedure, 7 villagers are high school/vocational school graduates, representing 21%, 20 villagers are university graduates, representing 61%, and 6 respondents are also postgraduates, representing 18% of the respondents who said that they have acquired very good knowledge of the mediation procedure. Of the 222 respondents who said they were familiar with the mediation procedure, 14 respondents were primary school graduates only, representing 6%; 26 respondents were secondary school graduates, representing 12%; 135 respondents were high school/vocational school graduates, representing 61%; and 47 respondents were university graduates, representing 21% of those who said they had a good knowledge of the mediation procedure. Of the 313 respondents who said that they were not familiar with the mediation procedure, 40 respondents were primary school graduates, representing 13%; 67 respondents were secondary school graduates, representing 22%; 173 respondents were high school/vocational school graduates, representing 55%; 26 respondents were university graduates, representing 8%; and 7 respondents were postgraduates, representing only 2%. Also, of the 132 respondents who said they had no knowledge of the mediation procedure, 59 respondents were primary school graduates only, representing 45%, 60 respondents were secondary school graduates, representing 45%, and 13 respondents were high school/vocational school graduates, representing 10% (Table 2 and Table 3).

Table 2. Structure of respondents' opinion on knowledge of the mediation procedure according to their educational background

Are you familiar with the mediation procedure?							
According to their level of education							
Level of knowledge	**gymnasium**	**high school /vocational**	**post-graduate**	**primary**	**university**	**Total**	
	No.	No.	No.	No.	No.	No.	%
well-known	0	7	6	0	20	33	5
popular	26	135	0	14	47	222	32
little known	67	173	7	40	26	313	45
unknown	60	13	0	59	0	132	19
Total	153	328	13	313	93	700	-
	22%	47%	2%	16%	13%	-	100%

Source: Own calculation.

Table 3. Structure of respondents' opinion on knowledge of the mediation procedure according to their educational background

Percentage deviations					
	gymnasium	**high school /vocational**	**post-graduate.**	**primary**	**univ.**
well-known	-100.00%	-54.73%	879.02%	-100.00%	356.17%
popular	-46.42%	29.78%	-100.00%	-60.93%	59.35%
little known	-2.07%	17.96%	20.42%	-20.83%	-37.48%
unknown	107.96%	-78.98%	-100.00%	176.88%	-100.00%

Source: Own calculation.

By statistically testing the sample structure (Chi-Square = 339.55***; Critical Value = 26.22 at a probability of p>0.01), it is observed that there is a significant association between the aspects analyzed, and from the analysis of R (standardized residual) very significant differences are observed, allowing us to conclude that, in most cases, the respondents' knowledge of the mediation procedure is influenced by the level of their studies.

Table 4. Structure of respondents' opinion on knowledge of the mediation procedure according to their educational background

Standardized Residue					
	gymnasium	high school /vocational	post-graduate.	primary	univ.
well-known	-2.69	-2.15	6.88	-2.31	7.46
popular	-3.23	3.04	-2.03	-3.65	3.22
little known	-0.17	2.17	0.49	-1.48	-2.42
unknown	5.80	-6.21	-1.57	8.17	-4.19
Calculated Chi-Square =	339.55 ***	Theoretical Critical Value =	3,57		p > 0.1(*)
			21.03		p > 0.05 (**)
Degree of freedom (df) =	12		26,22		p > 0.01 (***)
Cramer's V =	0.29	Pearson's C =	0.57		

Source: Own calculation.

From Table 4, we observe that there is an association between knowledge of the mediation procedure and the respondents' level of education (Pearson's C = 0.57; Cramer's V = 0.29), so that the legal aspects of the mediation procedure that are known by the respondents are influenced by their level of education.

In order to identify the categories of respondents who have the highest propensity to use mediation to resolve conflicts in which they become a party, according to their age group and gender, we will analyze in the following rows the proportion of the number of villagers surveyed who stated whether or not they had been party to a mediation process.

Thus, out of the total number of respondents who helped in the sociological research carried out in the rural communities of the study area, answering the question whether or not they had been part of a conflict mediation procedure, a total of 162 people gave a positive answer, representing 23% of the total number of villagers interviewed, and 538 individuals gave a negative answer, representing 77% of those interviewed. Of the 162 individuals who provided a positive response, a total of 88 individuals are female, representing 54%, and 74 respondents are male, representing 46%. Of the 538 individuals who responded negatively to this question in the questionnaire, 246 were female, representing 46%, and 292 were male, representing 54% (Table 5).

Table 5. Situation according to gender of respondents who were or were not part of a mediation process

Have you been party to a conflict mediation procedure?	Female	Male	Total
Yes	88	74	162
No	246	292	538
Total	334	366	700

Source: Own calculation.

Regarding the age of respondents who have or have not been part of a mediation process, out of the total number of people who provided a positive (yes) answer to the question whether they have been part of a conflict mediation procedure, 27 people are aged between 18 and 29, representing 16% of the respondents who answered *yes* to this question; 74 people are between 30 and 39 years old, representing 46%; 27 people are between 40 and 49 years old, representing 17%, and 34 respondents are in the 50-65 age group, representing 21%.

Of the 538 respondents who gave a negative response to the question, 86 respondents are aged 18-29, representing 16%, 87 respondents are aged 30-39, representing 16%, 148 respondents are aged 40-49, representing 28%, 124 respondents are aged 50-65, representing 23%, and 93 respondents are over 65, representing 17% of the reference base (Table 6).

Table 6. Situation by age of respondents who have or have not been part of a mediation process

Have you been party to a conflict mediation procedure?	18-29 years	30-39 years	40-49 years	50-65 years	over 65	Total
Yes	27	74	27	34	-	162
No	86	87	148	124	93	538
Total	**113**	**161**	**175**	**158**	**93**	**700**

Source: Own calculation.

CONCLUSIONS

The following general conclusions can be drawn from the analysis of the data presented in this research:

a) Even if their number is low, the sociological survey managed to identify respondents who are very familiar with the mediation procedure;

b) The percentage of people in rural communities in the study area who stated that they had no knowledge of the mediation procedure is very low. It is also interesting to note that the number of men who know about the mediation procedure is significantly higher than that of women, possibly due to the fact that this gender category leads in the number of conflicts experienced;

c) The segment of respondents who said they had little knowledge of the mediation procedure is made up of people who had heard about its existence but had not developed an interest in the subject;

d) People with elementary education (primary school/secondary school) and medium education (secondary school/vocational education) show the highest disinterest in the subject of the mediation procedure, this segment of respondents being also the most deprived in terms of information/education level.

e) The proportion of people who stated that they had been party to a conflict mediation procedure compared to the proportion of people who stated that they had had no contact with the mediation procedure is more than 3 times lower, which shows a serious numerical imbalance between people who choose to resolve their disputes through the amicable mediation procedure and people who choose other means of dispute resolution.

f) The number of women involved in mediation processes is slightly higher than that of men. Therefore, we can conclude that these people develop a greater interest in using mediation compared to men;

g) Respondents aged between 30 and 39 develop the greatest appetite for the use of mediation to resolve disputes to which they are a party, their number being considerably higher than the number of respondents belonging to other age groups - in the same response category. A possible argument for this is that these people are perhaps most actively involved in the full course of the social relationships to which they are party (family relationships, work relationships, etc.), and the risk of disputes arising in their case is higher.

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ECONOMIC IMPLICATIONS OF FOOD CONSUMPTION BEHAVIOR CHANGES IN ROMANIA DURING THE COVID-19 PANDEMIC

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Abstract

Besides the sanitary crisis, the COVID-19 pandemic has caused socio-economic downturn globally. Among the affected economic sectors, the agriculture and food sectors were no exception. In the context of on-going market transformations in Romania, the national demand of agri-food products rushed the links involved in the agri-food value chains to adapt to sudden consumption behavioral changes. The objective of this research was to explore food consumption and expenditure changes in Romania in relation with the pandemic and tap into the economic implications. Data used in this research were taken over from the Romanian National Institute of Statistics and were processed in a manner that allowed the average dynamics index to be in the spotlight of this research. Results show market pressure, especially at the beginning of the second quarter of 2020 and a peak of the food expenditure increase in the first quarter of 2021.

Key words: *food consumption patterns, food expenditure dynamics, market transformation, food waste*

INTRODUCTION

Since March 2020 [20], "the COVID-19 pandemic has become a major global concern and challenge for humanity, with direct socio-economic implications, including on the agri-food sector, which has been under additional pressure due to this crisis" [1]. Managing agri-food chains had already been challenging [3], especially if considering the sustainability factor and the transition to the circular economy [9, 10, 15–17]. On top of that, the emergence of the COVID-19 pandemic has caused additional pressure on the global agri-food value chain links and has brought even more significant issues on successfully ensuring food security globally [12, 14, 19].

As far as Romania is concerned, the COVID-19 pandemic has caught the dairy sector in a tight market spot, despite the fact that a trend was noticed, characterized by the preference towards sustainable dairy products, delivered by consumers who value the natural capital and strive to empower the circular economy through their 'green' consumption behavior [6]. Regarding the vegetables chain, during the early stages of the COVID-19 pandemic, consumers changed their purchasing manner using internet for ordering online fresh vegetables achieved by local producers [8]. Regarding bakery products, "a number of 718 Romanians manifested a strong reliance on purchasing cheap white-flour bakery products for their regular diet during the early stages of the COVID-19 pandemic" [13]. Other researchers pointed out that different samples of Romanians proceeded to buy more local and sustainable brands during the early stages of the COVID-19 pandemic [2]. In this case we may discuss about subjective norms and behavioral control which shaped the attitudes to sustainable products belonging sometimes to local brands. Another study [7] shows that the COVID-19 pandemic has brought disruption among Generation Z, with respect to their consumer behavior, especially if considering their eagerness for using digital platforms for purchasing food products online.

The scientific literature is not rich on papers covering the topic of the COVID-19 pandemic's impact on the consumption and expenditure on agri-food products. Some results pointed out price changes in relation with the COVID-19 pandemic [5], as well as changes in relevant indicators or indices like turnover and production price indices [11]. However, the dynamics concerning consumption and expenditure on agri-food products has not been yet explored.

The objective of this research was to analyze froma quantitatively point of view the food consumption and expenditure in Romania in a comparatively manner, using the data specific to the period before the COVID-19 pandemic and in the period marked by the COVID-19 pandemic. The expected results were destined to help decision-makers to better understand market feed-back to food supply chain crises, such as the one caused by the COVID-19 pandemic.

MATERIALS AND METHODS

In this research paper, time series specific to the consumption and expenditure on food in Romania have been accessed and taken over from the TEMPO Online Database of the Romanian National Institute of Statistics [18] and were concatenated in Table 1.

Table 1. The consumption and expenditure on food in Romania before (Quarter #1 2018 – Quarter #1 of 2020) and during the COVID-19 pandemic (Quarter #2 of 2020 – Quarter #1 of 2021), per product, year and quarter

Product	Unit of measure	Year 2018				Year 2019				Year 2020				2021
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Bread and bakery products	RON*	27.88	28.83	28.74	30.63	30.60	32.02	31.90	33.61	33.57	33.66	35.14	36.17	36.10
	kg**	7.792	7.988	8.354	8.046	7.716	7.886	8.179	7.922	7.772	7.394	7.819	7.53	7.203
Milk	RON*	17.16	17.07	16.79	18.51	18.63	17.92	17.93	19.24	19.81	19.13	19.68	21.05	22.25
	litres**	5.55	5.55	5.72	5.70	5.50	5.51	5.50	5.57	4.05	3.68	3.87	3.81	5.465
Cheese and cream	RON*	18.17	21.13	22.07	20.84	20.15	22.34	23.60	22.05	22.81	26.30	27.07	26.51	27.52
	kg**	1.4	1.567	1.628	1.485	1.45	1.545	1.609	1.496	1.485	1.506	1.598	1.521	1.601
Eggs	RON*	5.6	4.93	4.17	4.89	4.88	4.73	4.3	5.03	5.2	5.19	4.88	6.06	5.99
	pieces**	12.12	14.71	14.04	12.88	12.80	14.67	13.95	13.17	13.37	14.49	14.13	13.90	14.007
Fruits	RON*	16.4	16.47	13.65	16.82	16.61	17.06	14.93	18.83	20.5	22.86	18.79	23.66	23.83
	kg**	3.94	3.51	4.30	4.37	4.20	3.54	3.99	4.28	4.335	3.674	4.151	4.73	4.449
Potatoes	RON*	3.19	4.1	3.98	4.47	5.63	6.9	5.27	5.79	6.14	6.43	4.66	4.72	4.64
	kg**	3.04	2.92	3.06	3.05	3.02	2.74	2.89	2.93	2.93	2.69	2.877	2.999	3.042
Fresh meat	RON*	52.52	64.24	61.08	68.12	56.91	68.17	65.37	73.28	67.34	79.01	77.66	88.92	79.87
	kg**	7.005	7.82	10.036	7.547	7.006	7.544	9.793	7.993	6.987	7.418	9.554	8.102	7.547
Chocolate, sweets	RON*	3.59	3.41	3.32	4.87	3.76	3.89	3.33	5.24	4.11	4.08	3.71	5.85	5.2
	kg**	0.197	0.187	0.171	0.231	0.196	0.194	0.167	0.243	0.207	0.198	0.174	0.245	0.224
Alcoholic drinks	RON*	7.74	10.39	11.16	11.57	9.36	11.34	11.80	13.07	10.01	12.44	13.05	13.04	11.84
	litres**	2.341	2.761	2.912	2.668	2.522	2.732	2.731	2.732	2.437	2.677	2.804	2.596	2.516

* Represents the total monthly average per person expenditure, expressed in RON (local currency) for the purchase of food

** Represents the total monthly average consumption of agri-food products, quantities expressed in kilograms (kg), litres (l) and pieces (p)

Source: Authors' data concatenation based on the TEMPO online database (Raw data source: Romanian National Institute of Statistics, 2021).

Average dynamics indices with fixed base were calculated, according to the formula [4]:

$$\text{Average dynamics index} = \sqrt[4]{\prod_{t=2021}^{2016} I_{ijt}/t - 1}$$

where:

I_{ij} = average dynamics index for quarter "i", agri-food product "j";
$I_{ij/t-1}$ = average dynamics index for quarter "i", agri-food product "j", year "t" (2021 or 2020, based on data availability), reported to fixed base year (2016).
The purpose of calculating the average dynamics index per quarter and type of agri-food product was to explore the pandemic's impact of the consumption and expenditure on food in Romania, during various stages of the pandemic (Q2 = pandemic outbreak results).

RESULTS AND DISCUSSIONS

Table 2 was elaborated with two purposes: (a) to identify major food consumption behavior changes and trends during the analyzed period (Q1 of 2016 – Q1 of 2021), while considering different consumption patterns throughout the year (hence, the quarter analysisi); (b) to identify major food expenditure behavior changes and trends. Consequently, the average dynamics index was calculated based on the quarterly relative change results, per agri-food product, considering the year 2016 as the fixed base.
The average dynamics indices corresponding to quarter 1 show that bread & bakery products (2.307) and milk (2.392) were the two types of food that registered the most quarterly abrupt change (above the value of 2) from the perspective of monthly nominal food expenditure. However, the greatest expenditure increase (Q1 2021 reported to Q1 2016) was observed in the case of cheese and cream (97%), from 13.97 RON for 1.275 kilograms to 27.52 RON for 1.601 kilograms (average monthly nominal consumption of cheese and cream in Romania). The average dynamics index corresponding to the quantities of food consumed registered significantly lower scores (below 1) if compared to those of the expenditure. Moreover, the average dynamics indices for bread & bakery products and milk express a trend specific to the consumption reduction, in contrast with the rest of the analyzed food products.

Table 2. Average dynamics index with fixed base (year 2016)

Product	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Expenditure	Quantities	Expenditure	Quantities	Expenditure	Quantities	Expenditure	Quantities
Bread & bakery products	2.307*	0.604**	1.341*	0.979*	1.352*	1.080*	1.297*	0.871*
Milk	2.392*	0.846**	1.706*	1.960**	1.794*	2.282**	1.772*	1.529**
Cheese and cream	1.555*	0.775*	1.469*	1.150*	1.443*	1.112*	1.384*	1.122*
Eggs	1.617*	0.681*	1.380*	1.189*	1.418*	2.521*	1.539*	2.090*
Fruits	1.686*	0.745*	1.485*	1.051*	1.692*	1.472*	1.015*	2.957*
Potatoes	1.445*	0.403*	1.511*	1.280*	1.543*	1.520*	1.465*	1.157*
Fresh meat	1.629*	0.711*	1.528*	2.032**	1.616*	3.528**	1.330*	3.567**
Chocolate, sweets	1.684*	0.769*	4.133*	1.194**	3.607*	2.340**	3.733*	2.072**
Alcoholic drinks	1.732*	0.440*	1.487*	1.194**	1.675*	2.340**	1.489*	2.072**

*Trend: Increase of expenditure / consumption (quantities); ** Trend: Decrease of expenditure / consumption (quantities)
Source: Authors' own computation.

The greatest average dynamics indices resulted in the case of chocolate and sweets, with a peak specific to quarter 2 (4.133), followed by quarter 4 (3.733) and quarter 3 (3.607). This hints at market transformation: Romanian consumers tend to purchase less chocolate and sweets (as supported by the consumption average dynamics indices from quarters 2 – 4), but at a higher price (as supported by the expenditure average dynamics indices. The causes could be multiple: consumers have shifted their preference toward chocolate and sweets of better quality or even produced in a sustainable manner.
Fresh meat registered the most abrupt consumption behavior change in quarter 4 (decrease marked by the average dynamics

index of 3.567). In the same quarter, the fruits category registered the greatest quarterly average dynamics index (increase, 2.957), with the most insignificant expenditure dynamics index tracked (increase, 1.015). The quarterly food expenditure and consumption relative changes (fixed base = year 2016) were graphically represented in Figure 1, per food product and year. Moreover, the intervals corresponding to the expenditure and consumption relative changes were calculated and included in Table 3.

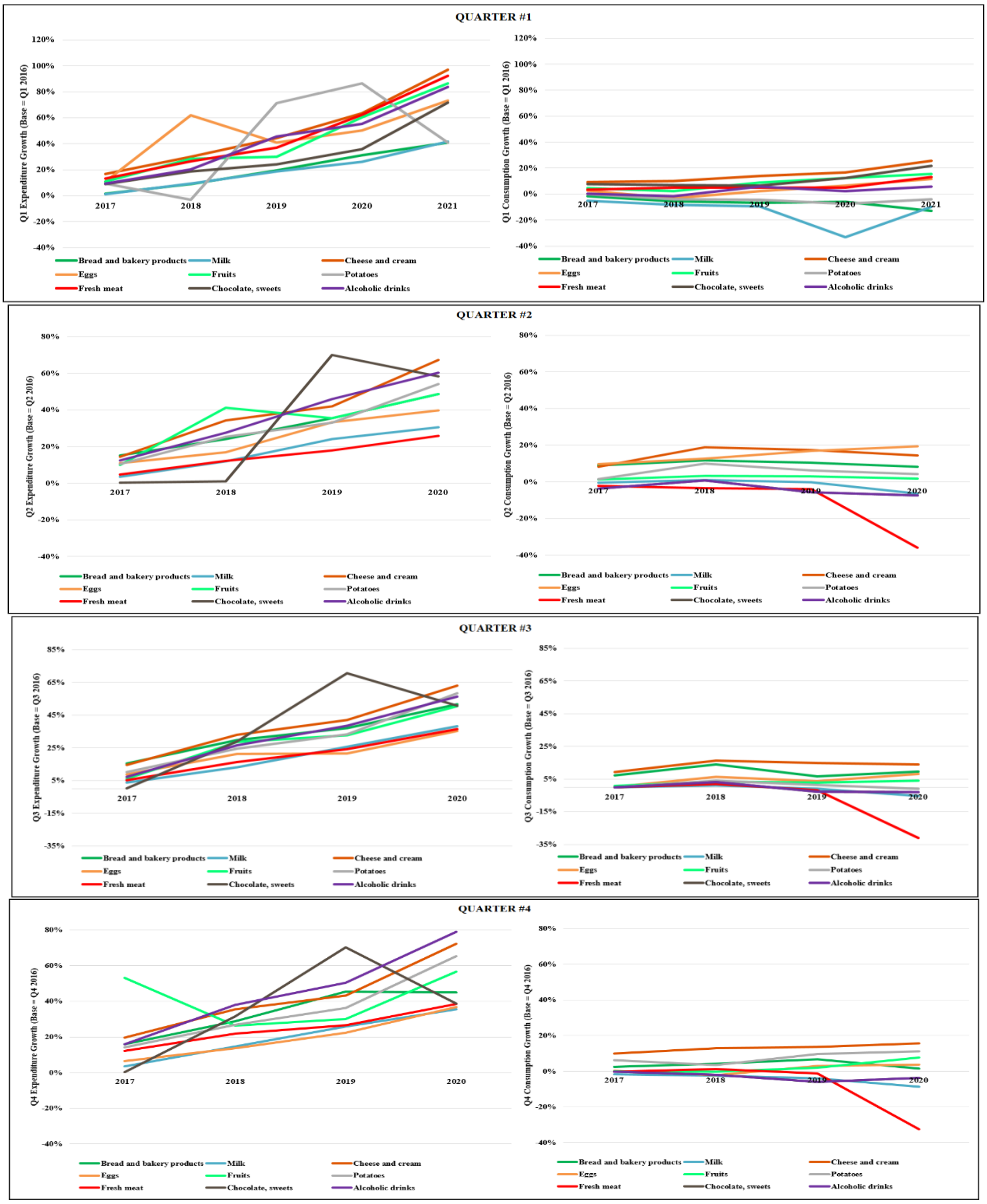

Fig.1. The quarterly food expenditure and consumption relative changes in Romania (fixed base = year 2016)
Source: Authors' own computation and visual representation.

Table 3. The intervals of expenditure and consumption relative changes, per quarter (fixed base = year 2016)

Product	Quarter 1				Quarter 2				Quarter 3				Quarter 4			
	Expenditure		Consumption		Expenditure		Consumption		Expenditure		Consumption		Expenditure		Consumption	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bread and bakery products	1%	41%	-13%	-2%	15%	49%	8%	12%	15%	52%	7%	14%	16%	45%	1%	7%
Milk	1%	42%	-33%	-5%	4%	31%	-7%	1%	4%	38%	-5%	1%	4%	35%	-9%	-2%
Cheese and cream	17%	97%	9%	26%	14%	67%	8%	19%	15%	63%	9%	16%	20%	72%	10%	16%
Eggs	11%	73%	-3%	12%	11%	40%	10%	19%	9%	35%	0%	8%	7%	37%	-2%	4%
Fruits	11%	87%	2%	15%	10%	49%	1%	3%	6%	51%	1%	4%	26%	57%	0%	8%
Potatoes	-3%	87%	-7%	0%	10%	54%	2%	10%	10%	58%	-1%	4%	14%	65%	3%	11%
Fresh meat	13%	92%	3%	13%	5%	26%	-36%	-2%	5%	36%	-31%	2%	12%	39%	-32%	1%
Chocolate, sweets	9%	72%	7%	22%	0%	70%	-7%	1%	0%	71%	-3%	3%	0%	70%	-6%	0%
Alcoholic drinks	9%	84%	-2%	6%	12%	60%	-7%	1%	7%	56%	-3%	3%	16%	79%	-6%	0%

Source: Authors' own calculations.

During the analyzed interval (Q1 2016 – Q1 2021), on average, the monthly nominal expenditure on food increased significantly (69.80% in Q1 2021; fixed base = Q1 2016), while the average food quantities consumed increased only in Q1 2021, not significantly however (7.40% in Q1 2021; decrease of 1% in Q2 2020; decrease of 0.9% in Q3 2020 and another decrease of 1% in Q4 2020; while having the quarters of 2016 as the fixed base). The causes that contributed to the general increase of the average nominal expenditure on food products are multiple: the consumer price index that has reached 115.05% in January 2021 compared to January 2016 [18], a refinement of consumer behavior with respect to the quality of the purchased food products – constantly increasing quality of life determines the occurrence of preferences for premium products, often times produced locally, in an environmentally-friendly manner, products specific to low-carbon foot-prints [17]. Moreover, consumption behavior change has impact on the issue of food waste, a global threat to global sustainability. The culture of consumerism and the low price levels of food act as the mix that can influence consumers to buy too much food, which might not even be needed, only later for consumers to realise and care about the risk of wastage and their contribution to global food wastage. Connecting the analyzed economic results in relation with food waste in Romania represents the premises of future research avenues. Moreover, this quantitative research can be easily replicated and provides the methodological framework for analyzing the impact of a phenomenon on the consumption behavior changes of agri-food products.

CONCLUSIONS

Matching food supply chain with demand and consumer needs delivers continuous market transformation. Under the influence of the COVID-19 pandemic, the Romanian agri-food sector has been under a lot of pressure, especially at the beginning of the second quarter of 2020, with significant market economic effects being felt especially in the first quarter of 2021. In this regard, multiple changes were noticed with respect to food consumption and expenditure in Romania.

Romanian consumers tend to spend more money on food, despite the fact that the consumption (quantity of food) has not changed as dramatically as the expenditure on food did. The most abrupt change was noticed in the case of chocolate and sweets, although the greatest expenditure relative change increase was noticed in the first quarter of 2021 in the case of cheese and cream.

This paper complements the existing literature with an economic perspective on how crises rush market transformations and shape consumer behaviors in various directions.

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PECULARITIES OF THE DEVELOPMENT OF WINERY ENTERPRISES UNDER UNCERTAIN ECONOMIC CONDITIONS IN UKRAINE

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Abstract

Conceptual provisions on the development of wineries in conditions of economic uncertainty are presented, which include: determining the adaptability, balance and effectiveness of the development of wineries; use of integrated assessments of balance as a basis for assessing the effectiveness of enterprises, which allows you to objectively develop directions for choosing a development strategy in accordance with business process indicators. It was proposed a scientific and conceptual approach to the development strategy of wineries in conditions of economic uncertainty, which, in contrast to the current, is based on the results of differentiated assessment of the level of development of wineries for different types of business processes in economic uncertainty and allows a reasonable choice of development strategy and identify a set of relevant strategic alternatives. Thus, for each winery should be defined tactical tasks for managing the development of wineries, based on certain coefficients of difficulty for the development of certain types of business processes of the winery. The integration of wineries development strategies with the strategic priorities of economic development in conditions of instability is presented in the matrix. Based on the presented matrix, it is determined that at the current level for balanced development of wineries development management priorities that meet the development strategy in conditions of economic uncertainty should be: overcoming the limited entry of domestic wine products into the domestic market, increasing international competitiveness and entering world markets; improving the quality of wines and ensuring a clear classification of their types and relevant technical requirements; improving the resource base for winemaking, streamlining the current regulatory framework; optimization of excise taxation; vertical integration of the industry; promoting the differentiation of approaches to regulating the activities of wineries in accordance with their size, insurance of crops and mutual funds, management of the varietal structure of vineyards, etc.

Key words: *wineries, regulation, strategy, development, mechanism, efficiency, economic uncertainty*

INTRODUCTION

Winemaking is one of the leading branches of the Ukrainian food industry. Domestic producers have a long tradition of making quality wine, which is valued not only in the domestic market but also worldwide. In turn the activities of wineries are marked by negative trends that threaten not only its effective functioning, but also opportunities for development. During the analyzed period 2012-2019, the production of wine materials decreased by 52%; production of natural grape wines by as much as 80.5%. In turn the share of own production in the retail trade network decreased (still wines - by 10.7 percentage points; sparkling wines - by 8.7 percentage points); the level of export of grape wines decreased rather quickly than imports; a situation is typical when the size of wine production is significantly reduced, and the level of their consumption is relatively stable, etc. [12]. Identified negative trends are influenced by a combination of factors, the main of which are: reducing the size of the area planted with grapes and increasing their liquefaction; annexation of Crimea, as a result of which the technological potential for growing grapes and a set of enterprises for bottling wine was lost, which significantly reduced the demand for domestic wine products in Odessa and Mykolaiv regions. Inconsistency and insufficient level of quality of wine material; reduction of the purchasing power of the entire population and significant loss of the market in the area of the anti-terrorist operation; imperfection of the instruments of the state policy of development of the enterprises of viticulture and winemaking concerning excessive taxation, disorder of operating permitting and technical requirements, etc. Theoretical, methodological and practical aspects of the development of wineries in conditions of economic uncertainty have found wide representation in the scientific works of domestic economists, among whom are V. Vlasov, I. Belous, V. Kucherenko, O. Garkusha, L. Nekrasova and others. In turn, the threatening trends that have developed today in the activities of wineries, indicate the low effectiveness of the implementation in economic practice of basic research results, which require the implementation of further research. In this context, the purpose of the article is to substantiate the scientific and applied principles of formation and implementation of strategic vectors of development of Ukrainian wineries in conditions of economic uncertainty.

MATERIALS AND METHODS

The study is based on the use of methods of systematic, comparative, retrospective, statistical, factor analysis, expert evaluation, analysis and synthesis. The information base of the study consisted of legal documents of the Ministry of Economic Development, Trade and Agriculture, official statistics from the resources of the State Statistics Service of Ukraine, research results and materials contained in scientific works of domestic and foreign scientists and economists, as well as author's research data.

The main empirical studies were conducted in the south of Ukraine, in such regions as Odessa, Mykolaiv and Kherson regions, where the main industrial viticulture is concentrated.

RESULTS AND DISCUSSIONS

The production of grape wines usually differs from other branches of the alcoholic group of goods (production of vermouth, vodka, cognac and others). Not being a leader in the introduction of modern innovative technologies for production, management and marketing tools, advertising and sales promotion, this segment of alcohol products has always been stable and highly developed in conditions of economic uncertainty. However, domestic wineries are going through a difficult period of their development, which is evidenced by the results of the analysis of indicators of wine production (Tables 1 and 2).

Table 1. The main indicators of development of the wine industry for 2012-2018

Indexes	2012	2013	2014	2015	2016	2017	2018
Area of vineyards, thousand (hectares)	71.0	71.0	67.6	69.0	67.9	67.1	44.2
Yield, (centner per hectare)	50.9	66.0	60.3	75.6	67.2	85.8	98.6
Gross harvest of grapes, (thousand tons)	415.2	468.7	407.9	521.8	456.0	575.4	435.6
Production of wine materials, (thousand decaliters)	26,597.0	31,113.0	30,675.0	25,067.0	23,048.0	28,269.0	15,074.8
Production of grape wines, (thousand decaliters)	21,050.0	23,102.0	29,611.0	17,003.9	12,510.6	11,602.7	6,061.9
Production of sparkling wines (thousand decaliters)	5,792.0	5,760.0	6,025.0	5,446.6	5,464.2	5,222.0	6,258.5

Source: based on official data from the State Statistics Service of Ukraine.

Based on the existence of tendencies to reduce the size of domestic alcohol production and reduce the market of the food industry in general, the dynamics of the wine industry is much contradictory.

It is determined that high-quality wine materials contribute to the production of natural high-quality wines. However, the current state of viticulture and winemaking is critical, as evidenced by the following indicators: the total area of vineyards in Ukraine tends to decrease, national wine producers are in fierce competition with existing foreign competitors significantly reduce supplies in the national market.

However, even in the conditions of destruction of old vineyards, domestic winemakers are working towards the establishment of new ones. In 2018, 527.2 hectares of vineyards were planted in Ukraine: 137.5 hectares in Odessa, 184.2 hectares in Mykolaiv region, 25.3 hectares in Kherson region, and 18.5 hectares in Zaporizhia region [8].

Table 2. Volumes of grape processing and wine materials production in Ukraine for 2012 –2018

Year	The area of vineyards		Crop capacity (Yield)		Gross harvest of grapes		Grape processing		Production of wine materials	
	thousand hectares	rate of change, %	centner per hectare	rate of change, %	thousand tons	rate of change, %	thousand tons	rate of change, %	thousand decaliters	rate of change, %
2012	71.00	-	50.50	-	360.00	-	437.00	-	31,088.00	-
2013	71.00	100.00	50.86	100.71	415.20	115.33	386.00	88.33	26,597.00	85.55
2014	71.00	100.00	66.00	129.77	468.70	112.89	421.00	109.07	31,113.00	116.98
2015	67.60	95.21	60.30	91.36	407.90	87.03	418.00	99.29	30,675.00	98.59
2016	69.00	102.07	75.60	125.37	521.80	127.92	354.00	84.69	25,067.00	81.72
2017	67.90	98.41	67.20	88.89	456.00	87.39	330.00	93.22	23,048.00	91.95
2018	67.10	98.82	85.80	127.68	575.40	126.18	425.00	128.79	28,269.00	122.65

Source: based on official data from the State Statistics Service of Ukraine.

A significant part of the structure of harvesting from vineyards is occupied by Odessa region, where the largest areas of plantations are concentrated - more than 26.3 thousand hectares (60.5% of the total area of vineyards in the country), where in 2018 from the total area of plantations was grown 296.70 thousand tons of grapes (63.5% of the total harvest of Ukrainian grapes).

As the Odessa region occupies a significant share in the structure of harvesting the entire harvest from vineyards in Ukraine, it is also a leader among other regions in the size of processing grapes into appropriate wine materials (Table 3).

Table 3. Dynamics of grape processing into wine materials by regions of Ukraine in 2017-2019

Regions	**Processed grapes, t**			**Growth rate 2017-2019, %**
	2017	**2018**	**2019**	
Ukraine, in total, including:	270,850.2	274,051.9	124,226.6	45.87
in percent	100	100	100	100
Mykolaiv region	82,189.7	98,076.6	20,973.9	25.52
share in total	30.35	35.78	16.88	x
Odessa region	150,994.6	142,944.2	83,452.1	55.27
share in total	55.75	52.16	67.18	x
Kherson region	33,382.0	29,693.6	14,926.5	44.71
share in total	12.32	10.84	12.02	x
Other regions	4,283.9	3,337.5	4,874.1	113.78
share in total	1.58	1.22	3.92	x

Source: based on official data from the State Statistics Service of Ukraine.

The share of Odessa region in grape processing increased from 55.75% in 2017 to 67.2% in 2019, namely by 11.5%. Thus, the structure of grape processing into relevant wine materials in all regions of Ukraine in 2017-2019 has changed significantly: the share of Mykolaiv region has decreased significantly (1.8 times), Kherson region - has not changed (only decreased by 0.3%), while the share of Odessa region makes it the leader

- 67.2%. The share of other regions of Ukraine in the processing of grapes into wine materials has increased almost by 2.5 times - from 1.58% in 2017 to 3.92% in 2019, (2.34%).

On the basis of situational analysis of the factors of adaptability, efficiency, balance and relevant problems of development of wineries identified key areas of its development: gradual balancing in the field of sorting the structure of grapes in accordance with certification requirements for winemaking products and vineyards; increase in sales of domestic wines on the domestic market and for export; increasing the efficiency of viticulture and grape processing technologies; segmentation of the industry by different types of wines, growth in the production of wines with a controlled name, vintage and aged ordinary wines; improvement of technical, tax and administrative regulation of wine enterprises; increasing the level of adaptability of wineries to seasonality and fluctuations in purchasing power to increase the level of balance of enterprise development, etc. [1].

Quite changing transformational management conditions in which wineries operate are primarily the search and justification of strategic directions of their development, which could be provided by the implementation and adaptation of development measures of wineries to exogenous and endogenous factors, as well as features of their operation. Under such circumstances, among the relevant areas is the socio-economic growth of enterprises, making them attractive for investment, allows it to meet the growing demand for wine products, it is one of the key factors in changing the market value of business [2].

This determines the importance of wineries to develop their own strategic models of development, adequate to modern conditions of economic uncertainty and able to provide positive socio-economic dynamics in the long- term strategic perspective.

Taking into account the results of the study, a scientific and conceptual approach to the development strategy of wineries in conditions of economic uncertainty is proposed, which, in contrast, is based on the results of a differentiated assessment of the level of development of wineries in different types of business processes in conditions of economic uncertainty.

It allows to make a reasonable choice of a comprehensive development strategy and identify a set of relevant strategic alternatives [5, 11].

The presented approach allows to define and substantiate the basic (universal or corporate) strategy of development of domestic wineries, which determines the main direction of their development in conditions of economic uncertainty.

The basis for making decision on the choice of an effective strategy is determined at the stage of evaluation of the level of balance of the development process for the relevant types of business processes (sufficiently balanced, insufficiently balanced, balanced and unbalanced development), which corresponds to the gradation of coefficients of balancing the development of domestic enterprises in conditions of economic uncertainty.

To implement the presented alternatives for the choice of strategies for the development of wineries in conditions of economic uncertainty, the author proposes strategic goals for development, which are systematized by the relevant types of business processes and selected areas for their evaluation (Table 4).

Achievements presented in Table 4 strategic goals for development need to be translated into the plane of calculations of certain indicators of development, taking into account the peculiarities of economic activity and the achieved level of balance of development of wineries [6, 7].

Table 4. Strategic development goals of wine industry enterprises grouped by types of business processes

	Type of business processes	Strategic goals
Production and technological business processes	Purchase and supply of champagne wine materials	Rationalization of wine procurement processes and increasing the efficiency of inventory and cost management at different stages of the production process
	Purchase and supply of champagne wine materials Production of champagne wines (actually the process of champagne) Quality control	Implementation of programs to optimize production processes in order to increase the efficiency of economic resources and reduce the loss cycle Reducing the level of material and labor intensity of production Reducing the level of product losses in the production process and increasing the efficiency of losses on raw material processing and production
Financial business processes	Storage in the warehouse of finished products, forwarding and shipment Development of budgets	Improving the efficiency of production capacity, taking into account the factors of bad seasonality and the peculiarities of the production cycle Improving the efficiency of the use of advanced capital and losses
	Organization of balancing resources, results and costs	
	Cash flow management	Optimization of cash flow management taking into account the seasonal nature of business activity
	Formation of a rational financing policy	Increasing the share of stable sources of financing in the capital structure of the enterprise
Marketing business processes	Optimization of the composition and structure of capital and assets Assessment of the level of solvency	Ensuring a balanced policy of borrowing and increasing financial stability Increasing the mobility of assets and reducing their illiquid part
	Storage in the warehouse of finished products, forwarding and shipment Formation and implementation of sales policy	Improving the efficiency of sales policy taking into account the factors of seasonality of "production". "Demand", "losses" and "cash receipts" Improving the efficiency of sales activities
	Organization of advertising and information activities Research of competitors' activity, nature and degree of competition in the industry	Optimization of advertising and information activities and marketing activities taking into account the peaks purchasing activity Development of effective competitive strategies taking into account the peculiarities of competition in the industry
	Research of consumer needs and identification of demand for products	Increasing the level of consumer loyalty to their own brand, taking into account fluctuations in market conditions and living standards

Source: developed by the authors.

Thus, for each winery should be defined tactical tasks for managing the development of wineries, based on certain coefficients of difficulty for the development of certain types of business processes of the winery. Integration of wineries development strategies with strategic priorities of economic development in conditions of instability is presented in the matrix (Table 5). Based on the presented matrix, it is determined that at the current level for balanced development of wineries development management priorities that meet the development strategy in conditions of economic uncertainty should be: overcoming the limited entry of domestic wine products into the domestic market, increasing international competitiveness and entering world markets; improving the quality of wines and ensuring a clear classification of their types and relevant technical requirements; improving the resource base for winemaking, streamlining the current regulatory framework; optimization of excise taxation; vertical integration of the industry; promoting the differentiation of approaches to regulating the activities of wineries in accordance with their size, insurance of crops and mutual funds, management of the varietal structure of vineyards, etc. [3, 4, 6].

Table 5. Matrix of strategies for ensuring the development of Ukrainian wineries in conditions of economic uncertainty

Level	Basic strategy of enterprise development		
	Growth	**Stabilization (limited growth)**	**Abbreviation**
Balanced	**Enterprise strategies** Intensive growth strategies (all varieties); integrated growth strategies (all varieties); diversified growth strategies **Regulatory priorities** Stimulating access to foreign markets; stimulation of organic winemaking; increase in excise tax rates, reduction of infrastructure assistance	-	-
sufficiently balanced	**Enterprise strategies** intensive growth strategies (all varieties); integrated growth strategies (progressive, reintegration); diversified growth strategies (centralized diversification strategy, horizontal diversification strategy) **Regulatory priorities** stimulating access to foreign markets, stimulating the domestic demand; strengthening of technical requirements; stimulation of scientific activity (selection work); stimulating the vertical integration	**Enterprise strategies** intensive growth strategies (market penetration strategies, product development strategies); market protection strategy (support of the achieved level of market penetration); market rationalization strategy (reorganization of strategic zones) **Regulatory priorities** stimulating domestic demand; stimulation of scientific activity; stimulation of insurance and mutual insurance, increase of requirements to quality of wines, promotion in on foreign markets, optimization of varietal structure of viticulture, tax privileges for winegrowers	-
insufficiently balanced	-	**Enterprise strategies** intensive growth strategies (market penetration strategies); market protection strategy (support of the achieved level of market penetration); market rationalization strategy (limitation of presence in unpromising markets) **Regulatory priorities** stimulating domestic demand; promoting the compliance of wine quality with international standards; stimulation of insurance and mutual insurance, optimization of the varietal structure of viticulture, tax benefits for winegrowers for VAT, increase of the special part of the excise tax for reduction of its rate as a whole; stimulating of vertical integration	**Enterprise strategies** market protection strategy (support of the achieved level of market penetration); market rationalization strategy (limitation of presence in unpromising markets); reduction strategies **Regulatory priorities** Public investment in the development of vineyards, tax benefits for growers for VAT; increase of the special part of the excise tax for reduction of its rate as a whole; increase in excise duties on strong alcoholic beverages of non-winy origin, direct grants to enterprises
Unbalanced	-	-	**Enterprise strategies** reduction strategies (strategy of "harvesting", "cutting off excess", cost reduction); liquidation strategies (rehabilitation, sale of the enterprise, bankruptcy) **Regulatory priorities** Nationalization of wine enterprises, stimulation of vertical integration, state monopoly on wine products, state investments in development

Source: developed by the authors.

CONCLUSIONS

The changing transformational conditions of the domestic economy, in which Ukrainian wineries operate, first of all require the search and justification of priority areas of sustainable development, which would be able to ensure the implementation and adaptation of winemaking development goals to changing external and internal environments and specific features of their operation. Thus, considering the above, in the process of forming a model of development of a winery in conditions of economic instability to adhere to the following key provisions: dynamic growth of equity will be balanced, provided that it is proportional to the growth of sales of wine products. [9, 10]. However, it is sometimes difficult to meet such a requirement, because the growth of equity and sales growth are not balanced in the time lag, and therefore the development of wineries may change every year. Therefore, it is necessary to enter into the model the initial sales, the initial amount of paid-in equity, the absolute amount of dividends received or the share of capitalized profits that companies plan to direct to sustainable production development, as well as other additional capital. This will accordingly allow to balance the initial state of operation of the winery with the future growth of key performance indicators; development of a model for the development of wineries should be based on the principle of dynamism, which requires coordination of the pace of improvement of various indicators (sales of wine products, liquidity, solvency, financial stability, turnover, etc.).

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ADAPTATION STRATEGIES TO DROUGHT AMONG SMALLHOLDER FARMERS IN SOUTHERN LEYTE, PHILIPPINES

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Abstract

Small-scale farmers faced numerous risks related to the adverse impact of climate change, particularly prolonged periods of drought. Although farmers use various risk-coping strategies, these are insufficient to prevent them from remaining food insecure. This study aimed to identify the determinants of farmer's adaptation strategies to drought in selected municipalities of Southern Leyte, Philippines. Logistic regression analysis was employed to identify the determinants. The results show that participation in agricultural training, awareness of drought and total farm income have positive and significant relationships with adaptation strategies. The result of the logistic regression implies that when farmers are aware, well-trained and equipped, they are more inclined to employ adaptation strategies to drought. The result also indicates that farmers who have experienced and are knowledgeable about dry spells have more tendencies to adapt and adjust during the actual occurrence of drought. More effort may also be made to older farmers as they are less likely to employ adaptation strategies. In addition, information and training about using drought-tolerant crop varieties is of the feasible options to consider in responding to drought.

Key words: *drought, adaptation strategies, extreme weather events, rural Philippines*

INTRODUCTION

Climate change threatens agriculture production's stability and productivity. In many areas of the world climate change is expected to reduce productivity to even lower levels and make production more erratic [5, 6, 10]. Long-term changes in temperature and precipitation patterns are expected to shift production seasons, pest and disease patterns and modify the set of feasible crops affecting production, prices, incomes, and ultimately, livelihoods and lives [6].

Climate change impacts include increased incidence of floods and droughts, soil degradation, water shortages and possible increases in destructive pests and diseases [6]. The main goal of climate change adaptation is to reduce vulnerability to climate change [2]. Agriculture is one of the sectors greatly affected by climate change and extreme weather events. Agriculture plays a crucial role in economic, social, and cultural activities. Climate change is expected to profoundly modify conditions related to agricultural production [8]. Physical damages, crop loss and drop in productivity are some of the examples of direct and indirect effects of extreme weather events [1]. The capacity to adapt varies considerably among regions, countries, and socioeconomic groups. The most vulnerable regions and communities are highly exposed to hazardous climate change effects and have limited adaptive capacity.

Across the tropics, farmers already face numerous risks to agricultural production. Extreme weather events are expected to disproportionately affect the farmers and make their livelihoods even more precarious [8]. In the Philippines, smallholder farmers with low levels of technology, inadequate information and skills, poor infrastructure, weak institutions, inequitable empowerment and access to resources have limited the capacity to adapt. Farmers in the Philippines are under significant threat from climate change, being situated in a naturally vulnerable location [4, 13, 19]. Farmers are frequently exposed to climate change hazards or extreme weather events like drought, which cause significant crop and income losses and exacerbating food insecurity issues. Few farmers have adjusted their farming strategies in response to climate change, owing to limited resources and capacity.

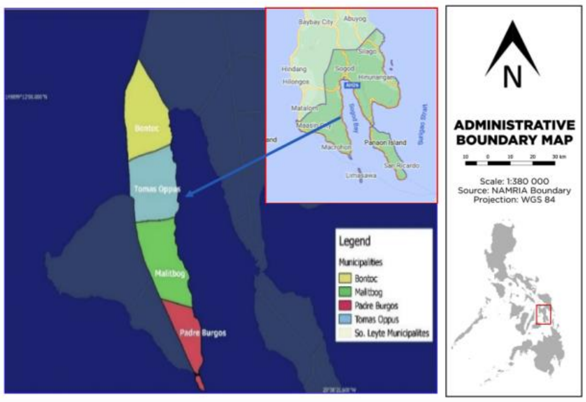
Adaptation and coping practices are necessary to reduce vulnerability to drought stresses and prepare for possible future extreme drought events. The reports of the Intergovernmental Panel on Climate Change (IPCC) define adaptation as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities [9, 10, 11]. Adaptation involves adjustments in reducing the vulnerability of households to climatic variability and change [23]. Smallholder farmers in the Philippines have long been exposed to climate variability. They have been implementing adjustments in farm management practices in response to climatic changes. One of the most commonly used adaptation techniques involves changes in the cropping patterns and cropping calendar, improved farm management, and utilization of climate-resilient crop varieties [7, 17, 18, 21].

Adaptation strategies are important to keep agricultural growth and resiliency. Growth in agriculture can be sustained through technological development [22] and adoption of climate smart practices [18]. In particular, adaptation strategies are needed to cope with the impact of extreme weather events such as drought [16]. Farmers are particularly vulnerable to drought because it could reduce their farm productivity and negatively affect their livelihood [12]. Farmers' adaptation strategies depend on several factors [3, 20, 24]. This study focuses on identifying the farmer's adaptation strategies, particularly to drought and investigate their determinants. Answers to these questions are essential to formulate tailored policy directions and programs that can contribute to farmers' resiliency and capacity to adapt to a changing climate.

MATERIALS AND METHODS

Study Site

The island of Leyte is divided into two provinces, namely, Leyte and Southern Leyte. The study sites are located in the municipalities of Southern Leyte, namely, Bontoc, Tomas Oppus, and Padre Burgos. All municipalities lie along the western side of Sogod Bay (Map 1).



Map 1. Map showing the study sites
Source: [15].

Sampling Procedure and Size of Sample

The sampling procedure used in the study is probabilistic in nature. The following formula was used to determine the sample size obtained using simple random sampling:

$$n_o = (Z^2_{\alpha/2})(\sigma^2)/(e^2) \qquad (1)$$

where n_o refers to the sample size to be determined, $Z_{\alpha/2}$ is the confidence interval, σ^2 is the population variance and e refers to the margin of error.

The study used a 99% confidence interval and 8% margin of error. The established Z-value for the 99% confidence interval is 2.585. Since there was no prior information with regards to the population variance (σ^2), it was estimated using proportion of 0.5. With these assumptions, the sample size (n_o) was determined as follows:

$$n_o = (Z^2_{\alpha/2})(p)(1-p)/(e^2)$$
$$n_o = (2.585^2)(0.5)(0.5)/(0.08^2) = 261$$

However, since the population of the study is finite, it was necessary to adjust the computed sample size. To adjust the computed sample size, the following formula was used:

$$n = n_o /[1+ n_o/N] \qquad (2)$$

where: n is the adjusted sample size, n_o refers to the initial sample size computed using equation 1 and N is the population under study. The population in the study is the total number of farmers for each of the municipality under study. Using equation 2, the estimated sample size for the study area is computed as follows:

$$n = 261 /[1+ 261/4000] = 245$$

Based on the computation, a total of 245 respondents were randomly interviewed for this study.

Data analysis

There are four major factor groups that are hypothesized to affect farmers' decision to adapt to the various adaptation strategies to drought. These include the social, economic, physical and institutional/entitlement factor (Figure 1). The social factors include the individual characteristics of the household, such as household size, gender, age, educational attainment, and marital status. On the other hand, economic factors include income level, cost of production, occupation, social capital such as access to financial and credit assistance in the locality, and off-farm work. The physical factors such as farm area and number of parcels cultivated are also considered as contributing factors. Lastly, institutional factors like knowledge and information, innovation, organization, decision-making and governance were also included.

The logistic regression model was used to identify the factors that significantly affect farmers' adaptation strategies to drought.

The dependent variable indicates whether or not a household has adopted drought adaptation strategies.

A value of one was assigned to households adopting at least one adaptation strategy (adopter) and zero was assigned to households that did not practice adaptation strategies (non-adopter).

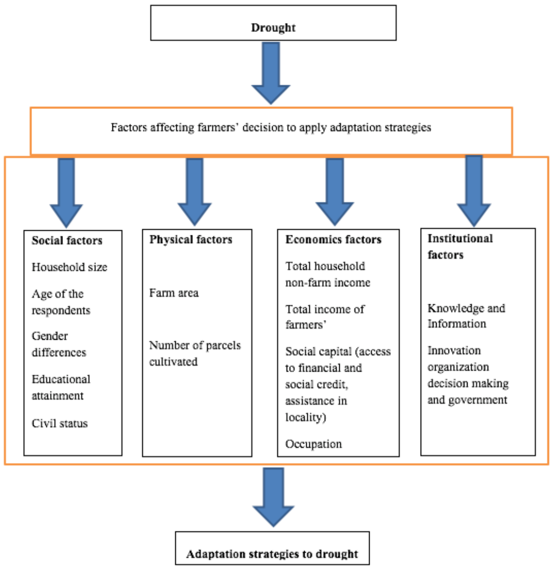


Fig. 1. Schematic diagram showing the factors affecting farmers' adaptation to drought.
Source: [14, 25].

The farmer's decision to adopt or not to adopt any adaptation strategies is influenced by social, physical, economic and institutional factors. The econometric model is postulated as follows:

$$\begin{aligned} drght\_adapt = {} & \beta_0 + \beta_1 age + \beta_2 married + \beta_3 male \\ & + \beta_4 education + \beta_5 frm\_inc + \beta_6 nonfrm\_inc \\ & + \beta_7 hhsize + \beta_8 othr\_occu + \beta_9 ten\_stat \\ & + \beta_{10} acredit + \beta_{11} notif + \beta_{12} farm\_expr \\ & + \beta_{13} crop\_subsidy + \beta_{14} crop\_insrnce \\ & + \beta_{15} totfarm\_area + \beta_{16} drghtaware \\ & + \beta_{17} training + \mu \end{aligned}$$

where:

drght_adapt	=is a dummy variable, assigning a value of 1 for farmers who indicated that they had taken adaptation strategies in response to drought and a value of 0 if otherwise.
age	=age of the respondents
married	=1 for married and 0 otherwise
male	=1 for male and 0 if female
education	=actual years in formal schooling
frm_inc	=total annual farm income of farmers
nonfrm_inc	=total annual income of other occupation
hhsize	=actual number of the household members
othr_occu	=other occupation of the farmer respondents
ten_stat	=dummy variable for tenure status, 1 if owner -operator and 0 if

otherwise

crd_access = dummy variable for access to credit, 1 if with access and 0 if otherwise

notif = dummy variable for notification on drought, 1 if notified, and 0 if otherwise

farm_expr = farming experience (years in farming)

cropsubsidy = dummy variable, 1 if with access to crop subsidy program and 0 if otherwise

cropinsrnce = dummy variable for the crop insurance, 1 if farmers have access and 0 if otherwise

totfarmarea = cultivated farm area (hectare)

drghtaware = dummy variable for awareness to drought, 1 if aware and 0 if otherwise

agri_train = number of agricultural training attended by farmers

μ = the usual remaining error term

RESULTS AND DISCUSSIONS

Distribution of Farmer Respondents by Adaptation Classification

In this study, a farmer is considered an adopter if the farmer employs at least one adaptation or coping strategy to abate the negative effects of drought. The non-adopter refers to farmers who have not taken adaptive measures in response to the negative effect of drought. Table 1 shows the distribution of farmer respondents who employed adaptation strategies to drought in the selected municipalities of Southern Leyte.

Table 1. Distribution of farmer respondents by adaptation classification in Southern Leyte

Municipality	Classification				Total	
	Non-adopter		Adopter			
	n	%	n	%	n	%
Bontoc	84	67.2	41	32.8	125	100
Tomas Oppus	58	66.7	29	33.3	87	100
Padre Burgos	24	72.3	9	27.3	33	100
Total	166	67.8	79	32.2	245	100

Source: Authors' own calculation and analysis (2021).

It can be noted that less than one-third (32.2%) of the total number of farmers interviewed were adopters of drought adaptation strategies while a bigger proportion (67.8%) were not. This proportion can be consistently observed in the three municipalities covered by the study (Table 1).

Socio-Demographic Profile of the Farmer Respondents

The socio-demographic characteristics of the farmers are presented in Table 2. Majority of the adopter and non-adopter farmers were male and married (87.8% and 81.2%, respectively).

Table 2. Socio-demographic characteristic of farmer respondents in Southern Leyte

Socio-Demographic Characteristics	Types of Respondent				Total	
	Adopter		Non- Adopter			
	n	%	n	%	n	%
Gender						
Male	73	92.4	142	85.7	215	87.8
Female	6	7.6	24	14.5	30	12.2
Total	79	100	166	100	245	100
Civil Status						
Married	67	84.8	132	79.5	199	81.2
Single	4	5.1	10	6.0	14	5.7
Widowed	5	6.3	19	11.4	24	9.8
Separated	1	0.6	0	0.0	1	0.4
Cohabitation	3	3.8	4	2.4	7	2.9
Total	79	100	166	100	245	100
Age						
21-40 years old	10	12.7	13	7.8	23	9.4
41- 60 years old	39	49.4	79	47.6	118	48.2
61-80 years old	30	38.0	72	43.4	102	41.6
80 Above	0	0.0	2	1.2	2	0.8
Total	166	100	79	100	245	100
Mean	55.49		57.75		57.02	
Educational Attainment						
No formal schooling	0	0.0	1	0.6	1	0.4
Elementary Level	13	16.5	33	19.9	46	18.8
Elementary Graduate	31	39.2	58	34.9	89	36.3
High school Level	13	16.5	13	7.8	26	10.6
High school Graduate	14	17.7	38	22.9	52	21.2
College Level	2	2.5	14	8.4	16	6.5
College Graduate	6	7.6	9	5.4	15	6.1
Total	79	100	166	100	245	100
Mean	7.57		7.72		7.67	
Household size						
1 to 3	22	27.8	56	33.7	78	31.8
4 to 6	42	53.2	81	48.8	123	50.2
7 to 9	11	13.9	25	15.1	36	14.7
10 to 13	4	5.1	4	2.4	8	3.3
Total	79	100	166	100	245	100
Mean	4.77		4.61		4.66	

Source: Authors' own calculation and analysis (2021).

The average age was about 57 years, with the adopters being slightly younger (55.49 years old) than the non-adopter (57.75 years old). The two farmer groups were similar in terms of number of years spent in school, which was about seven years or high school level. The biggest percentage of adopter and non-adopter farmers (39.2% and 34.9%, respectively) were elementary graduates. The two farmer groups were also similar in terms of average household size (5), with most households having 4- 6 members. Only a few of them (3.3%) have a relatively big household size of 10-13 members.

Farmer and Farm-Related Characteristics

The characteristics of the farm and the farmer respondents in Southern Leyte are presented in Table 3. The tenure status of the farmers shows that there were more tenant farmers (52.2%) than owner-cultivators (47.8%) in the study area. Among the adopter farmers, the proportion of tenants was higher (55.7%) compared to the non-adopter farmers (50.6%).

Table 3. Characteristics of smallholder farms in Southern Leyte, Philippines

Characteristics	Types of Respondents				Total	
	Adopter		Non-Adopter			
	N	%	n	%	n	%
Tenure Status						
Tenant	44	55.7	84	50.6	128	52.2
Owner-Cultivator	35	44.3	82	49.4	117	47.8
Total	79	100	166	100	245	100
Number of year in farming						
1 to 10 Years	30	38.0	36	21.7	66	26.6
11 to 20 Years	11	13.9	36	21.7	47	19.2
21 to 30 Years	12	15.2	27	16.3	39	15.9
31 to 40 Years	12	15.2	30	18.1	42	17.1
41 to 50 Years	10	12.7	22	13.3	32	13.1
51 Years	4	5.1	15	9.0	19	7.9
Total	79	100	166	100	245	100
Mean	22.36		27.57		25.89	
Total area Cultivated (hectares)						
Below 1 hectare	33	41.8	76	45.8	109	44.5
1 to 3 hectares	41	51.9	74	44.6	115	46.9
4 to 6 hectares	4	5.1	12	7.2	16	6.5
6 to 8 hectares	1	1.3	2	1.2	3	1.2
Above 9 hectares	0	0.0	2	1.2	2	0.8
Total	79	100	166	100	245	100
Mean	1.28		1.57		1.47	

Source: Authors' own calculation and analysis (2021).

In terms of years in farming, the adopter farmers appeared to have a longer farming experience of about 28 years compared to the non-adopter farmers with about 22 years. It was observed that many of the adopter farming (38%) had a relatively short farming experience at 1 to 10 years. The average area cultivated by the farmers was less than one and a half hectare (1.47 ha.). Very few farmers owned big farm area. The biggest farm area reported by the adopters was around 6-8 hectares, while for the non-adopters the biggest farm area was reported to be above 9 hectares. The non-adopter farmers had a bigger average farm area of 1.57 hectares compared to the adopters with an average farm area of 1.28 hectares (Table 3).

Adaptation Strategies to Drought

The occurrence of drought is detrimental to agricultural production. Every time drought occurs in Southern Leyte, smallholder farmers are the most vulnerable as since they have very low adaptive capacity. However, they can still minimize agricultural losses through localized adaptation strategies. Among the adaptation strategies reported by many farmers to lessen the negative effects of drought was to plant drought tolerant crops (35%). With this, they require less water than others once they are established. Some farmers (27.2%) also built/bought water impounding facilities (Table 4).

Water impounding facilities or small water impounding is a structure constructed across a narrow depression or valley to hold back water. It develops a reservoir that will store rainfall and run-off during the rainy season for immediate or future use.

Other farmer respondents (14.6%) availed of loan programs as one of their adaptation strategies. A loan program for the farmers provides access to credit and they can have additional resources in their production. A small proportion of farmer respondents (7.8%) availed of small-scale irrigation programs. Irrigation usually on small plots in which farmers have the controlling influence using a level of technology that they can operate and maintain effectively. On the other hand, about 6.8% of the farmer respondents availed themselves of crop insurance for protection against crop losses. For them, it is another adaptation strategy to recover their losses from extreme weather events such as drought. Other adaptation strategies like mulching, participating in training programs, cleaning the planted crops area, hiring a laborer to water the planted crops, buying a water pump, and watering the planted area were also practiced.

Table 4. Adaptation strategies to drought employed by farmer respondents

Adaptation Strategies	n	%
Planted drought tolerant crop	36	35.0
Built/bought water impounding facilities	28	27.2
Availed loan program	15	14.6
Availed small-scale irrigation program	8	7.8
Availed crop insurance	7	6.8
Availed weeding planted area	3	2.9
Mulching	1	1.0
Availed training program	1	1.0
Cleaning the planted crops area	1	1.0
Hired a laborer to water the crops	1	1.0
Bought water pump	1	1.0
Watering the planted	1	1.0

Source: Authors' own calculation and analysis (2021).

Determinants of Farmers' Adaptation Strategies to Drought

In identifying the determinants affecting the adoption of adaptation strategy during drought, logistic regression was employed (Table 5). Logistic regression is used to determine the relationship between the limited dependent or outcome variable and one or more categorical or continuous explanatory variables. The outcome variable is a binary variable with a value of 1 if the farmer is employing adaptation strategy and 0 if not.

Based on the results of the analysis, it was found out that farmers' attendance or participation in agricultural training, awareness of drought, and total farm income has a positive and significant relationship to adaptation. In contrast, total area cultivated and years in farming have a negative and significant relationship to adaptation strategies to drought.

The results imply that farmers who have participated in agricultural training are more likely to employ adaptation strategies than those who have not undergone agricultural training. The result validates the importance of training the farmers in order to improve their farming capabilities. Trainings regarding agriculture ensure that farmers are equipped with the relevant knowledge concerning farming. Those farmers who are aware of drought are more likely to employ adaptation strategies to drought than those who are not aware. This suggests that farmers who are knowledgeable about dry spells can adapt and adjust during the actual occurrence. This is due to the fact that prior knowledge allows the farmers to estimate possible effects and damages; therefore, they know what to do in times of drought.

As with income, the result implies that an increase in income is associated with an increase in the likelihood that farmers have adaptation strategies to drought. With an increase in income, the farmers will have higher adaptive capacity and mitigate the adverse effect of drought on production.

The association between years in farming and adaptation strategy to drought is negative. Farmers are relatively old and are not keen to pursue innovative approaches in farming. In terms of land area, the association with farm size and adaptation is not as expected because the coefficient is negative. This may indicate that farmers with bigger farms were less likely to employ adaptation strategies. Large farms require larger investment to implement adaptive strategies to drought. This maybe one of the reasons why farmers with bigger farm did not employ adaptive strategies.

Table 5. Logistic regression model

Variables	Coefficient	Std. Error
Age	-0.0019	0.0164
Married	0.5268	0.4659
Male	0.8808	0.5728
Education	-0.7969	0.0547
Farm income	0.000015***	0.000005
Non-farm income	0.0000004	0.0000003
Household size	0.3283	0.0826
Other Occupation	0.4383	0.6878
Tenure_ owner	-0.01024	0.3480
Access to credit	-0.2287	0.3711
Notification	-0.2989	0.5133
Years in farming	-0.0310***	0.0118
Crop Subsidy	0.3956	0.3660
Crop Insurance	-0.8560	0.9315
Total farm area	-0.1426*	0.0842
Awareness to drought	2.8047***	0.4816
Agriculture training	0.7970**	0.3659
Constant	-3.9892**	0.1612
Observations	245	

Note: LR $chi^2(17)$ = 81.41; Prob > chi^2 = 0.0000; Pseudo R-square = 0.2643; ***significant at 1%, **significant at 5% , *significant at 10%.

Source: Authors' own calculation and analysis (2021).

CONCLUSIONS

The study aimed to analyze the adaptation strategies of farmers to drought in selected municipalities of Southern Leyte, Philippines. Specifically, it aimed to describe the socio-economic characteristics of the farmers in Southern Leyte; identify the farmer's adaptation strategies to drought; and identify the factors that influence farmer's decision to apply adaptation strategies to drought. Results showed that, among the 245 sample farmer respondents, only 79 farmers, or 32.2%, had employed an adaptation strategy to drought.

Among the adaptation strategies to abate the adverse effects of drought, many farmers (35%) planted drought-tolerant crops. Some farmers (27.2%) also built/bought water impounding facilities. Other farmer respondents (14.6%) availed of loan programs as one of their adaptation strategies. A small proportion of farmer respondents (7.8%) availed of small-scale irrigation programs. Irrigation usually on small plots in which farmers have the controlling influence using a level of technology that they can operate and maintain effectively. Moreover, about 6.8% of the farmer respondents availed themselves of crop insurance for protection against crop losses.

Results show that agricultural training programs provide opportunities for the smallholder farmers to develop their skills and acquire knowledge in dealing with climate change. However, this study found that only a little over half (55.9%) of the farmer respondents were involved in agricultural training programs. They have attended training programs 1 to 5 times. With this, agricultural training programs for the farmers concerning extreme weather events such as drought are essential to improve smallholder farmers' resiliency.

Organizations and local government units (LGUs) may consider disseminating information regarding climate change and its impacts so that farmers will be more aware and minimize the possible losses and impact of extreme weather events, especially drought. More effort may also be made to older farmers as they are less likely to employ adaptation strategies. Farmers will also need to be informed on adaptation strategies that are not too costly, like using drought-tolerant varieties. Results imply that the costs associated with employing adaptation strategies hinder many farmers from employing them.

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RESEARCHES ON THE BEHAVIOR OF JERUSALEM ARTICHOKE VARIETIES GROWN ON SANDY SOILS IN TERMS OF NUTRITIONAL QUALITY OF TUBERS

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Abstract

The aim of this study was to evaluate the quality of Jerusalem artichoke tubers in genotypes grown on sandy soils in Southern Oltenia. The area of sandy soils in southern Oltenia offers favorable conditions for the growth and development of Jerusalem artichoke plants. The average productions obtained for this species in the pedoclimatic conditions from SCDCPN Dăbuleni showed the resistance of the species to the high temperatures in this area. Inulin was present in tubers in a percentage of 12.08 % in the local population of Dăbuleni and 13.39 % in the Dacic variety, with an average of 12.93 % which confirms the functional potential of the species and recommends the species as a "source of fiber".

Key words: *quality, artichoke genotypes, sandy soils, Romania*

INTRODUCTION

The Jerusalem artichoke is a species that belongs to the genus *Helianthus L*., Asteracea family, Asterales category and has the *Helianthus tuberosus L*. scientific name [28].
The Jerusalem artichoke, native to the north of the United States, is a perennial species that can be grown as an annual species. It is a temperate zone to culture it , with a high ecological plasticity, it is cultivated between 40-55 Celsius degrees, from north to south latitude [12]. It grows well in semi-arid tropical areas [18]. Today it is widely grown in France, Norway, Russia, Great Britain, Germany, Spain, Italy, Asia, America or Australia.
For over 300 years, the interest in this species has varied from area to area. Currently, the latest studies highlighted an increased interest in the Jerusalem artichoke culture due to its benefits in human and animal diets and due to its increased potential to be used for biofuel production [23] [25].
The researches made in Romania by [33], led to the hypothesis that the plant is much older in our country, being almost non-existent when researches began on this plant in Romania.
The Jerusalem artichoke tubers are composed of 80 % water, 15 % carbohydrates and 1-2 % protein [10]. Data on its composition are relatively small compared to other species, however, they reveal significant variations between certain parameters. They contain very little or no starch, are virtually fat-free and have a relatively low calorie level [5]. In the small amount of fat found in the tubers, unsaturated fatty acids were identified and no saturated fatty acids were determined [34]. Tubers are a good source of dietary fiber, due to the presence of inulin, which is the main storage carbohydrate [30]. Inulin in tubers ranges from 7 to 30 % by fresh weight and about 50 % by dry weight [31].
The chemical composition of the tubers clearly highlights their nutritional value. The average values recorded show that they have a high dry matter content, over 22 %, protein 1.6 %, fat 0.2 %, cellulose 1.1 %, mineral salts 0.95 %, non-nitrogenous extractive

substances in the form of inulin , sucrose and starch 18.43 %.

Comparing to other plants studied so far, it has been found that inulin in Jerusalem artichoke that has the lowest percentage of glucose and sucrose, thus helping patients with diabetes, contributing to the normalization of blood sugar [32].

The researches undertaken on Jerusalem artichoke highlighted the role of the variety studied together with the other elements of technology: fertilization, density, planting season, and so on.

Due to the rapid growth rate of plants, weed competition is low [29].

The variety is one of the main factors of the technology, the cultivation of a variety must be done only after a prior test regarding its adaptability to natural environmental factors.

Plant pathogens, pests and weeds are one of the most important drivers of the diversity in plant breeding, new crop management and practices, new methods and technologies in agriculture and food research and production [19].

The researches conducted by [36] highlighted a relationship between genotypes and the geographical origin of the Jerusalem artichoke variety. The production of tubers, the number of tubers per plant and the size of tubers in Jerusalem artichoke are influenced by the interaction between genotype and environmental conditions [4].

The higher the size of the tubers, the lower the number of them as proved by the negative correlation between these indicators [21].

The research mentioned by [11] showed the production of fresh tubers that varied from 40 to 100 t/ha. [17] obtained productions between 20 and 60 t/ha for different Jerusalem artichoke clones in the semi-arid region of China. [14] and [1] proved that high temperatures increased the sugar content. In addition, high temperatures registered at some planting dates generally determined a late maturity. Other research results proved that a late harvesting could improve Jerusalem artichoke inulin [2], [27] and a late harvesting prolongs the accumulation of inulin in Jerusalem artichoke tubers and results in a large amount of inulin.

However, the inulin content depends mainly on the used varieties [3],[2]. The differential responses of Jerusalem artichoke varieties to planting seasons for total dry weight, inulin content, also indicated the importance of selection for certain varieties adapted to the most appropriate growing areas that differ in temperature values.

One of the biggest advantages of Jerusalem artichoke culture is its adaptability to different environmental conditions and productive regions [24]. It adapts to an annual amount of annual rainfall from 310 to 2,800 mm [7]. In addition, it can be grown on soils with a pH from 4.4 to 8.6 [15], although its production is favored by slightly alkaline soils, its performance may decrease in heavy soils [6].

The climate changes in Romania require to introduce new species in culture capable of capitalizing on the climatic conditions on sandy soils, one of them being Jerusalem artichoke. In this species it is necessary to identify and use well-adapted varieties to make a faster introduction into production [13] and later in human nutrition. In this sense, in the pedoclimatic conditions at Research Development Station for Plant Culture on Sandy soils Dabuleni in the period 2018 – 2020, research was conducted on the adaptability of some genotypes of Jerusalem artichoke on sandy soils and the determination of the nutritional quality of tubers.

MATERIALS AND METHODS

Between 2018 – 2020, at Research and Development Station for Plant Culture on Sandy Soils (SCDCPN) Dăbuleni were studied four genotypes of Jerusalem artichoke, which were followed by the processes of growth and development of plants and the nutritional quality of tubers at harvest.

The studied varieties were: Dacic, Olimp, Rustic and a local population of Dăbuleni. To determine the quality of Jerusalem artichoke tubers, samples were taken at technological maturity, and the following determinations were performed in the laboratory:

(1) water and total dry matter (TDM) (%) using the gravimetric method;

(2) soluble dry matter (SDM) (%), using the

refractometric method;
(3) C vitamin (mg/100 g f.s.) using the iodometric method;
(4) inulin (%) by means of the gravimetric method;
(5) soluble carbohydrates (%) using Fehling-Soxlet method;
(6) production per variant (kg / ha) - by weighing with DESSIS type balance, with three decimals (error + / - 5 /10 g).

RESULTS AND DISCUSSIONS

The experiment was located on a sandy soil with a nitrogen content between 0.05 – 0.08 %, values that indicate a low state of soil supply in nitrogen. The phosphorus content was between 45 ppm and 62 pmm, so the soil was well supplied with extractable phosphorus, and the values of exchangeable potassium (23 – 29 ppm) indicate a low supply of potassium. The non-uniformity of the soil could be observed from the results obtained from organic carbon (0.19 – 0.50 %). The pH of the soil showed values between 5.34 – 5.56, so a weakly acid reaction.
The results obtained regarding to the nutritional quality of Jerusalem artichoke tubers according to the studied variety are presented in Table 1.
The quality and level of production are the result of the interaction between the stability of the soil nutrition regime, the technological measures applied and the variation of the environmental factors [20].
The studied genotypes accumulated in the tubers a total amount of dry matter between 21.77 % in the Olimp variety and 27.91 % in the local population of Dăbuleni, with an average of 24.46 %. The highest total dry matter content was determined in the local population of Dăbuleni (27.91 %) and in the Dacic variety (25.03 %).
[35] showed that Jerusalem artichoke contains a quantity of dry matter between 19.26 % and 23.21 %, so values similar to those obtained on sandy soils in southern Oltenia. [8] obtained similar data (an average of about 22.0 %). The amount of water from Jerusalem artichoke tubers was between 72.09 % in the local population of Dăbuleni and 78.23 % in the Olimp variety, with an average of 75.54 %.
A higher amount of water in the tubers (82.4 %) was reported by [26]. Using the refractometrical method, the amount of soluble dry matter varied between 20.13 % for the Olimp and 22.93 % for the Dacic variety, meaning 21.68 % in average. Variety Dacic (22.93 %) and the local population (22.70 %) registered higher values than the average value of the other varieties.
The carbohydrate content of Jerusalem artichoke tubers had high values, accounting for 17.10 % for the Olimp variety and 19.47 % for the Dacic variety, with an average of 18.44 %. Also, the Dacian varieties and the local population had a higher carbohydrate content compared to the average of the varieties.
[22] determined in carbohydrate tubers a carbohydrate content of 15 %, and [12], in a study conducted in Canada determined in different groups of varieties a carbohydrate content between 8.2 % and 20.7 %. Inulin is a form of carbohydrate stored in Jerusalem artichoke tubers as opposed to starch which is stored in most tuber crops and in roots [12], [27].
Inulin is a kind of polysaccharide handled in a different way by the body compared to other types of starch. The Inulin has the ability to strengthen the defense mechanisms against infections and to neutralize viruses and bacteria that cause colds and flu in the winter season. Inulin helps the body maintain stable blood sugar and therefore diabetics, people with a predisposition to gain weight or who are struggling with obesity should consume as many foods rich in inulin as possible. The inulin content was between 12.08 % in the local population of Dăbuleni and 13.39 % in the Dacic variety, with an average of 12.93 %. A study conducted in Northern China obtained similar results (14-18%) [16]. The vitamin C content of Jerusalem artichoke tubers accounted for 11.44 mg in the Dacic variety and 14.96 mg in the local population of Dăbuleni, with an average of 13.42 mg. The literature indicates in Jerusalem artichoke an average of vitamin C that contents of 4 mg/100 g fresh substance.

Table 1. Biochemical composition of Jerusalem artichoke tubers depending on the genotype studied in the period 2018-2020

Genotype	Total dry matter (%)	Water (%)	Soluble dry matter (%)	Carbohy drates (%)	Inulin (%)	C vitamin (mg/100g f.s*)	The tubers production (kg/ha)
Dacic	25.03	74.97	22.93	19.47	13.39	10.56	25.20
Olimp	21.77	78.23	20.13	17.10	13.31	11.15	70.77
Rustic	23.12	76.88	20.97	17.83	12.93	13.19	57.16
Local population of Dăbuleni	27.91	72.09	22.70	19.35	12.08	13.49	22.87
Average genotypes	24.46	75.54	21.68	18.44	12.93	12.10	44

f.s* - f.s - fresh substance
Source: Own results.

[9] determined a vitamin C content of 9.7 mg in Jerusalem artichoke tubers under Martinique conditions.
The production of Jerusalem artichoke tubers was between 22.87 t/ha for the local population of Dăbuleni and 70.77 t/ha for the Olimp variety, with an average of 44 t/ha. The highest yields were determined for the Olimp (70.77 t/ha) and Rustic (57.16 t/ha) varieties. According to literature, the yield of the Jerusalem artichoke is highly variable, depending largely on environmental conditions and ranging from 28 to 128 t/ha [15]. The yield of tubers depends not only on climatic conditions, soil type, cultural practices, and harvest period but also on the quality of the plant and especially the choice of cultivars, having high production in fructose, a correct choice of cultivar is the first necessity for the improvement of this crop [12].
Between the amount of total dry matter in the tubers, the carbohydrate content, inulin and vitamin C, polynomial correlations given by second degree equations were established, with significant correlation factors for carbohydrates and insignificant for inulin and vitamin C (Figure 1). The amount of carbohydrates and inulin accumulates in the tubers up to a total dry matter accumulation of 25 %, after which they decrease in percentage, and the amount of vitamin C increases insignificantly, with increasing amount of total dry matter in the tubers.

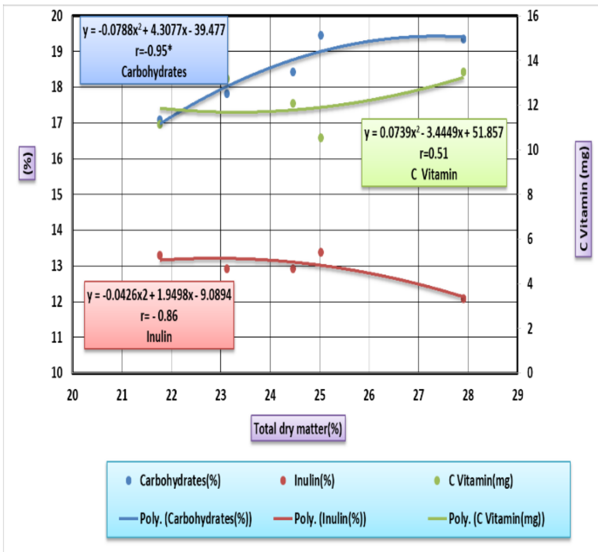

Fig. 1. The correlation between total dry matter in tubers, carbohydrate content, inulin and C vitamin
Source: Own results.

Between the production of tubers and the amount of total dry matter, a polynomial correlation was established given by a second degree equation, with a significant correlation factor (r = 0.92 *) (Figure 2). The total amount of dry matter in the tubers decreases with increasing tuber production. Edaphic factors determined, to a greater extent than genetic factors, the nutritional value of tubers. Assessment of the influence of varietal characteristics, meteorological conditions, and geographic location on the amount of biologically active compounds in Jerusalem artichoke will allow growers and consumers to choose the most suitable cultivars. From a climatic point of view, the three years of study were different.

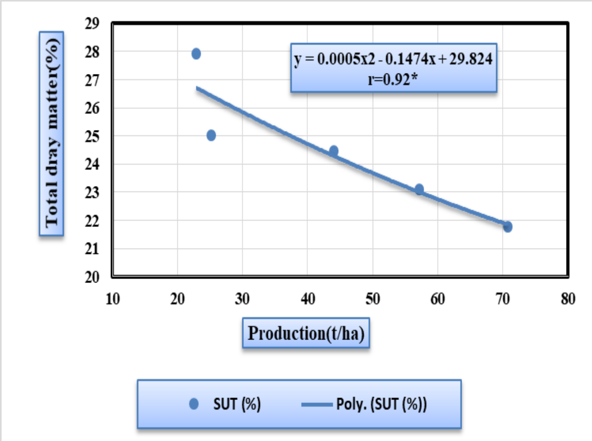

Fig. 2. Correlation between tuber production and total amount of total dry matter in tubers
Source: Own results.

The year 2018 was very warm (20.4 °C average temperature during the vegetation of, Jerusalem artichoke), but also rich in rainfall especially during the period of intense plant growth and tuber initiation (Table 2).

In 2019 and 2020 were warm, but with little precipitation compared to 2018. If in 2019 the amount recorded of precipitation was better represented in the first part of the vegetation period, in 2020 for the entire vegetation period, there were recorded at least 40 mm of precipitation per month.

One of the biggest advantages of Jerusalem artichoke culture is its adaptability to different environmental conditions and productive regions [24].

It adapts to annual rainfall from 310 to 2800 mm [7]. In addition, it can be grown on soils with a pH of 4.4 to 8.6 [15], although its production is favored by slightly alkaline soils, so its performance may decrease in heavy soils [6].

Table 2. The main climatic elements during the vegetation of Jerusalem artichoke (2018 - 2020)

Year/ The climatic element	**2018**	**2019**	**2020**
Average temperature during the vegetation period (^{0}C)	20.4	19.5	19.5
Rainfalls (mm)	518,7	289	276,2
Absolute maximum temperature (^{0}C)	35.7	38.4	37.3

Source: Own results.

The climatic conditions of the three years of study influenced the nutritional quality of Jerusalem artichoke tubers. The results obtained are presented in Table 3. Ensuring moisture in the soil, against the background of high air temperatures (climatic conditions in 2018) led to the accumulation of percentage of total dry matter, soluble dry matter, carbohydrates, inulin and vitamin C in the tubers of Jerusalem artichoke.

Table 3. Biochemical composition of Jerusalem artichoke tubers depending on the year of study

Year/ Quality index	**Total dry matter (%)**	**Soluble dry matter (%)**	**Carbohydrates (%)**	**Inulin (%)**	**C vitamin (mg/100g f.s*)**
2018	24.79	22.95	19.12	13.53	13.42
2019	26.00	22.88	19.64	13.34	11.66
2020	22.58	19.23	16.55	11.92	11.25

f.s- fresh substance
Source: Own results.

In the climatic conditions of 2018, the highest content of inulin (13.53 %) and C vitamin (13.42 mg/100 g f.s) was determined in Jerusalem artichoke tubers. Also, the amount of total dry matter, soluble dry matter and soluble carbohydrates showed higher values in 2018 and 2019. The lowest values of the quality indices were determined in the conditions of 2020, a warm year with lower rainfall during the period of intense accumulation of biochemical components.

The results showed that temperature was important for the production of an increased yield of tubers with a high inulin content during the dry season. According to [3] (Italy), when the plant is fully harvested (vegetative mass and tubers) at preflowering, the best results are obtained both in terms of production and in terms of sugar and inulin yield. In addition to the production of tubers, the inulin content of the tubers is of great importance and they are influenced by the temperatures during the vegetation period. The yield of tubers and the inulin content increase in conditions of high temperatures in temperate areas, while low temperatures have had detrimental effects on growth and inulin content.

CONCLUSIONS

The Jerusalem artichoke is considered to be a species with a relative high tolerance to thermohydric stress and with very high adaptability to unfavourable environmental factors and can be an alternative in the conditions of climate change in Romania.

The area of sandy soils in the southern of Oltenia offers favorurable conditions for the growth and development of Jerusalem artichoke plants. The average productions obtained for this species in the pedoclimatic conditions from RDSPCS Dăbuleni show the resistance of the species to the high temperatures in this area.

The production of Jerusalem artichoke tubers was between 22.87 t/ha for the local population of Dăbuleni and 70.77 t/ha for the Olimp variety, with an average of 44 t/ha. The highest yields were determined for the Olimp (70.77 t/ha) and Rustic (57.16 t/ha) varieties.

The Inulin was presented in tubers in a percentage of 12.08 % in the local population of Dăbuleni and 13.39 % in the Dacic variety, with an average of 12.93 % which confirms the functional potential of the species and recommends the species as a "source of fiber".

The climatic conditions of the three years of study decisively influenced the quality of Jerusalem artichoke tubers, and the lowest values of quality indices were determined in 2020, a warm year with low rainfall during the period of intense accumulation of biochemical components.

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MANAGEMENT OF FERTILIZATION WITH NON-POLLUTING PRODUCTS IN THE CULTURE OF COWPEA (*VIGNA UNGUICULATA* L. WALP) IN THE SANDY SOILS CONDITIONS

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Abstract

*The researches were carried out in the period 2020-2021 on the cowpea crop, located in irrigated conditions, on a sandy soil with low natural fertility, in the southern area of Oltenia, and aimed at reducing the effects of abiotic stress and increasing production, through management fertilizing the crop with environmentally friendly products. Five variants of foliar fertilization were experimented (non-fertilized foliar, Basfoliar 36 Extra, in a dose of 3 l / ha; Maturevo 3.35.35 + ME, in a dose of 3 kg/ha; liquid Biohumussol in a concentration of 1 %; Polyactiv Mn, at a dose of 1.5 l/ha), on two agrofunds of root fertilization (N30P30K30; N60P60K60). The obtained results showed that ensuring a rational fertilization of cowpea, in relation to the requirements of the plant and the state of soil fertility can regulate the mechanisms of plant protection against stressors on sandy soils. The foliar fertilization with environmentally friendly products has positively influenced the percentage of dry matter, bound water and the concentration of vacuolar juice in cowpea leaves, increasing the plant's resistance to thermohydric stress. Through the foliar fertilization of the cowpea crop, there were increases of production between 30-47.5%, on the agrofound of N30P30K30 and of 15.8-22.1% on the agrofund of N60P60K60. The cowpea registered a maximum production (2,983.4 kg/ha), at the fertilization with Maturevo 3.35.35 + ME, in a dose of 3 kg/ha, on the agrofund of N60P60K60, with the significant difference (p>0.05), compared to unfertilized foliar. There was a positive correlation, distinctly significant, between between the leaf area index and cowpea grain production (r = 0.882 **).*

Key words: *thermohydric stress, physiological indices, leaf area, biometrics, productivity*

INTRODUCTION

Originally from Central Africa, the cowpea (*Vigna unguiculata* L. Walp) is a leguminous plant that, due to its special biological and morphological peculiarities (very strong root system, with a high absorption power, waxy layer on the leaves), can make very good use of the sandy soils from Romania and has a high tolerance to thermohydric stress conditions [6], [25]. Stomatous closure is the common strategy used by different cowpea genotypes to avoid dehydration of the foliar apparatus, and the genotypic variance in stomatal conductance increases considerably in drought conditions [1], [11]. Having the possibility of biological fixation of atmospheric nitrogen, with the help of symbiotic bacteria of the genus Rhizobium), cowpea are successfully grown in crops in areas with sandy soils [10], [16], [23]. The process of biological nitrogen fixation has great significance, given the prospect of population growth, which requires increased production of cereals and legumes, which are achieved with very large amounts of chemical fertilizers with nitrogen [12] [2]. Due to the low organic matter content of sandy soils in Romania, which is closely dependent on the amount of organic residues and the activity of soil organisms, for the success of most crops, large amounts of chemical fertilizers are needed, which can often lead to groundwater pollution with nitrates taking into account the deficient hydro-physical properties in terms of chemical retention [5], [19]. From the point of view of ensuring the nutrients necessary for the nutrition of cowpea plants, sands and sandy soils are characterized by low natural fertility, determined by the low content of organic matter and fertilizing elements. Often on these lands there is a lack of microelements, especially zinc and magnesium [3], [8], [20]. Research results have shown that when a single nutrient is deficient in the plant, or one of the technological factors is not optimally ensured, the yields obtained on sandy soils can be significantly reduced [14], [4], [18]. In intensive agriculture, which requires high yields, in order to maintain the health of the soil, the yields obtained and finally the consumer, the importance of using inputs (pesticides, fertilizers) is undeniable [17]. In this sense, research has been initiated on the cowpea crop, which aimed to reduce the effects of abiotic stress and increase production, by managing the fertilization of the crop with environmentally friendly products.

MATERIALS AND METHODS

The researches were carried out in the period 2020-2021 on the cowpea crop located in irrigation conditions, on a sandy soil with low natural fertility in the southern area of Oltenia. Organic carbon showed values in the range of 0.20% - 0.63%, indicating a reduced state of soil supply of organic matter, and soil pH ranged between 4.53 and 6.08, values that show a reaction moderately acidic to slightly acidic.

The experiment was placed in field conditions, according to the method of plots subdivided with 2 factors:

Factor A - Root fertilization;

a_1- 1/2 of the technological dose of nitrogen, phosphorus and potassium, respectively: N30P30K30

a_2 - technological dose of nitrogen, phosphorus and potassium, respectively: N60P60K60.

Factor B - Foliar fertilization:

b_1 - unfertilized foliar

b_2 - Basfoliar 36 Extra, in a dose of 3 l/ha

b_3 - Maturevo 3.35.35 + ME, in a dose of 3 kg/ha

b_4 - Liquid Biohumussol, in a concentration of 1%

b_5 - Polyactiv Mn, at a dose of 1.5 l/ha

Fertilization with N30P30K30 (a_1) was performed in the preparation of the germination bed, and the dose of N60P60K60 (a_2) was applied in two fractions (1/2 in the preparation of the germination bed and ½ in the phase of 4-5 true leaves). Foliar fertilization was carried out in the phase of 6-8 leaves of the plant, by applying doses of foliar fertilizers, calculated for 250-300 l water/ha (Photo 1). During the vegetation period, determinations of physiology, biometrics were made (Photo 2, Photo 3) and grain production was determined at harvest.

Physiological determinations of water forms and dry matter in the leaves were performed gravimetrically by oven drying. The leaf area was determined in the laboratory using the Area Metter AM 300 device. The vacuolar juice concentration was read with a Pocket Refractometer. The results obtained from cowpea were calculated and analyzed by the method of analysis of variance (ANOVA) and using mathematical functions.

RESULTS AND DISCUSSIONS

The impact of fertilization on some physiological aspects of the cowpea plant

The results on the influence of fertilization on physiological indices in beans highlighted the fact that, in addition to the direct influence of environmental factors, special importance should be given to the type and dose of fertilizers used in the crop. Table 1 shows the results obtained in the period 2020-2021 in terms of dry matter, bound water content and vacuolar juice concentration in the leaves. The dry matter registered values between 13.4% for the variant fertilized with N30P30K30, foliar non-fertilized and 16.5%, for root fertilization with N60P60K60 + foliar fertilization with the product Maturevo 3.35.35 + ME, in a dose of 3 kg/ha, in the phase of 6-8 leaves of the plant. Ensuring a rational fertilization of cowpea, in relation to the requirements of the plant and the state of soil fertility, can regulate the mechanisms of plant protection against stressors on sandy soils. Thus, it was noticed the increase of the percentage of bound water from 2.4-2.9%, values registered in foliar non-fertilized variants, to 3.2-3.6%, by foliar fertilization with Maturevo 3.35.35 + ME, in a dose of 3 kg / ha, in the phase of 6-8 leaves of the plant. The concentration of vacuolar juice was differentiated depending on the root and foliar fertilization, registering values in the range of 7.7-9.9%.

Photo 1. Application of foliar fertilization with Vermorel
Source: Original.

Table 1. Value of physiological indices in cowpea according to fertilization

The experimental variant		Dry matter (%)	Bound water (%)	Vacuolar juice concentration (%)
Root fertilization (agrofond)	Foliar fertilization			
N30P30K30	Unfertilized foliar	13.4	2.4	7.7
	Basfoliar 36 Extra	15.5	2.9	8.3
	Maturevo 3.35.35 + ME	16.1	3.2	9.3
	Biohumussol Liquid	16.1	2.9	8.7
	Polyactiv Mn	15.9	3.0	8.3
Average		15,4	2.9	8.4
N60P60K60	Unfertilized foliar	15.2	2.9	8.1
	Basfoliar 36 Extra	15.6	3.5	9.6
	Maturevo 3.35.35 + ME	16.4	3.6	9.9
	Biohumussol Liquid	16.2	3.6	9.6
	Polyactiv Mn	16.4	3.1	9,5
Average		16	3.3	9.3

Source: Own research.

Foliar fertilization with Maturevo 3.35.35 + ME, at a dose of 3 kg/ha increased the stress resistance of the cowpea, by recording the highest values of physiological indices in the flowering phase of the plant, namely dry matter, bound water and juice concentration vacuolar (Figure 1). Compared to unfertilized foliar fertilizer, Maturevo 3.35.35 + ME increased the dry matter by 13.6%, the bound water by 28.3% and the vacuolar juice concentration by 21.5%. In addition to the plant's nutrient regime, the variety is an essential factor in the stress behavior of cowpea. Research in South Africa has highlighted the stress resistance of cowpea and their ability to rehydrate, depending on the variety [13], [21]. The results show that a tolerant variety can recover all photosynthetic parameters after 60 hours of rehydration, being able to maintain a higher photochemical activity and a gas exchange of leaves during water deficit for a longer period compared to a sensitive variety.

The impact of fertilization on some morphological properties of the cowpea plant

The results presented in Table 2 highlight the role of fertilization on the growth and development of cowpea plants, in sandy soil conditions, characterized by low macro and microelement content**.** Thus, the nutrition of the plant with N60P60K60 led to a better development of the plants and to the increase of the number of pods with 2 pods / plant, compared to the application of ½ from the dose of NPK. Also, the foliar fertilization was highlighted, on the two agrofunds of NPK. When fertilizing the cowpea crop with 1/2 of the technological dose, respectively N30P30K30, the plants reacted by intensifying the fruiting process of the plant to the foliar fertilization with Maturevo 3.35.35 + ME, applied in a dose of 3 kg/ha. Maximum results were observed on the agrofund N60P60K60, for foliar fertilization with Maturevo 3.35.35 + ME, applied in a dose of 3 kg/ha and with Biohumussol Liquid, in a concentration of 1%. In these variants, the bean yielded 17 pods / plant with a number of 11-12 seeds in the pod, registering high values of the foliar index (8-8.5). Research conducted in Brazil has highlighted the major role of phosphorus fertilization and irrigation on cowpea pod formation [24].

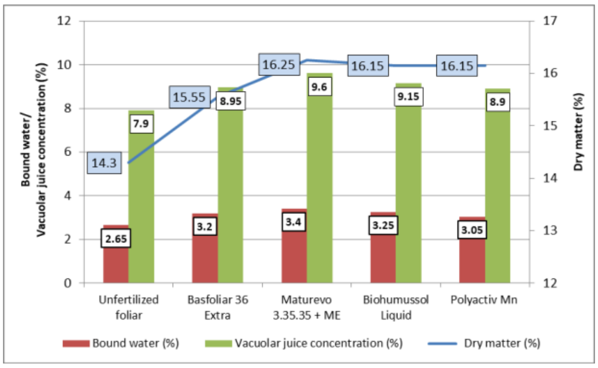

Fig. 1. The influence of foliar fertilization on some physiological indices in cowpea
Source: Own research.

Photo 2. Observations in the experimental field with cowpea
Source: Original.

Table 2. Value of biometric and productivity traits in cowpea in different fertilization variants

The experimental variant		Plant height (cm)	Nr. pods/ plant	Nr. grains/ pods	pod length (cm)	Leaf area index (LAI)
Root fertilization (agrofond)	Foliar fertilization					
N30P30K30	Unfertilized foliar	83.7	9	8	11.6	5.9
	Basfoliar 36 Extra	90.7	13	10	13.2	6.5
	Maturevo 3.35.35 + ME	92.0	15	11	14.0	6.9
	Biohumussol Liquid	89.5	12	10	13.2	6.4
	Polyactiv Mn	89.5	14	10	12.3	6.2
Average		89.08	13	10	12.86	6.38
N60P60K60	Unfertilized foliar	89.1	12	10	12.9	6.4
	Basfoliar 36 Extra	87.3	13	10	13.5	6.8
	Maturevo 3.35.35 + ME	96.3	17	11	14.1	8.5
	Biohumussol Liquid	93.5	17	12	14.2	8.0
	Polyactiv Mn	94.0	16	12	12.5	7.4
Average		92.04	15	11	13.44	7.42

Source: Own research.

The impact of fertilization on cowpea production results

Leguminous plant that symbiotically synthesizes 80.6% of the nitrogen needed for nutrition, cowpea need this element, at the beginning of vegetation until the installation of microbial activity in the soil in order to carry out the normal metabolism of the plant [15], [7], [9]. The results obtained when fertilizing the cowpea crop with N60P60K60 and presented in Table 3, showed an increase in grain production by 453.8 kg/ha, compared to the use of the dose of N30P30K30, an increase that is within the limits of the experimental error ($p < 0.05$).

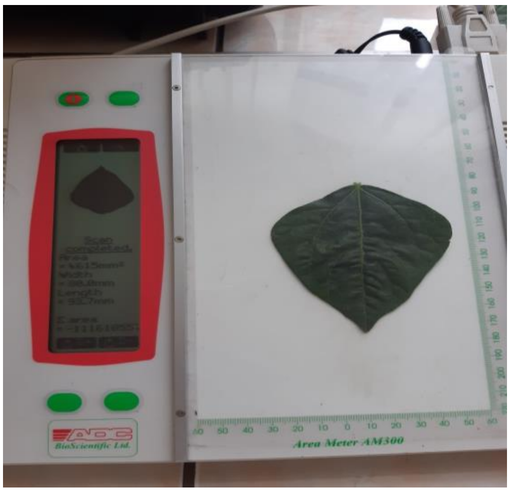

Photo 3. Measured the area of a cowpea leaf with the Area Metter AM 300
Source: Original.

Table 3. Significance of cowpea production obtained from basic NPK fertilization

Root fertilization	Grain yield		The difference compared to the control kg/ha	Significance
	kg/ha	%		
N30P30K30	2,343.4	100.0	Control	Control
N60P60K60	2,797.3	119.4	453.8	-

LSD 5%=565.2
LSD 1%=1,305.3
LSD 0.1%=4,153.8

Source: Own research.

The analysis of the influence of foliar fertilization on cowpea production, compared to the non-fertilized foliar variant, shows a distinctly significant differentiation of grain production ($p > 0.01$), obtained by fertilizing the crop in the 6-8 leaf phase, with one of Basfoliar 36 Extra products, at a dose of 3 l/ ha, or Maturevo 3.35.35 + ME, at a dose of 3 kg/ha, variants in which 2,746.2-2,782.3 kg/ha were registered (Table 4).
The effect of the application of the product Basfoliar 36 Extra is due, in particular, to the high content of magnesium and trace elements that are chelated by biodegradable compounds, being very quickly absorbed by the leaves and do not turn into compounds inaccessible to plants.

Table 4. Significance of cowpea production obtained in terms of foliar fertilization

Foliar fertilization	Grain yield		The difference compared to the control kg/ha	Significance
	kg/ha	%		
Unfertilized foliar	2,126.6	100	Control	Control
Basfoliar 36 Extra	2,782.3	130.8	655.7	**
Maturevo 3.35.35 + ME	2,746.2	129.1	619.6	**
Biohumussol Liquid	2,604.6	122.5	478.0	*
Polyactiv Mn	2,592.0	121.9	465.4	*

LSD 5%=360.27
LSD 1%=496.22
LSD 0.1%=683.15

Source: Own research.

Also, the very high content of microelements of the product Maturevo 3.35.35 + ME, especially magnesium, as the main component of chlorophyll, ensured the maintenance of the foliar apparatus for a longer period of time and therefore a prolonged development of the process of photosynthesis. Fertilization with the product Maturevo 3.35.35 + ME acts on the metabolism of the cowpea plant, increasing the selective absorption from the soil of nutrients, especially phosphorus and potassium, which play an essential role in fruiting and increase resistance to stress.
Due to the low content of humus and microelements of sandy soils, in the crops located on these lands, there are often disorders of metabolism in the plant [5]. Research in Spain has highlighted the positive response of the cowpea plant to mineral and organic fertilization, as the differences between the two methods are not significant, so that fertilization with organic products can be successfully applied to this crop [22]. The results on the influence of foliar fertilization on grain production, obtained from cowpea, highlight statistically assured differences depending on root fertilization (Table 5). Thus, by foliar fertilization with one of the four tested products, production increases between 30-47.5% were obtained, on the N30P30K30 agrofund and by 15.8-22.1% on the N60P60K60 agrofund. The maximum production, of 2,983.4 kg / ha, was achieved at the fertilization with Maturevo 3.35.35 + ME, in a dose of 3 kg / ha, on the agrofund of N60P60K60, the difference of production compared to non-fertilized foliar being significant ($p > 0.05$).

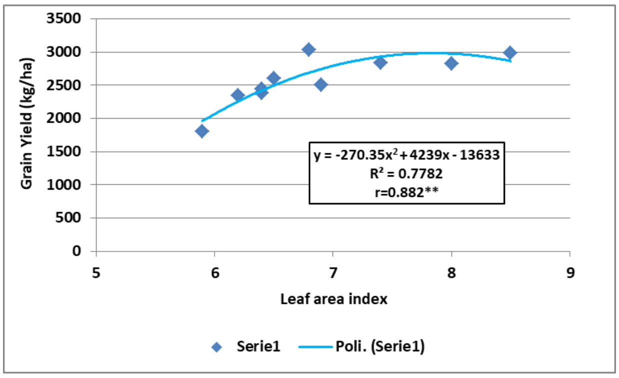

Fig. 2. The correlation between the leaf area index and the grain production obtained from cowpea
Source: Own research.

Intraspecific competition between plants takes place during the development of the root and leaf system, and the results obtained show that higher increases in production are achieved as the plant is grown in an area as similar as possible to the origin, and develops an area larger foliar [14], [4]. The analysis of the functional link between the leaf area and the cowpea production, obtained in the 10 fertilization variants, showed a positive correlation, a phenomenon highlighted very well by the polynomial function of degree 2, whose coefficient r = 0.882 ** underlines a correlation distinctly significant between cause and effect (Figure 2).

Table 5. Significance of grain production obtained from cowpea under the influence of root and leaf fertilization

The experimental variant		Grain yield		The difference compared to the control kg/ha	Significance
Root fertilization (agrofond)	Foliar fertilization	kg/ha	%		
N30P30K30	Unfertilized foliar	1,809.2	100.0	Control	
	Basfoliar 36 Extra	2,667.7	147.5	858.5	**
	Maturevo 3.35.35 + ME	2,509.0	138.7	699.8	*
	Biohumussol Liquid	2,379.1	131.5	569.9	*
	Polyactiv Mn	2,352.1	130.0	542.9	*
N60P60K60	Unfertilized foliar	2,444.1	100.0	Control	
	Basfoliar 36 Extra	2,896.8	118.5	452.7	
	Maturevo 3.35.35 + ME	2,983.4	122.1	539.3	*
	Biohumussol Liquid	2,830.1	115.8	386.0	
	Polyactiv Mn	2,831.9	115.9	387.8	
			LSD 5%	509.5	
			LSD 1%	701.7	
			LSD 0.1%	966.1	

Source: Own research.

CONCLUSIONS

Ensuring a rational fertilization of cowpea, in relation to the requirements of the plant and the state of soil fertility can regulate the defense mechanisms of the plant against stressors.

Foliar fertilization with the product Maturevo 3.35.35 + ME, in a dose of 3 kg/ha, applied in the phase of 6-8 leaves of the cowpea plant determined the increase by 13.6% of the dry matter, by 28.3% of the water related and 21.5% of the vacuolar juice concentration, compared to the unfertilized foliar control.

The results regarding the influence of foliar fertilization on grain production, obtained from cowpea, underline differentiations statistically ensured according to root fertilization, registering increases between 30-47.5%, on the agrofund of N30P30K30 and 15.8-22.1 % on the agrofund of N60P60K60.

The cowpea registered a maximum production (2,983.4 kg/ha), at the fertilization with Maturevo 3.35.35 + ME, in a dose of 3 kg/ha, on the agrofund of N60P60K60, the difference compared to non-fertilized foliar being significant ($p > 0.05$).

There was a positive correlation, distinctly significant, between the leaf area and cowpea production (r = 0.882 **).

ACKNOWLEDGEMENTS

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IMPACT OF THE GRASSLAND MANAGEMENT PLANNING APPLICATION ON SOME FEATURES OF THE GRASSLAND VEGETATION FROM WESTERN ROMANIA – CASE STUDY

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Abstract

Permanent grasslands in Romania represent an important resource for animal breeders because they represent a very high rate from the total agricultural land. The problems characteristic for many grassland surfaces from lowland area are mainly degradation determined by overgrazing, improper management or the lack of the management works. The aspects related with the management of permanent grasslands from Romania are regulated by a national law (34/2013 with the latest updates) that imposes to the permanent grassland owners (private and public) to elaborate a Grassland Management Planning that is based on the preliminary evaluation of the grassland's vegetation and the problems found there. The planning sets the proper measures for permanent grassland use and maintenance of the vegetation cover. This work is a case study that takes in consideration six permanent grasslands from lowland area of western Romania that are in public ownership and rented by private animal breeders. The purpose of the work was to determinate the application of the Grassland Management Planning that is reflected in the grassland vegetation quality and biodiversity. The results obtained show that the forager value of the analysed grasslands is low according with the pastoral value obtained. Thus, biodiversity expressed as Shannon index is relatively high, but this fact is due to a great number of annual weed species that colonizes the grasslands, their origin being the surrounding access ways and the arable land from the vicinity.

Key words**:** *permanent grassland, pastoral value, biodiversity, grassland management planning*

INTRODUCTION

Worldwide during the last decades, the agricultural systems and landscape evolution have changed significantly as a consequence of interaction among multiple factors, such as global population increase, people movement through the areas with more resources, cities development, technical and genetically progress, consumption diversification, improved cropping technologies, machinery revolution, faster access to the information, climate variability and climate changes, grasslands diversity and multifunctionality [1][2][3][4][5][6][8][9][20][21][22][27][28] and [29]. Permanent grasslands' importance, diversity and multifunctionality are aspect already illustrated in the researches from this scientific field, being from far one of the most used agricultural land from Europe [23].
In Romania, from the all about 5 million hectares of permanent grasslands most of them are affected by an intense degradation process. This degradation implies the aspects as agricultural – forager value, biodiversity and landscape.
Diversity expressed as species richness has kept especially the attention of the researchers from the field of botany, ecology and grassland science bringing important contributions to the knowledge regarding the

dynamics of the sward of the permanent grasslands [19].

Species diversity is a key factor that allows grasslands to evolve in the context of some continuous changes, processes that are accelerating nowadays due to the climate changes that are more obvious at global level [18]. The management practices, changes of the rainfall and temperatures regime and the anthropic intervention are the main factors that are influencing the vegetation of the pastures and hayfields and their distribution [11].

Looking at large scale and comparing with the situation of the permanent grasslands from the past their surface decreased considerably (49%) comparative with the forests surface (29%)[15]. Nowadays, the surfaces occupied with agricultural land are representing 11% from the total land surface and those occupied with grasslands represents 29% from the total land surface [15].

Thus, regarding the pastoral patrimony from Romania there are affected plant communities, and most are favoured certain species that are invasive [14].

The structure of the vegetation cover of the permanent grasslands is determining the quality of the forage obtained and production potential of these ecosystems. Grasslands are the cheapest forage sources for the grazing animals [12].

In Banat region (western Romania) an important surface of land is covered with permanent grasslands. Their distribution shows that they are covering about 69,000 hectares in the plain area, over 250,000 hectares in hill area and about 26,500 hectares in mountain area [11].

Along the time the grassland surfaces from Romania were diminished, especially those from the plain area followed by those from hill area. These have become forested grasslands or are parts of the extended infrastructure from the nearby area (as secondary roads, widened trenches etc). A considerable part of them is affected by abandonment, occasionally use, and extensive grazing because the surfaces aren't delimited by adequate fitments (e.g., electric fences etc.)

MATERIALS AND METHODS

Plains occupies about a half from the Banat region surface and represents the lowest morphologic level with altitudes comprised between 75-200 metres a.s.l. The slope is very smooth and the land is usually flat with very few undulations and valleys with low depth [16]. The permanent grasslands analysed in this work are placed in Banat region (western Romania), Timiș County following the transect where are positioned the localities Dudeștii Noi (DdN), Becicherecu Mic (Bm), Biled (Bd), Șandra (Sn), Tomantic (Tmn) and Cenad (Cd). Grassland from Dudeștii Noi (DdN) was considered as control.

The altitude of the analysed grasslands is comprised between 78-90 m a.s.l. as it follows: Dudeștii Noi (DdN) 90 m, Becicherecu Mic (Bm), Biled (Bd) 78 m, Șandra (Sn) 86 m, Tomantic (Tmn) 83 m and Cenad (Cd) 87 m.

The main feature of the analysed area is represented by the high amount of clay in the soil, excessive in some points [16].

The observations and data were collected in the year 2019 in the second decade of April, first decade of July and last decade of September.

The present work is a case study and its purpose is to highlight the state of the vegetation, the forager value and biodiversity at a certain moment.

The investigations related with the management of these surfaces considered for research were realised on the background of personal observation and verbal communication of the grassland users that are managing these land surfaces.

Synthesizing the general pieces of information regarding the analysed grasslands they can be characterised as follows:

-grassland Dudeștii Noi (DdN) is grazed with cattle there being respected in general the regulations regarding the time of keeping the animals on pasture; the electric fences are present delimiting the pasture surface.

-grassland Becicherecu Mic (Bm) is overgrazed with sheep, the maintenance works aren't applied consequently; it isn't delimited with electric fence, only by some

trenches and ditches that can be easily crossed by the grazing animals.
-grassland Biled (Bd) is exploited with sheep and is delimited by electric fences.
-grassland Șandra (Sn) is occasionally grazed by sheep; there were applied works for shrubs' clearing.
-grassland Tomantic (Tmn) is under-grazed, there usually are grazing sheep and sometimes cattle.
-grassland Cenad (Cd) is under-grazed; it is mainly grazed by sheep; isn't delimited by electric fence.
The grassland swards were investigated using the linear point quadrate analysis method [10]. This method had helped to the calculation of the pastoral value (VP) this index being important for the assessment of the agro-forager value of a permanent grassland. Its calculation implies several steps as follows:
(1)multiplication of the specific volume (VS) for every species with the specific quality index (IS);
(2)Summing of the obtained values and division of their sum with 5.
Using the same method there was calculated specific frequency (FS%) for every species from the vegetation sward of the analysed grasslands.
For the calculation were used the vegetation surveys they being used also for the calculation of the biodiversity index Shannon.

RESULTS AND DISCUSSIONS

The floristic composition and typological characterisation of the permanent grassland represents a necessary background in the setting of the proper management measures for the use and conservation of the permanent grassland [30].
Thus, after the determining of the participating species in the vegetation cover in the six analysed sites they were grouped in the functional groups, respectively grasses, legumes and plants from other botanical families (forbs) as is shown in Figure 1.

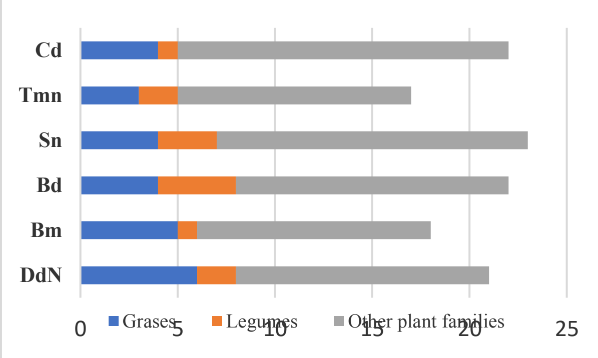

Fig. 1. Number of species on main functional groups (grasses, legumes and species from other plant families) measured in studied grasslands.
Source: Own experiment.

Compared with the control (DdN) the less numerous grasses species were determined in the grassland (Tmn), species as *Alopecurus pratensis* L., *Lolium perenne* L., *Cynodon dactylon* L., *Festuca pratensis* L.
A particular aspect on this grassland is determined by the presence of the species *Vulpia myuros* L., a therophype species (Th), xero-mesophytic, moderate thermophilic, without forager value, and a quite great participation rate in the sward. This species was identified also on grasslands from northern Oltenia region (Romania) where it occupies open habitats and is accompanied with a variable number of species depending by the soil and climate conditions [25].
This aspect is due to the fact that the animals are consuming this species sporadically and the cuts for the cleaning by mowing of the remained plants after grazing are applied only randomly.
Other grass species that had kept the attention by its presence in variable rates on all analysed grassland is *Cynodon dactylon* L.
On the base of some correlations resulted from anterior researches regarding the dynamics of this species had resulted that it has a great capacity to explore the existent resources and is able to adapt to the existent climatic conditions (low rainfall amount during the vegetation season, high temperatures, deficient management [11].
The higher and higher presence and coverage rate of these grasses in grasslands from a year to other suggests a certain trajectory of transformation of these grasslands from mesophytic to xero-mesophytic.

An important specific frequency (FS%) in the vegetation cover of the analysed grasslands have the leguminous species.

In all the analysed sites species *Trifolium repens* L. was present in different rates.

Many researches had in view observations on the spread, morphology and dynamics of species *Trifolium repens* L. These have shown that the species has a greater intensity of leaves and flowers growth in vicinity of the species *Poa pratensis* L. and *Dactylis glomerata* L. [33].

On the grassland from Biled (Bd) the specific frequency of the species *Trifolium repens* L. was 6%, on the grassland from Șandra (Sn) 4% and 1% on the grassland from Cenad (Cn). In the case of the grassland from Cenad (Cn) is noticeable that the specific frequency (FS%) approximatively equal with the species *Lotus corniculatus* L. (3.6%) has the species *Ononis spînosa* L., this species having no forager value and being avoided by herbivores (domestic and wild).

There is known that the performances of the species in a vegetation community are supported by a sum of conditions: growing rate, possibility to exploit soil resources, water, temperature and reproductive capacity.

All these aspects are supporting the constant existence of a species in a certain place for a considerable period of time [24].

The presence of the forbs is sward is also important. There were found species as: *Capsella bursa pastoris* L., *Mentha arvensis* L, *Cirsum aevense* (L). Scop., *Chenopodium album* L., *Cerastium arvense* L., *Cichorium inthybus* L., *Senecio vulgaris* L., *Stellaria media* L. The forbs were found in the greatest rate on the grassland Cenad (Cd) and Șandra (Sn) in comparison with the grassland from Dudeștii Noi (Dn) and Biled (Bd) where the maintenance works are satisfactory applied according with the Grassland Management Planning recommendations.

The contact with the agricultural land and the uncontrolled movement of the animals and the soil seed bank are only some of the reasons that determinate the presence in a high rate of the forbs mainly ruderal species that are advancing from the edge of the plots to the interior.

Ruderal species as is shown by some researchers are well adapted to the environmental stress situations. This is due mainly to their short life cycle and high prolificity [34].

Along the time the researches regarding the grassland species from the permanent grasslands and on the cultivated temporary grasslands have facilitated the getting of new pieces of information that have allowed the ecological and agronomical characterization of the main grassland species (e.g., nutritional value, palatability, digestibility etc.).

The relative character of the pastoral value was analysed by many researchers, they considering that it is influenced by the grassland use mode (cutting, grazing, type of grazing herbivores and treir feeding preferences) [17].

Specific frequency (FS%) of the species in the vegetation cover and their dynamics give important pieces of information regarding the agronomic and forager value of the analysed grasslands.

Thus, on the base of the vegetation surveys there was calculated the pastoral value (VP) (0-100 scale), the obtained VP for the control Dudeștii Noi (Dn) was VP = 39 and the lowest VP obtained was determined on the grassland Sandra (Sn) VP = 23, followed close by Cenad (Cn) VP = 24. Most of the analysed grasslands have low forager value (Cenad (Cn), Becicherucu Mic (Bm), Tomnatic (Tmn) except the control grassland Dudeștii Noi (Dn) that can be considered medium – to good forager from the point of view of the forager value.

All these can be explained by the fact that under-exploitation determinate a high seed multiplication of the grasses that are growing in bunches [18], mainly the non-valuable ones. In our case study the situation is confirmed by *Vulpia myuros* L from the grassland Tomnatic (Tmn) respectively *Bromus hordeaceus* L. from the grassland Becicherecul Mic (Bm), Cenad (Cn) and Șandra (Sn).

It is possible that these grass species have excluded other species less competitive for light and in this way to determinate bare soil patches in the sward that favours new species more competitive [32].

Most of the researches are concluding that a decrease of the grazing pressure favours the increase of biodiversity in the vegetation community by the appearance of new species [32].

A similar situation was found on the grassland from Cenad (Cn) where Shanonn index for biodiversity (*H′*) had the highest value (*H′*=4.03) being similar with the value of the control and the other analysed sites. Even it is the grassland with the highest biodiversity it hasn't valuable species from forager point of view.

This situation is explained by the fact that there can be found numerous annual species resulting from the contact with the arable fields from the surrounding area.

Correlation of the pastoral value with Shannon biodiversity index (Figure 2) of the analysed grassland sites show a positive correlation coefficient r_{calc} = 0.52, but the value obtained is slightly below the signification level $p \geq 0.05$ (r_{value} = 0.669). Thus, the determination coefficient (R^2 = 0.278) show that the hypothesis is true for 27.8% from the analysed situations. The positive trend of the correlations and the linear regression suggests the need to apply these statistics on a greater number of sites to have more clear conclusions regarding the relationship between Shannon biodiversity index and pastoral value of the grasslands from the target area.

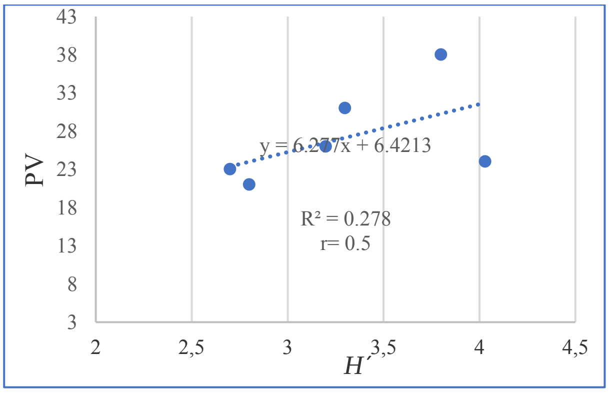

Fig. 2. Pearson's correlation between Shannon index (*H′*) and Pastoral Value (VP) (one tailed test; *df* = 5; $p \geq 0.05$)
Source: Own results.

On the other grassland surfaces analysed there the biodiversity index show a low to medium value, this aspect being influenced by the wrong management, lack of the application of the works for the improvement of the floristic composition.

Regarding the works for the improvement of the floristic composition and restoration and maintenance of the biodiversity of the grasslands the most popular ones are based on the seed transfer using hay harvested at the seed maturation stage of the main species from other grasslands from surrounding area with a higher biodiversity [31].

Research results show that this improvement method can be applied successfully on degraded grasslands [31].

To understand better the analysed vegetation features are necessary more researches to have a more complex view on the grassland vegetation features. The knowledges in this way are very useful and represent some of the most important details for proper grassland management and conservation [7], [35], [13].

CONCLUSIONS

Analysis of the floristic composition and its trajectories isn't always enough to do a proper characterisation of the changes from functional point of view, respectively the species coverage rates in a certain site.

The adaptation strategies of the species in stress conditions (changes in the rainfall amounts, oscillating temperatures etc.) or in proper environments are aspects necessary to be investigated.

Regarding the present case study there can be concluded that most of the analysed grasslands are framing in the category of the low to mediocre quality; and where were applied maintenance works consequently can be noticed an improving trend.

Grassland surfaces analysed here are recently influenced by the measures set by the grassland management planning regulated by the grassland law 34/2013 [22] with latest updates. The recommendations from these regulations are a start point for the achievement of a satisfactory balance among the floristic composition, applied management and conservation when is the case.

In the past land owners weren't considering that is necessary to apply rational grazing or to find a way economically efficient for the improvement of the agronomical and economical value of these communal pastures and to maintain the biodiversity.

In present the new applied policies at national level are pushing the responsibility to the grassland owners or concessionaires or other types of grassland users to apply a right management mostly when they are applying for agro-environment subsidies.

The time interval for the permanent grassland from private and public ownership restoration or at least maintenance in a relatively good condition depends by the application of the proper maintenance works.

Monitoring of these grassland surfaces has become a priority at least after the year 2000 for most of the grassland scientists and financing entities in our country, the main goal being sustainability and preservation of biodiversity, production and maintenance of the open landscape in relationship with its' proper exploitation.

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RURAL AGRITOURISM IN THE SYSTEM OF RURAL DEVELOPMENT: A CASE STUDY OF UKRAINE

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Abstract

In the article we proved that the development of rural areas lies in the plane of non-agricultural areas of entrepreneurial activity, among which agritourism plays an important role. In the manuscript we identify and highlight the main role and place in the economic system of the tourism industry in the direction of the social and economic situation in rural areas of Ukraine, as well as to study the development of agritourism in Ukraine. According to the results of the work, it was established that conducting agritourism activities in the studied regions of Ukraine allowed the rural population to receive new and additional types of income, which in turn contributed to improving their living standards and development of rural areas in general.

Key words*: *rural agritourism, rural development, agritourism farms, green tourism

INTRODUCTION

In the conditions of urbanization and the intense rhythm of city life, rural green tourism is becoming more and more popular, the urgent element of the union of man with nature. According to European statistics, 35% of urban dwellers in the European Union choose to spend their holidays in rural areas [33].

The development of rural areas lies in the plane of non-agricultural areas of entrepreneurial activity, among which agritourism plays an important role. A significant share of agritourism farms and estates in Ukraine is concentrated in the Western region, in particular in its two regions – Lviv and Ivano-Frankivsk [14].

The low level of agricultural efficiency does not make it possible to offer enough jobs for the rural population, which has found itself in difficult socio-economic realities. The question arose of finding additional and stable types of income [12]. Under such conditions, using all their potential, the peasants quickly reoriented to a new type of entrepreneurship, namely agritourism, which helped ensure a certain village`s certain economic stability.

Rural green tourism is necessary both for vacationers and for the owners of their estates, peasants, village councils, the whole region, and the state as a whole. We believe that the development of agritourism will contribute to the development of all sectors of the economy.

Important prerequisites for agritourism

activities were available labour and land resources, free rural housing, clean rural environment, natural resources, rich historical and cultural heritage [15]. Agritourism is associated with an increase in the number of agro-villages and farmsteads, which receive a larger flow of tourists who invest in rural infrastructure, improving the welfare of farmers, and thus contribute to the development of the village, which is the cradle and treasure of Ukrainian traditions. As Viacheslav Lypynskyi once said: «Without tradition, there is no culture, without culture there is no nation» [46]. The development of agritourism and green tourism in rural areas was studied in their works O. Agres [1], O. Apostolyuk [2], O. Binert [3], V. Chegley [5], M. Dziamulych [7-10; 34-36], S. Hutkevych [12], V. Lypchuk [14, 15], I. Lytvyn [16], L. Marcuta [19], L. Marmul [20], A. Popescu [21, 22; 23; 24; 25; 26; 27; 28; 29; 30; 31; 32], O. Serdiukova [33], R. Sodoma [37, 38], O. Stashchuk [39, 40; 41], I. Tsymbaliuk [42], I. Yakoviyk [44], Ya. Yanyshyn [45], L. Zaburanna [46], I. Zhurakovska [47].

MATERIALS AND METHODS

The purpose of our article is to identify and highlight the main role and place in the economic system of the tourism industry in the direction of the social and economic situation in rural areas of Ukraine, as well as to study the development of agritourism in Ukraine.

The research is characterized by a comprehensive and systematic approach to solving current problems and solving problems of formation of rural agritourism in the system of rural development, in the process of which a system of modern methods, techniques, and tools of research was used.

The study used a set of modern methods, including methods: theoretical generalization, systems analysis (to systematization of theoretical foundations and foreign experience in the development of agritourism in rural areas of Ukraine);

- method of analysis and synthesis, methods of abstraction (to scientific substantiation and generalization of proposals for solving the problems of agritourism in rural areas and development of recommendations for further development of rural green tourism and agritourism in Ukraine);
- methods of comparative, structural, functional analysis (to provide substantiation of conclusions and recommendations obtained from the results of the study), etc.

RESULTS AND DISCUSSIONS

Ukraine, which is rich in natural and recreational resources, has all the prerequisites for the successful development of rural green tourism. In Ukraine, there are about 150 thousand potential participants in rural green tourism [17].

From ancient times to the present day it is known that the main value of Ukraine is its rich lands, in its beautiful nature, which has always been the main treasure for its conquerors. Over the past 5 years, the number of tourists has tripled.

The potential demand for agritourism services in Ukraine is quite high. This opinion is justified by the significant activity of the Ukrainian population in terms of tourism outside Ukraine (Fig. 1). Therefore, high-quality agritourism services can be both a good alternative to foreign recreation and its interesting addition and expansion because the consumption of healthy products (fresh vegetables and fruits) grown by villagers and consumed directly from the field and stay in natural scenic climates conditions of Ukraine can create preconditions for interesting and full rest in the countryside and rapid development of agritourism.

Rural green tourism plays an important role in the organization of leisure and recreation and accounts for a significant share in the tourism industry, thereby expanding the boundaries of the national economy. It is worth noting that the positive socio-economic impact of rural green tourism is hampered by the difficult life of the rural population and urbanization. Thus, according to the State Statistics Service of Ukraine, there is an annual population decline of 9% in rural areas. Addressing these issues requires support from the government and the public [43].

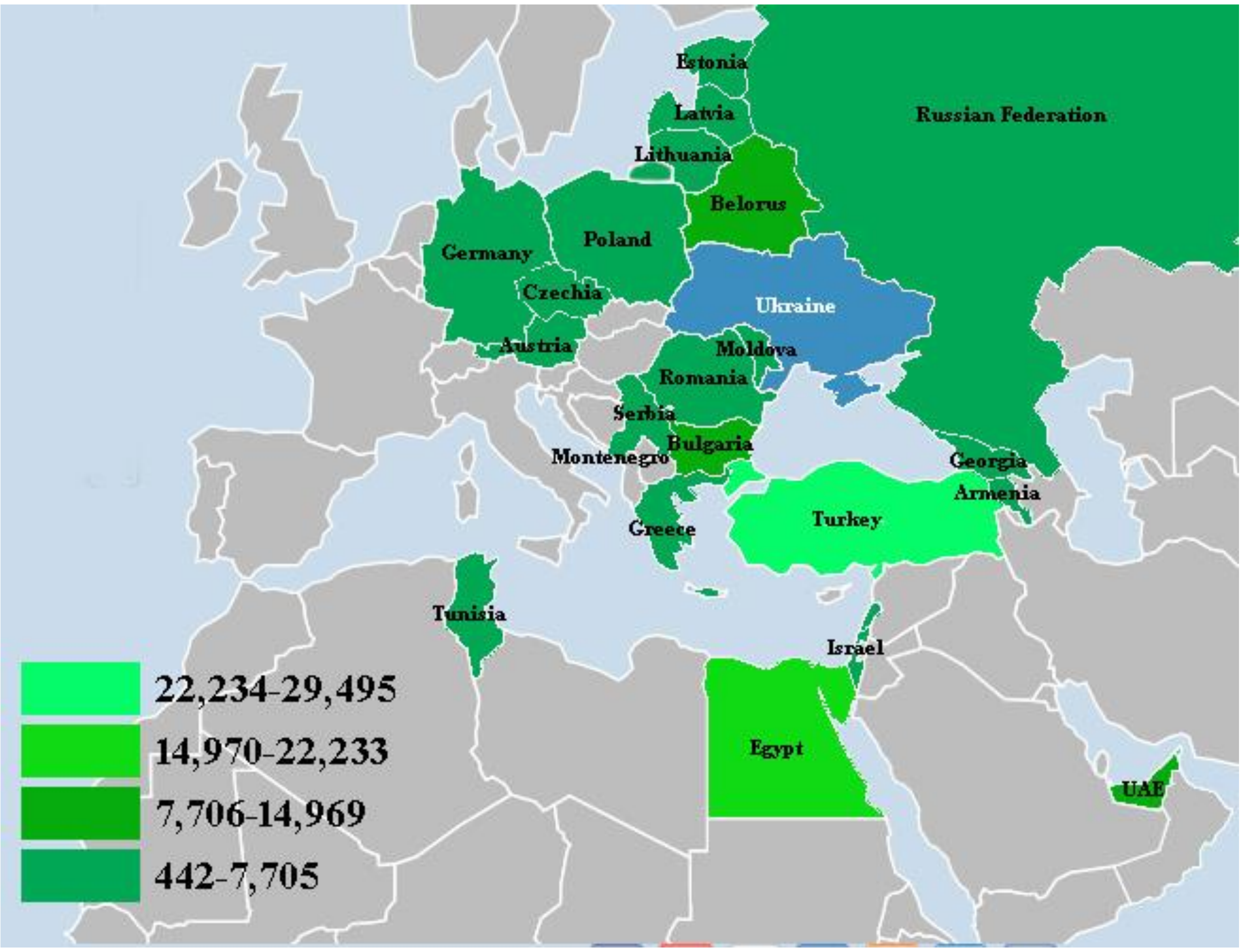

Fig. 1. The cartogram of the grouping of visits of other countries by Ukrainians for the purposes of tourism in 2019, persons
Source: own development, built according to the Administration of the State Border Guard Service of Ukraine (information submitted without taking into account the service personnel of vehicles and servicemen).

Rural green tourism contributes to the economic development and prosperity of the country, addressing several issues related to:
– increase in jobs in the village;
– creation of improvement of estates and villages as a whole, development of infrastructure;
– increase in income and average living standards at low cost;
– the opportunity to sell local products to tourists, receiving income from it;
– organization and increase of protection of local historical monuments, preservation of local customs and traditions, folklore, folk crafts;
– raising the cultural and educational level of the rural population, etc.

In the world, rural green tourism is seen as an alternative to agriculture in terms of income. In addition, the development of rural tourism infrastructure does not require such significant investments as other types of tourism and can be carried out at the expense of the peasants themselves without additional investment. Reducing migration from rural to urban areas will save significant financial and material resources, because, according to experts of the European Bank for Reconstruction and Development, resettlement in rural areas is 20 times more expensive than creating conditions for his life and work in rural areas [11].

Thanks to the use of such a form of recreation as green tourism, many Western European countries have made a giant step in the development of the rural economy.

The development of rural green tourism in the world began in the second half of the 20th century when in England and the United States was created the concept of "Bed & Breakfast" – living about 7 days in empty rooms, regardless of their location (Table 1).

Table 1. Classification of recreation bases belonging to the type «bed & breakfast»

Name	Characteristic	Feature
Bed & breakfast cottage	Rented cottage in a resort and recreational area, in an area that has the status of a rural area or belongs to the resort	Location by the sea, lake or in the mountains
Bed & breakfast farm vacation	Family vacation with children in picturesque countryside with valuable recreational resources	Possibility of rest in "home" atmosphere of children of different age groups separately from parents
Bed & breakfast homestay	Accommodation in the house of the owner of the farmstead together with his family in separate guest rooms	Acquaintance with traditions, culture, a life of that family with which guests live
Bed & breakfast farmstay	Accommodation in a farmer`s house or in a campsite on the farm	Eating products grown by the owner of the estate, participation in agricultural work on the farm

Source: [5].

In Ukraine, in particular, there are no systematic data on tourist activity of the population in rural areas. The only information obtained from individually targeted surveys is available. For example, according to surveys of agritourists who were on vacation in rural areas of the Vinnytsia region of Ukraine, it was found that the largest share of such agritourists came from neighbouring regions, namely – Kremenchuk and Kyiv regions of Ukraine (Fig. 2). The obtained results provide grounds to claim that Ukrainians are interested in agritourism services in rural areas with good climatic conditions and sufficient infrastructural development.

It should be noted that in Ukraine there are many interesting places located in relatively prosperous ecological regions. The most active regions that develop green tourism on their territory are Transcarpathian, Ivano-Frankivsk, Vinnytsia, Kyiv, Lviv, Poltava [15].

We studied the peculiarities of conducting and developing agritourism activities in the Lviv and Ivano-Frankivsk regions of Ukraine, as they are characterized by high favourable for the development of agritourism, the availability of sufficient climate and recreational resources. In particular, the largest share of rural farmsteads and agritourism farms is concentrated in the Carpathian recreational region, due to favourable climatic conditions, specific terrain, picturesque landscapes, ecologically clean areas, the availability of sufficient rural historical resources in Ukraine, and the number of facilities, the preservation of national authentic traditions and skills, high culture of management and the mentality of the indigenous population.

The resource potential of agritourism is formed by: natural, recreational, industrial, demographic, logistical, socio-economic, informational, political and legal, historical, and ethnocultural resources [12; 14]. The treasury of the nature reserve fund of the Lviv region of Ukraine consists of 350 objects with a total area of 175 thousand hectares, which is 7% of the region, while the nature reserve fund of the Ivano-Frankivsk region of Ukraine includes 474 objects with a total area of 218.8 thousand ha, which is 15.7% of the total area of the Ivano-Frankivsk region. The recreational potential of the region is 30% of the national with a large share of forested areas [17; 18].

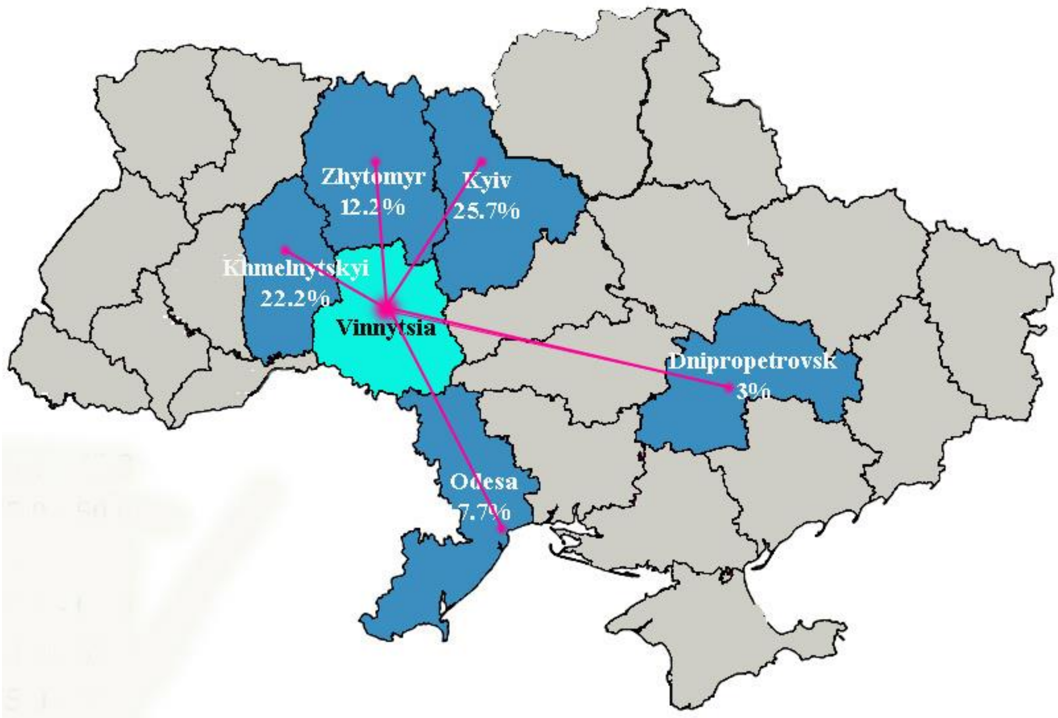

Fig. 2. Map of visualization of tourist attractiveness of Vinnytsia region of Ukraine in 2019 (according to the results of a survey of vacationers in rural areas of the region from other regions of Ukraine)
Source: own development based on the results of the survey.

Living space in rural areas of the Lviv region – 15,924 thousand m^2, or 28.3% of the total housing stock, it is about 205.4 thousand private rural houses, of which 37.2 thousand uninhabited, while in the Ivano-Frankivsk region living space in rural areas is 12,637 thousand m^2, or 36.7% of the housing stock - about 172.5 thousand private homes. It should be noted that according to the administrative division in the Lviv region there are 1,850 rural settlements (the largest number in Ukraine), and in the Ivano-Frankivsk – 765 rural settlements [17; 18].

As of January 1, 2016, the share of the rural population in the Lviv region of Ukraine was 989.3 thousand people (39.03%), while in the Ivano-Frankivsk region of Ukraine this figure was 777.8 thousand people (56.26%). Labour resources of the Lviv region of Ukraine number 592 thousand people of the rural working population with an employment rate of 52.9%, while in the Ivano-Frankivsk region of Ukraine this figure is 697 thousand people with an employment rate of 54.1% [17; 18].

According to the results of the study, it is established that the development of agritourism is characterized by high zonation. The main share of agritourism farms is located in the mountainous and foothill zone of the Carpathians. Almost nine out of ten agritourism farms are concentrated here. Certain agro-recreational units have been formed, i.e. «a set of agro-recreational points grouped around a resort and tourist centre within a certain compact area» [14]. Such well-known agro-recreational hubs in the Carpathian region of Ukraine are Slavske in Lviv, Kosiv, and Yaremche in the Ivano-Frankivsk region. Of the total number of rural estates that provide tourist services, 67.9% are located here [12]. Agritourism farms also operate on a slightly smaller scale in other natural areas, in particular in Zhovkva, Yavoriv, Kamianka-Buzka, Busk, and Zolochiv districts of the Lviv region. Selective surveys of agritourism farms showed that in 2019 in the study region rested about 112.9 thousand people. At the same time, the stay of one tourist on the farm was 2-3 days.

Scientists and specialists in the field of agritourism have developed an integrated indicator of agritourism attractiveness of the regions of Ukraine studied by us according to the following distribution of selected attractiveness criteria:

1) wooded area ($x1$) – 29 %; 2) availability of agricultural land ($x2$) – 25 %; 3) ecological

purity ($x3$) –23 %; 4) availability of protected areas ($x4$) – 17 %; 5) population density ($x5$) – 6 % [14; 15].

Taking into account these criteria, the coefficient of favourability of the territory of agritourism development ***Ic*** will be equal to:

$$I_c = 0.29(X_1) + 0.25(X_2) + 0.23(X_3) + 0.17(X_4) + 0.06(X_5).$$

In each of the districts of the Lviv and Ivano-Frankivsk regions, a coefficient favourable for the development of agritourism has been determined (Fig. 3).

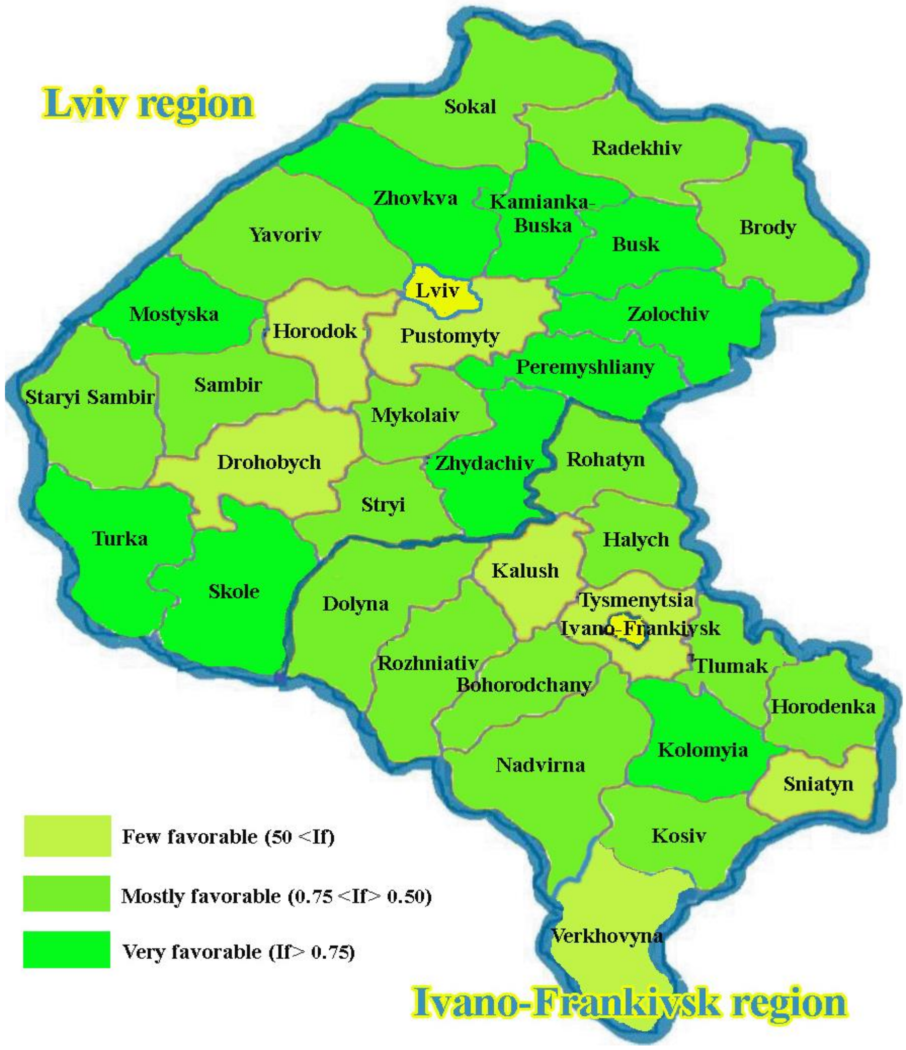

Fig. 3. The cartogram of the grouping of districts of Ivano-Frankivsk and Lviv regions of Ukraine (Carpathian region of Ukraine) by favourable development of agritourism
Source: own development based on the results of calculation of the integrated indicator of agritourism attractiveness.

It should be noted that objective official data in Ukraine, in particular in the Western region, on the number of farms of rural green tourism and agritourism farms, which both officially and unofficially conduct their business, is not enough. Therefore, in assessing the dynamic and other trends, we used the materials of Ivano-Frankivsk and Lviv regional organizations of the Union for the Promotion of Rural Green Tourism in Ukraine, village councils, the results of questionnaires, and our own research and observations.

It should be noted that more than 92% of farms of rural green tourism and agritourism farms are not officially registered as entrepreneurs, mainly due to high taxation, and therefore they do not undergo the procedure of voluntary categorization, which actually limits their level of activity. The state of development of rural green tourism and agritourism is evidenced by data on their dynamics (Fig. 4).

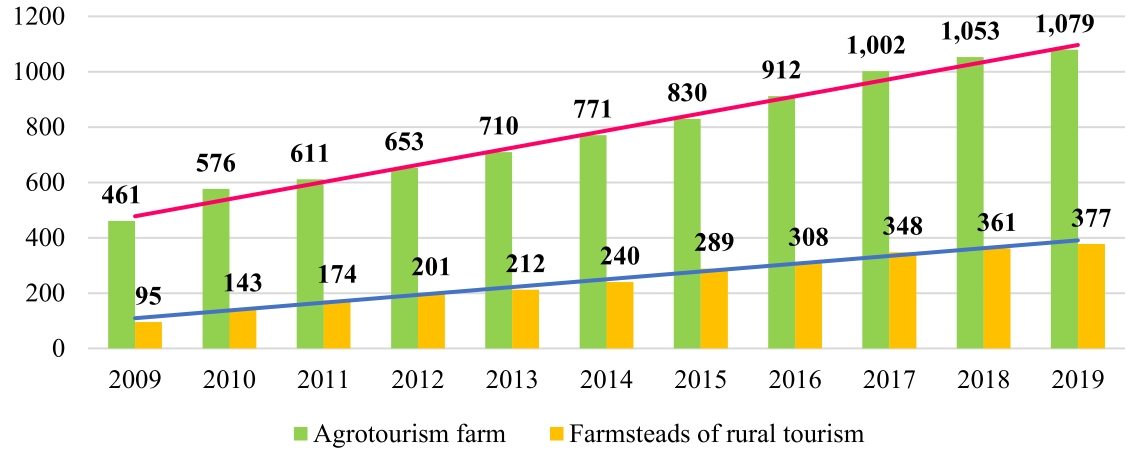

Fig. 4. Dynamics of farmsteads of rural tourism and agritourism farms in the Lviv and Ivano-Frankivsk regions of Ukraine in 2009–2019
Source: own research.

Note that the dynamics of increasing the number of agritourism farms in the study region of Ukraine is much more active than the dynamics of the market of agritourism services in conditions of low competition. The farmsteads of rural tourism are marked by even faster dynamics (Fig. 4) [15].

The study found that the agritourism business encourages rural communities to pay more attention to rural development, reforming transport infrastructure, educational and medical facilities, restoring local cultural institutions, architectural monuments, ensuring environmental cleanliness, cluster development, and agritourism business planning etc.

Note that at the present stage, all national organizations of rural tourism in Europe have merged into the European Federation of Farm and Rural Tourism (Eurogites). The main goals of this organization are to promote the development of rural green tourism and targeted investment in rural tourism development projects. Features of the organization of rural green tourism of different countries are given in Table 2.

Table 2. Features of organization of rural green tourism in different countries

Country	Features of the organization of rural green tourism
Italy	agritourism business is closely related to the resort, international specialization astronomical and tasting tourism
Austria	employment of guests in collecting herbs, preparing dairy products, grazing cattle, active mountain, and ecological tourism
Finland	ownerless houses located on the shores of protected lakes, and rivers
Romania	there is a National Association of Rural and Cultural Tourism, specializing in ethnographic and gastronomic tourism
Hungary	tax benefits, international specialization equestrian tourism
Poland	lack of close connection with the traditions of the country - only accommodation and meals
France	seaside farmsteads, horse farms, wine farmsteads, ski chalets, agro-cottages, castles, fishing houses
Spain	rural hotels opened in the Canary and Balearic Islands, as well as in converted monasteries and historic castles
Denmark	operates the National Association of Agritourism, specializing in cycling tourism
Iceland	categorization of rooms into three categories, categorization of guesthouses (A, B, C, D, T, F, G)
Germany	most tourists come to participate in international fairs and trade shows
Great Britain	affordable prices, special discounts for children, NZT advertising, and information catalogues are printed

Source: [5].

It is worth noting the significant state support for programs to involve rural communities in green and agritourism in European countries. The European Union sees rural tourism as the main lever for the economic recovery of its rural areas. According to experts of the European Bank for Reconstruction and Development, the arrangement in the city of a native of rural areas is 20 times more expensive than creating conditions for his life and work in the countryside. It is also estimated that the income received from one bed-place is equivalent to the annual income of a farmer from one cow [46].

The classic European traditions and values of rural recreation have been professed by Great Britain for many decades. English tourism has an all-season character: it is very popular to spend not only summer vacations in this country but also to celebrate Christmas. In the UK, there is the National Organization for Rural Tourism and Agritourism, which provides accreditation for homes. The popularity of rural tourism has prompted British farmers to come together to offer a variety of services in their homes. For example, in the southwest of England, old farms are being restored, which are popular with tourists, where the increased level of comfort is combined with partially preserved old furniture [46].

In Europe, the leaders of the rural green tourism industry are Spain and France, where it has long grown into a highly profitable industry. Rural tourism in this country is represented by the National Organization of Holiday Homes and Green Tourism [13].

In Romania, the interests of agro-village owners are represented by the National Association of Rural, Ecological and Cultural Tourism. Rural tourism in this country is developing primarily in the Southern Carpathians and focuses on the same benefits as Ukraine, i.e. the preservation of the natural environment and ethnocultural traditions. Polish legislation clearly distinguishes the basic concepts and principles of rural green tourism from other types of tourist services provided in rural areas, but legally related to business activities. In rural tourism, the Polish government sees a source of development for regions that have natural resources to develop productive sectors of the economy [4]. Polish agritourism maintains its material base due to its connection with the countryside, agriculture, traditional architecture, and interior. The agritourism product offered by Polish farms is often reduced exclusively to accommodation and meals, but we know that the profitability of accommodation facilities increases with the provision of, for example, other services [14].

In Ukraine, based on the Polish experience, there is also a system of environmental certification and voluntary categorization «Green Estate», which was developed by the All-Ukrainian Union for the Promotion of Rural Green Tourism. The certification scheme is based on the principles of reducing the harmful impact of agritourism facilities on the environment, support of folk traditions and crafts, support of the local economy, developing environmentally friendly types of entertainment and recreation [6]. Based on the study of the experience of different countries, it is possible to identify areas and prospects for the development of rural green tourism in Ukraine while improving the legislative regulation of rural green tourism (Table 3).

The first and so far the only special program known document on rural green tourism in Ukraine is the order of the Ministry of Agrarian Policy and Food of Ukraine "On approval of the Action Plan of the Ministry of Agrarian Policy of Ukraine for rural green tourism until 2019" № 24 from 18.01.2017, which provides for the implementation of a number of measures:

– organization of the study of the tourist resource of the regions in order to develop guidelines or the development of rural green tourism;

– promotion through the media and the Internet;

– participation in the development and implementation of special regional programs to support the development of this type of tourism;

– training of specialists for work in the field of rural green tourism, participation in the presentation of the product of rural green tourism in the regions among the population in order to generate demand;

– involvement of farms and private farms in the provision of services in the field of rural green tourism;

– development of a road map for the functioning of rural green tourism in Ukraine and others [17].

Table 3. Directions and prospects of agricultural green tourism development in Ukraine on the basis of world experience

Country with similar experience	Direction of agricultural green tourism development in Ukraine
Germany, Italy, Austria, Poland, Hungary	preferential tax regime
France	joint development of rural areas and tourism with financial support from the private sector and government coordination; division of the district into recreation areas and green areas
Italy	development of agritourism business is connected with the resort, specialization on gastronomic and tasting rounds
Italy, Spain	the emergence of special hotels in the countryside near the monasteries
Austria	employment of guests in collecting herbs, cooking dairy products, grazing cattle
France	seaside farmsteads, horse farms, wine farmsteads, fishing houses
Romania	ethnographic types of rural green tourism

Source: [5].

It should be noted that significant support for rural green tourism is provided by the Union for the Promotion of Rural Green Tourism in Ukraine, the main purpose of which is to meet public economic, social, cultural, and environmental interests by promoting rural green tourism by promoting rural hospitality and related cultural heritage; assistance in increasing the employment of the rural population, providing advisory services in the field of rural green tourism.

CONCLUSIONS

According to the results of the work, it was established that conducting agritourism activities in the studied regions of Ukraine allowed the rural population to receive new and additional types of income, which in turn contributed to improving their living standards and development of rural areas in general. Unique nature, powerful recreational resources, available human resources, and rich culture make attractive rural areas of the Western region of Ukraine, which are developing dynamically with the development of agritourism services.

Thus, we believe that among the main areas of rural green tourism in Ukraine are:

– creation of favourable conditions for obtaining tax benefits and loans for owners of farmsteads;

– advertising of agricultural services, issue of various guides, distribution of various types of agritourism business, including resort specialization of rural green tourism.

Thus, in the conditions of permanent economic crisis, rural green tourism in Ukraine is becoming a good alternative to expensive foreign resorts and advertised routes, because many citizens of Ukraine will be able to choose for active recreation rural estates of the Ukrainian Carpathians, Podillia, or Dnipro regions of Ukraine.

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OLIVE MILL WASTEWATER TREATMENT USING ELECTROCOAGULATION TECHNIQUE

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Abstract

The electrocoagulation energy consumption, specific electrocoagulation energy consumption removal efficiency of COD and removal efficiency of TSS from olive mill waste water were examined by using electrocoagulation cell. Iron and aluminium were used as a material of electrodes. The distance between electrodes were 1, 1.5, 2, 2.5 and 3 cm, the electrocoagulation time were 10, 20, 30 and 40 mint and retention time 30 mint. The electrocoagulation voltage was 20 V while the electrical current was changing from 0.8 to 4 A. The electrocoagulation energy consumption increasing with decreasing distance between electrodes and increasing electrocoagulation time for two types of electrodes. At 1cm distance between electrodes and 40 mint electrocoagulation time, electrocoagulation energy consuming was 17.8 kW.h.m^{-3} for Al electrodes and 16.8 kW.h.m^{-3} for Fe electrodes. There were substantial ($p<0.05$) variations in COD removal efficiency and electrode distance. The effectiveness of the elimination of COD was 26.3 and 27.3 % for Fe and Al electrodes at a gap of 1cm between electrodes and 40 mints electro-coagulation times. The specific energy consumption increases with increasing process time. For Al electrodes and distance between electrodes 1 cm, the specific electrical energy consumption were 0.64, 1.15, 1.46 and 1.57 kW.h.g^{-1} COD at process time 10, 20, 30 and 40 mint respectively. The removal efficiency of TSS increasing with decreasing distance between electrodes and increasing electrocoagulation time for two types of electrodes. At 1cm distance between electrodes and 40 mint electrocoagulation time, the removal efficiency of TSS were 47.6 and 42.9 % for Al and Fe electrodes respectively.

Key words: *electrocoagulation technique, olive mill wastewater, electrodes, COD, TSS*

INTRODUCTION

The nutritional and health advantages of olive food crops are recognized. The berries are frequently utilized for oil mining and are consumed in a processed form. A total of 2,87 million tons of table olive were produced globally in 2018 [2]. Virgin olive oil has a unique taste because they contain phenolic compounds derived from the hydrolysis of oleuropein [19].
Olive oil products usually utilize around 0.4–0.8 m^3 of water in the debitter stage per ton of green olives. In the same investigation in Greece have been reported that, olive handling plants generating 3,9–7,5 m^3 wastewater for each ton of green olives and 0,9–1,9 m^3 wastewater for each ton of black olives [18]. In regard to inorganic chemicals with environmental hazards which require appropriate clean up procedures, the discharge generated includes various organic combinations such as phenolic. Usually, because to high organic content, these wastewaters possess strong chemical oxygen requirements (COD); for instance, this quantity is 48.500 mg.L^{-1} for effluent in olive mills [3, 13].
In comparison to control sites, soil irrigated with olive mill effluent showed considerably higher organic material concentration lower bulk density, and comparatively greater overall porosity, although lower macro porosity. Solvent exchange amongst inter and intra soil aggregate water was hampered when the soil became more covered with complex organic compounds coming from olive mill waste water[15]. Irrigation with untreated olive mill wastewater killed the plants in a couple of days. Treated olive mill wastewater was found to be useful in irrigating tomato crops at economic level [21].

[14, 9] investigated the effective performance of electrocoagulation technique in the treatment of olive mill wastewater using aluminium electrodes. Electrocoagulation is one of the efficient electrochemical methods for the cleaning of several types of wastewaters. During Electrocoagulation, when a potential change is applied between an anode, such as Fe or Al and the cathode, ferrous or aluminium and hydroxyl ions are generated, respectively, at the anode and the cathode. In the Electrocoagulation process, electrochemically generated aluminium can remove most contaminants present in olive mill waste water via precipitation and adsorption. The aluminium type acts as a coagulant by joining with the pollutants to form large size groups and can then be taken away via settling and flotation [12, 10, 23, 7].
[20, 5] showed that the optimal total suspended solids (TSS) and chemical oxygen demand (COD) removal was found at the optimum experimental parameters for example electrical current, pH, and electrocoagulation time. After electrocoagulation, most organic composites still remained in effluent. [16] resulted that a significant effect of electrical current and electrocoagulation time on the removal efficiency of total phenolic compounds and chemical oxygen demand.
Electrocoagulation includes the generation of coagulants in situ via dissolving electrically moreover aluminium or iron ions from aluminium or iron electrodes, respectively. Metal ions are produced at the anode, and hydrogen is released from the cathode. Hydrogen will also help float flocculated particles out of water. Electrodes can be arranged in unipolar or dipole patterns. These materials can be plate-shaped aluminium or iron, or they can be packed in chips, such as steel turning and milling. [1, 6, 11].
Total organic carbon, chemical oxygen demand, color, turbidity, or the concentration of a particular species such as a metal ion are all used to evaluate electrocoagulation efficiency. The anode of the sacrifice dissolves and must be constantly changed. In addition, the development of an oxide layer on the cathode surface may lead to reduced processing efficiency. To decrease electricity consumption, high conductivity is required for waste water [24, 17]. The current density and EC duration of electrocoagulation are the two main factors for eliminating pollutants, and the ideal way to reduce the energy consuming is to substantially improve them [8, 22].
The objective of the present study is to evaluate the performance of electrocoagulation on the treatment of olive mill waste water by exploring the effects of various process parameters such as electrodes materials, electrical current, distance between electrodes and electrocoagulation time on COD and TSS removal. Also, estimated electrocoagulation energy consumption.

MATERIALS AND METHODS

The olive mill waste water was taken from a traditional oil mill in El-Salhia, Egypt during the season 2019-2020. No chemical substance additives were used through the production olive oil. The specifications of fresh olive mill waste water were recorded (Table 1). The experiments were carried out in Agricultural Engineering Department, Faculty of Agriculture, Kafrelsheikh University, Egypt.

Specification of electrocoagulation cell

A laboratory model electrocoagulation (Fig. 1) was used for experiment. The power supply voltage was ranged from 0 to 30 V and the electrical current variations was 0 – 6 A. Surrounding temperature was stable through the experiment around 22 C°. Electrocoagulation unit made of plexiglass with the dimension of 20 cm ×10 cm × 15 cm and equipped with 7 parallel electrodes (4 anode and 3 cathode). Electrodes made of aluminium (Al) and iron (Fe). The dimension of electrodes was 8 cm × 3 cm ×0.3 cm and the effective area of electrodes was 168 cm^2. The distance between electrodes variations 1 – 3 cm. The electrodes were connected to the power supply and fixed voltage at 20 V. Digital magnetic stirrer for mixing olive mill waste water (mixing speed 200 rpm). At the end of the run, the solution stayed for 30 mint as a retention time.

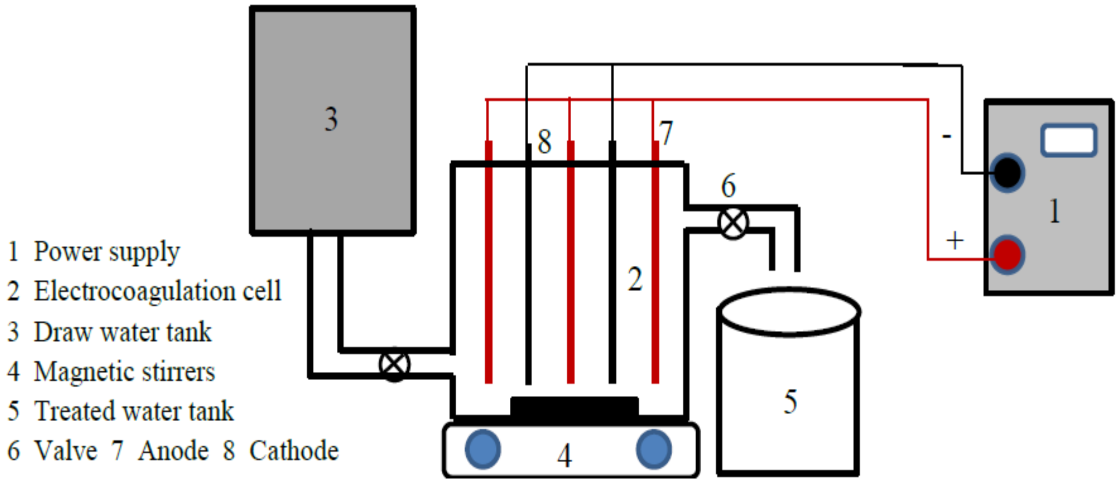

Fig. 1. The electrocoagulation cell model used in laboratory experiment
Source: Author's schematic drawing.

Measurements

Analysis of COD and TSS were determined by the procedure described in the standard method [4]. A digital calibrated pH meter was used to measure the pH of the Olive mill waste water. NO3, phenol, volatile acids and dray residue were estimated in food technology laboratory.

The electrocoagulation energy consumed, expressed as kW.h per m^3 of treated waste water. Removal efficiency of COD and specific electrocoagulation energy consumption kW.h per g of removed COD were calculated using following equations [16]:

$$Electrocoagulation\ energy\ consumption = \frac{V \times I \times t}{60 \times v}$$

$$Removable\ efficiency\ of\ COD\ (\%) = \frac{COD_{initial} - COD_{final}}{COD_{initial}} \times 100$$

$$Specific\ electrocoagulation\ energy\ consumption = \frac{Electrocoagulation\ energy\ consumption}{COD_{intial} - COD_{final}}$$

where: V is working electrical potential (in Volts), I is electrical current (A), t is electrocoagulation time (mint). *v* is the sample volume (litter), COD_{intial} is the initial concentration of the organic load ($g.L^{-1}$) and COD_{final} is final concentration of the organic load.

Experimental parameters

The voltage was constant at 20 V and the electrical current is measured in all treatments according to the resistance of the olive mill waste water. During the study the following treatments were tested:

1-Distance between electrodes: it included the five levels (1, 1.5, 2, 2.5 and 3 cm).

2-Electrocoagulation time: it included the four levels (10, 20, 30 and 40 mint).

3-Type of electrodes: it included tow types of electrodes (aluminum (Al) and iron (Fe)).

Statistical analysis

MATLAB statistical analysis software (Mathworks, USA) was used for carrying out the analysis of variance (ANOVA) and the least significance difference (LSD) tests at 95 % confidence level for obtained data.

RESULTS AND DISCUSSIONS

Effects of the experimental parameters on the olive mill wastewater, electrocoagulation energy consumption, COD removal efficiency and TSS removal efficiency were investigated in this section.

Olive mill wastewater specifications

Table 1 summarizes the specifications of olive matt wastewater before and after electrocoagulation under optimum conditions (distance between electrodes = 1cm and electrocoagulation time = 40 mint) for two types of electrodes (Fe and Al). As is clear from table 1, the changes of water quality after electrocoagulation for Al electrodes was better than Fe electrodes. COD removal efficiency were 27.29 and 26.33 % for Al and Fe electrodes respectively. Removal efficiency for TSS were 47.62 and 42.86 %

for Al and Fe electrodes respectively. All water specifications for Al electrodes were higher than Fe electrodes under all study parameters.

Table 1. Specifications of olive matt wastewater before and after electrocoagulation at distance between electrodes 1 cm and time 40 mint

Parameter	Olive matt waste water	After electrocoagulation		Removal efficiency, %	
		Al electrode	Fe electrode	Al	Fe
Temperature, °C	22	43 (±2)	42 (±2)		
TSS, mg. L^{-1}	2,100	1,100 (±20)	1,200 (±25)	47.62	42.86
pH	4.2	4.5 (±0.1)	4.5 (±0.1)		
COD, mg. L^{-1}	41,400	30,100 (±500)	30,500 (±400)	27.29	26.33
NO3, mg. L^{-1}	49	37 (±3)	38 (±2)	24.49	22.45
Volatile acids, mg. L^{-1}	9,000	6,700 (±100)	6,800 (±100)	25.56	24.44
Phenol, mg. L^{-1}	43.2	37.8 (±3)	38.1(±2)	12.50	11.81
Dry residue, mg. L^{-1}	15,460	12,900 (±600)	13,700 (±500)	16.56	11.38

Source: Own calculation.

Electrocoagulation energy consumption

The electrical current is important effective parameter in electrocoagulation systems. At Al electrodes, electrical current were 4, 2, 1.3, 1 and 0.8 A for distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively. Since electrocoagulation energy consumption is straight related to applied current and the voltage, electrocoagulation energy consumption of the electrochemical process at the time and steady state condition was stated increased at higher density. Distance between electrodes had a significant differences effect ($p<0.05$) on electrical energy consumption at different electrochemical process time and different electrode types. It can be seen from Fig. 2 the electrocoagulation energy consumption increasing with decreasing distance between electrodes for two types of electrodes. The electrocoagulation energy consumption for Al electrodes at distance between electrodes 1 cm were 4.4, 8.9, 13.3 and 17.8 kW.h.m^{-3} at time process 10, 20, 30 and 40 mint respectively. While, the electrocoagulation energy consumption for Fe electrodes at distance between electrodes 1 cm were 4.2, 8.4, 12.7 and 16.9 kW.h.m^{-3} at time process 10, 20, 30 and 40 mint respectively.

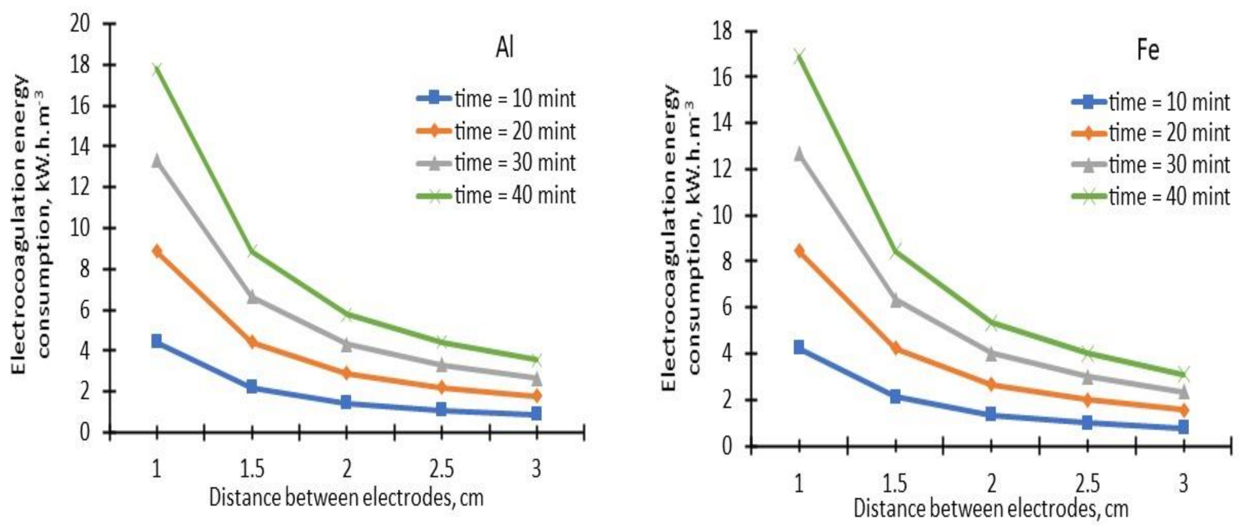

Fig. 2. Relation between electrocoagulation energy consumption and distance between electrodes (1, 1.5, 2, 2.5 and 3 cm) for two types of electrode at different process time (10, 20, 30 and 40 mint).
Source: Own calculation.

Electrocoagulation process time had a significant differences effect ($p<0.05$) on electrical energy consumption at different distance between electrodes and different electrode types. It can be seen from Fig. 3 the electrocoagulation energy consumption increasing with increasing process time for two types of electrodes. The electrocoagulation energy consumption for Al electrodes at time process 40 mint were 17.8, 8.9, 5.8, 4.4 and 3.6 kW.h.m^{-3} at distance between electrodes 1, 1.5, 2, 2.5 and 3cm respectively. While, the electrocoagulation energy consumption for Fe electrodes at time process 40 mint were 16.9, 8.4, 5.3, 4 and 3.1 kW.h.m^{-3} at distance between electrodes 1, 1.5, 2, 2.5 and 3cm respectively.

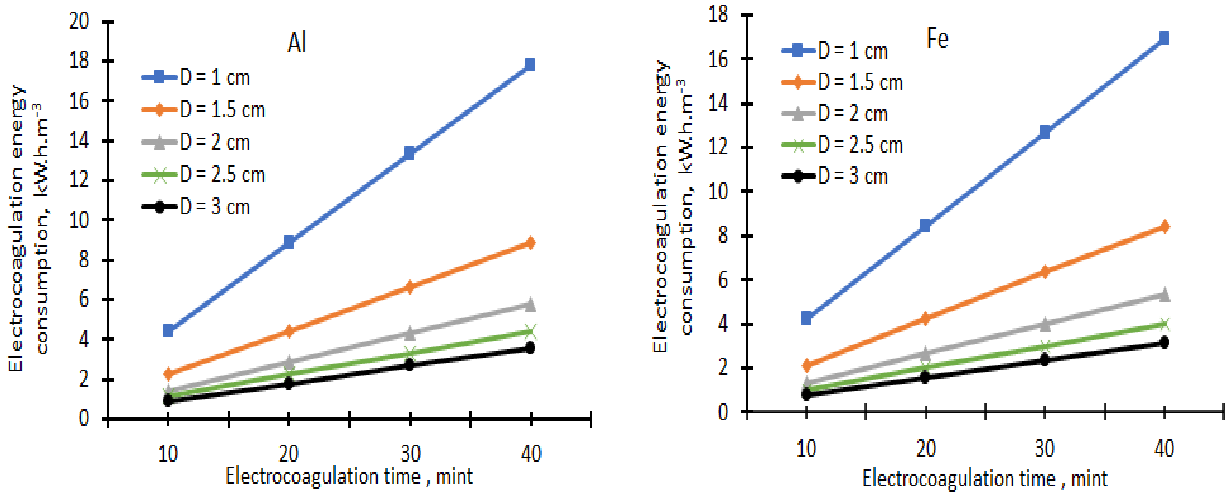

Fig. 3. Relation between electrocoagulation energy consumption and process time (10, 20, 30 and 40 mint) for two types of electrode at different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm).
Source: Own calculation.

The electrocoagulation energy consumption for Al electrodes were higher than the electrocoagulation energy consumption for Fe electrodes at all experiment conditions because the electrical conductivity for Al higher than Fe (Fig. 4).

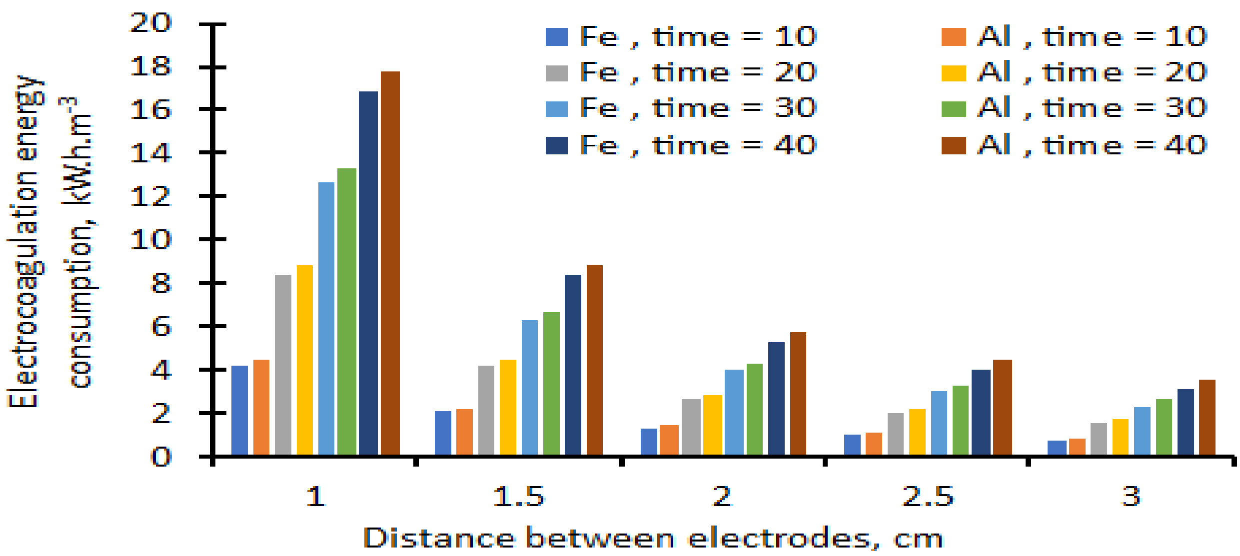

Fig. 4. Shows the compering electrocoagulation energy consumption for Al and Fe electrodes at different process time (10, 20, 30 and 30 mint) and different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm)
Source: Own calculation.

Removal efficiency of COD

The development of the removal COD concentration as a function of process time and distance between electrodes is significant for determining best conditions for the degradation of harmful organic substance. There were significant differences ($p<0.05$) between removal efficiency of COD and distance between electrodes. The removal efficiency of COD increasing with decreasing distance between electrodes for two types of electrodes. The removal efficiency of COD for Al electrodes at distance between electrodes 1 cm were 16.8, 18.6, 22.1and 27.3 % at time process 10, 20, 30 and 40 mint respectively. While, the removal efficiency of COD for Fe electrodes at distance between electrodes 1 cm were 16.4, 18.3, 21.8 and 26.3 % at time process 10, 20, 30 and 40 mint respectively (Fig. 5).

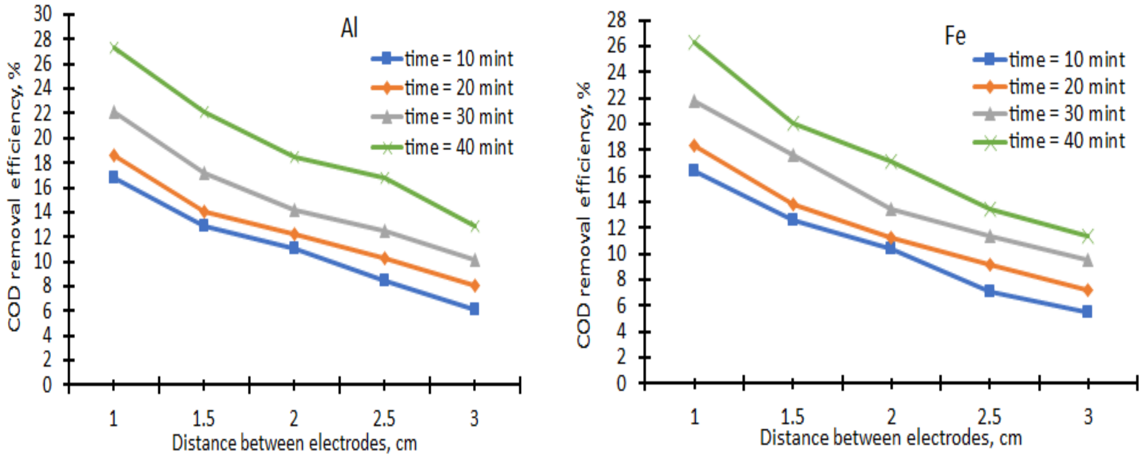

Fig. 5. Relation between removal efficiency of COD and distance between electrodes (1, 1.5, 2, 2.5 and 3 cm) for two types of electrode at different process time (10, 20, 30 and 40 mint)
Source: Own calculation.

There were significant differences ($p<0.05$) between removal efficiency of COD and process time. The removal efficiency of COD increasing with increasing process time for two types of electrodes. According to Fig. 6 the removal efficiency of COD for Al electrodes at process time 40 mint were 27.3, 22.1, 18.5, 16.8 and 12.9 % at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively. While, the removal efficiency of COD for Fe electrodes at process time 40 mint were 26.3, 20.1, 17.1, 13.5 and 11.4 % at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively.

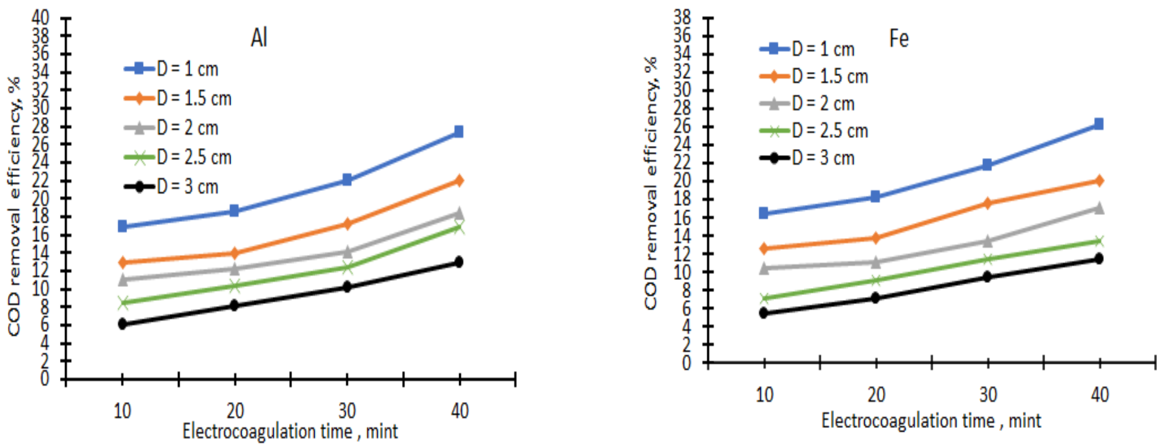

Fig. 6. Relation between removal efficiency of COD and process time (10, 20, 30 and 40 mint) for two types of electrode at different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm)
Source: Own calculation.

There were significant differences ($p<0.05$) between removal efficiency of COD and types of electrodes (Al and Fe). Fig. 7 shows that the removal efficiency of COD for Al electrodes was higher than Fe electrodes for all experimental conditions. At process time 40 mint and distance between electrodes 1 cm the removal efficiency of COD were 27.3 and 26.3 for Al and Fe respectively.

Specific electrical energy consumption is one of important indicator for electrocoagulation process. As shown as from Table 2, the specific energy consumption increases with increasing process time. For Al electrodes and distance between electrodes 1 cm, the specific electrical energy consumption were 0.64, 1.15, 1.46 and 1.57 kW.h.g^{-1} COD at process time 10, 20, 30 and 40 mint respectively. For Fe electrodes and distance between electrodes 1 cm, the specific electrical energy consumption were 0.62, 1.11, 1.40and 1.55 kW.h.g^{-1} COD at process time 10, 20, 30 and 40 mint respectively. The specific energy consumption increases with decreasing distance between electrodes. For Al electrodes and process time 40 mint, the specific electrical energy consumption were 1.57, 0.97, 0.75, 0.64 and 0.67 kW.h.g^{-1} COD at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively. For Fe electrodes and process time 40 mint, the specific electrical energy consumption were 1.55, 1.01, 0.75 0.72 and 0.66 kW.h.g^{-1} COD at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively.

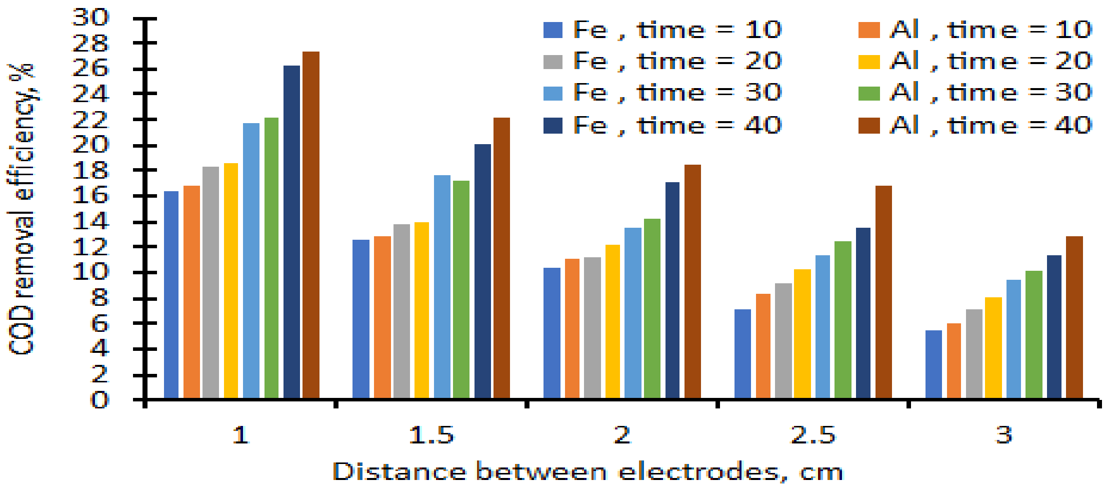

Fig. 7. Shows the compering removal efficiency of COD for Al and Fe electrodes at different process time (10, 20, 30 and 30 mint) and different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm).
Source: Own calculation.

Table 2: Specific electrical energy consumption (kW.h per g removal of COD) under different experimental conditions

Type of electrode	Time, mint	Specific electrical energy consumption, kW.h.g^{-1} COD				
		Distance between electrodes, cm				
		1	1.5	2	2.5	3
Al	10	0.64	0.42	0.31	0.32	0.35
	20	1.15	0.77	0.57	0.52	0.53
	30	1.46	0.94	0.74	0.64	0.63
	40	1.57	0.97	0.75	0.64	0.67
Fe	10	0.62	0.40	0.31	0.34	0.34
	20	1.11	0.74	0.58	0.53	0.52
	30	1.40	0.87	0.72	0.64	0.59
	40	1.55	1.01	0.75	0.72	0.66

Source: Own calculation.

Removal efficiency of TSS:

There were significant differences ($p<0.05$) between removal efficiency of TSS and distance between electrodes. The removal efficiency of TSS increasing with decreasing distance between electrodes for two types of electrodes. The removal efficiency of TSS for Al electrodes at distance between electrodes 1 cm were 9.2, 18.4, 38.8 and 47.6 % at time process 10, 20, 30 and 40 mint respectively. While, the removal efficiency of TSS for Fe electrodes at distance between electrodes 1 cm were 7.3, 16.4, 33.1 and 42.9 % at time process 10, 20, 30 and 40 mint respectively (Fig. 8).

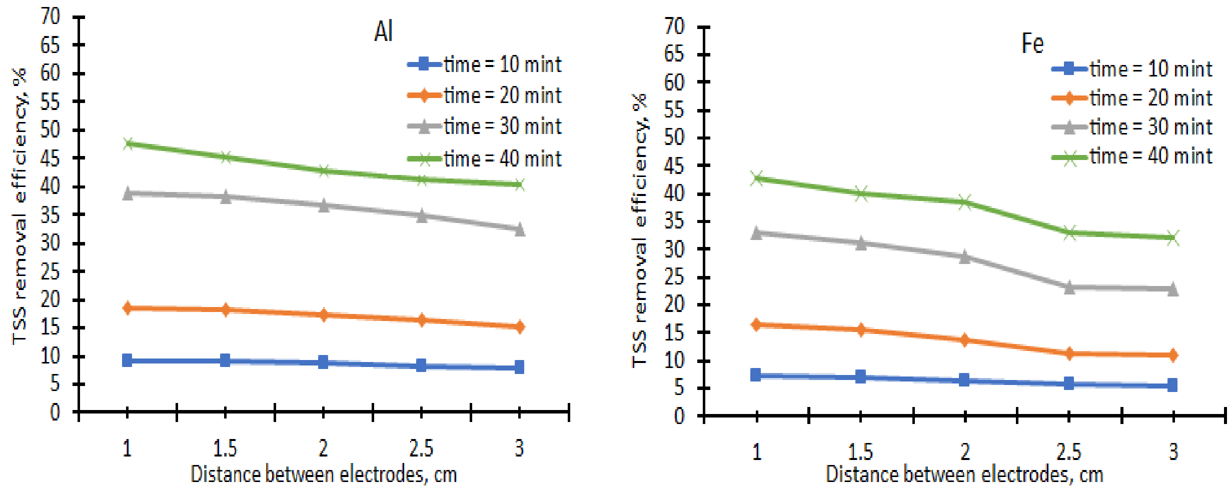

Fig. 8. Relation between removal efficiency of TSS and distance between electrodes (1, 1.5, 2, 2.5 and 3 cm) for two types of electrode at different process time (10, 20, 30 and 40 mint)
Source: Own calculation.

There were significant differences ($p<0.05$) between removal efficiency of TSS and process time. The removal efficiency of TSS increasing with increasing process time for two types of electrodes. According to Fig. 9, The removal efficiency of TSS for Al electrodes at process time 40 mint were 47.6, 45.2, 42.8, 41.2 and 40.4 % at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively. While, the removal efficiency of TSS for Fe electrodes at process time 40 mint were 42.9, 40.2, 38.4, 33.1 and 32.2 % at distance between electrodes 1, 1.5, 2, 2.5 and 3 cm respectively.

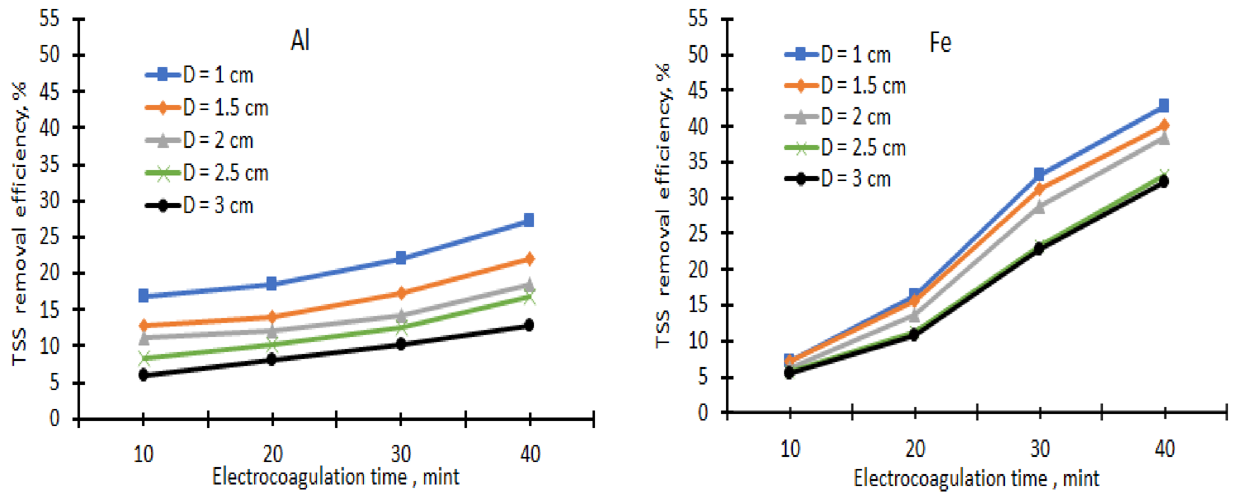

Fig. 9. Relation between removal efficiency of TSS and process time (10, 20, 30 and 40 mint) for two types of electrode at different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm)
Source: Own calculation.

There were significant differences ($p<0.05$) between removal efficiency of TSS and types of electrodes (Al and Fe). Fig. 10 shows that the removal efficiency of TSS for Al electrodes was higher than Fe electrodes for all experimental conditions. At process time 40 mint and distance between electrodes 1 cm the removal efficiency of TSS were 47.6 and 42.9 for Al and Fe respectively.

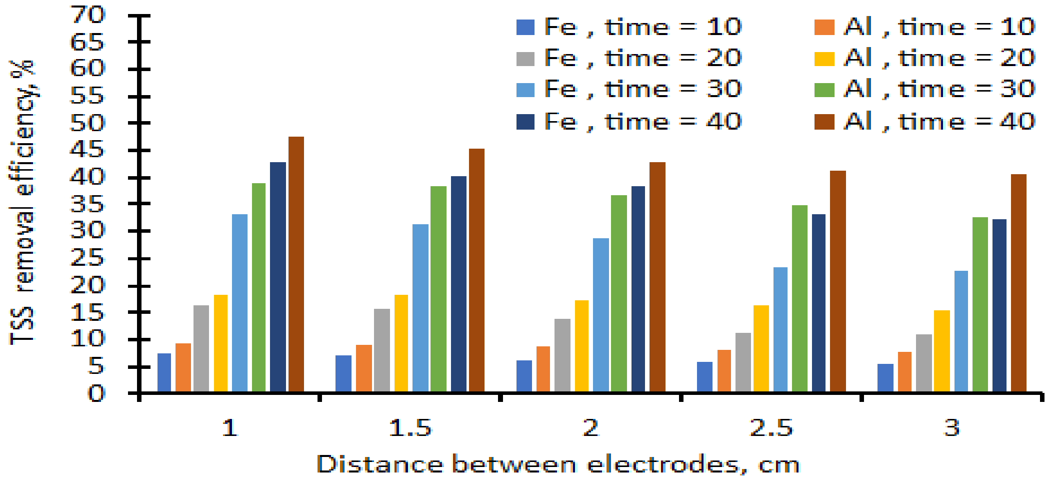

Fig. 10. Shows the compering removal efficiency of TSS for Al and Fe electrodes at different process time (10, 20, 30 and 30 mint) and different distance between electrodes (1, 1.5, 2, 2.5 and 3 cm)
Source: Own calculation.

CONCLUSIONS

Electrocoagulation one of the most electrochemical methods for waste water treatment. The electrocoagulation can be used to treat olive mill waste water. To obtain the optimum efficiency of electrocoagulation cell using Al electrodes, distance between electrodes 1 cm and electrocoagulation time 40 mint. In future studies, the olive mill wastewater treated in this process can be mixed with fresh water in different proportions and use in irrigation of agricultural crops and study the effect of that on soil structure and crop growth rate.

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ANALYSIS OF FISH FEED MARKETING IN IKEJA LOCAL GOVERNMENT AREA, LAGOS STATE NIGERIA

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Abstract

This study analyzed marketing of fish feeds in Ikeja, Local Government Area (LGA) of Lagos State, Nigeria. The study described socioeconomic characteristics of the marketers, identified distribution channels, determined marketing margins and efficiencies of the feed marketers, compared their profits and determined factors influencing supplies of fish feeds in the area by feed millers and the marketers. Primary data were gathered with structured questionnaires from 21 fish feed mills and from 84 fish feed marketers (63 fish feed retailers and 21 fish feed wholesalers) and analyzed with descriptive and Inferential statistical methods. Fish feed wholesalers posted a relatively higher monthly marketing margin and marketing efficiency than the retailers. In terms of profitability the fish feed retailers posted a higher Gross margin per kilogram of unbranded fish feed sold than the wholesalers. The OLS estimates revealed that supply of fish feed by wholesalers is positively influenced by price of the feed, cost of transportation, and access to credit but negatively influenced by cost of storage. To the retailers, the supply of fish feed was negatively influenced by unit cost of close substitute of fish feed (pelleted poultry feed), and daily charge of market toll. It was positively influenced by price of the fish feed, access to credit, and marketing experience. To encourage both wholesale and retail trade on fish feeds, Lagos State government should assist in bringing down transport costs; bankers should make fish feed traders have easy access to loans and landlords charge lower rents on old stalls and warehouses. Transportation costs can be reduced by subsidizing cost of fuel, providing cheap input delivery vans, and repairing damaged roads.

Key words: *marketing, fish feed, Ikeja, Nigeria*

INTRODUCTION

Fish farming is the rearing or production of fish in a controlled environment such as pond, cage, tank, irrigated canals, reservoirs and other types of enclosures [4]. In Nigeria production and supply have been on the increase in the last decade and demand for farmed fish is expected to continue to rise amidst soaring prices of imported fish and decline in capture fisheries [15]. Research has shown that the single most important input in fish farming is good quality fish feed, which represents 60-70 percent of the cost of operation [5, 18].

The fish feed industry in Nigeria is an important farm input subsector that has been developing to meet the demands of the country's fish farmers. It started with imported feeds and later local feed producers sprang up and started developing improved and cheaper feeds for the local fish farmers. The Lagos State government recently motivated fish farmers with free allocation of these feeds. Ordinarily, the fish feeds get to the farmers through the market system. Agricultural Marketing is concerned with all business activities that facilitate the movement of farm products or the inputs from the point of production until they are in the hands of consumers [12]. Fish feed marketing in a Ikeja area entails all business activities in moving formulated feeds from feed mills to fish farmers (processing, assembling, packaging/grading, transportation and storage/preservation). It also involves exchange, facilitating and institutional functions [13]. To analyze the marketing performance of these fish feed stakeholders in Ikeja, Lagos Nigeria, this study described the socioeconomic characteristics and distribution; determined and compared fish feed marketing margins and efficiencies of the traders, estimated and compared the profitability of the trade and determined factors influencing supplies of fish feeds in the area.

MATERIALS AND METHODS

Study Area

This study was carried out in Ikeja Local Government Area (LGA) of Lagos State, Nigeria. Ikeja LGA with its headquarters in Alausa is located in southwestern part of Nigeria within Latitudes $6^0.36^/$ and 6^0 $62^/$ North of the Equator and Longitudes $3^021^/$ and 3^0 $35^/$ of the Greenwich Meridian. The study area (49.92Km^2) hosts 861,300 inhabitants [7]. Ikeja LGA is bounded in the North by Agege LGA, to the East by Shomolu LGA, to the South by Oshodi-Isololah and Mushin LGAs, and to the West by Alimosho LGA. Ikeja is home to a large Textile plant, wood seasoning plant and lot of manufacturing factories in foot wears, pharmaceuticals, plastics, paper and cork, ceramics, paints, livestock (feed mills) and light bulbs. Poultry farming, especially chicken egg production and fish farming for cheap protein predominates in Ikeja, Lagos State Nigeria.

Sampling Technique

This study employed both purposive and random sampling methods in selection of respondents and gathering of data. In sampling fish feed traders in Ikeja LGA, seven (7) nucleus popular locations was randomly chosen from ten (10) nucleus popular areas (Oregun, Ojodu, Opebi, Akiode, Alausa, Agidingbi, Magodo, Oba, Maryland, and Government Residential Area (GRA). The chosen locations are Oregun, Ojodu,, Akiode, Alausa, Agidingbi, Magodo, and Oba. Twelve fish feed traders (9 retailers and 3 wholesalers) were randomly selected from each of the seven chosen locations that gave a sample of 84 fish feed traders and 21 fish feed mills were involved in this study. This means that sixty-three (63) fish feed retailers, twenty-one (21) fish feed wholesalers and twenty-one fish feed millers were involved in this study.

Data Collection

Primary data were collected following a cross sectional survey using a semi-structured questionnaire. The questionnaire was administered on respondents using interview method. The data collected included socioeconomic characteristics of respondents, cost price of fish feed, selling price of fish feed, monthly quantity of fish feed bought, monthly quantity of fish feed sold, distribution route, unit trade prices, transportation cost, storage/stall charges, cost of packaging material(s), wages to casual and permanent purchasing and sales workers.

Analytical Technique

A combination of analytical tools was employed in data analysis. The socioeconomic characteristics of the marketers as analyzed descriptively with frequency distribution Table, means and percentages. Marketing margins was defined as the difference between the price paid to the first seller and that paid by the final buyer [1]. The marketing efficiency was determined with Shepherd-Futrell model and as used by [18]. We determined the factors influencing supplies of fish feeds by feed millers and marketers using the Ordinary Least Square (OLS) technique.

Model Specification

MMw = wP minus PP ....(1)

where:
MMw is Marketing Margin of wholesalers;
wP is wholesalers Price;
PP is Producers Price;

MMr = rP minus wP .... (2)

where:
MMr is Marketing Margin of retailers;
rP is retail Price;
wP is wholesale Price.

The Shepherd Futrell model was specified as follows:

ME= Value added by Marketing/Total Marketing cost + Marketing Margin x 100 …..(3)

where:
ME is Marketing efficiency.
Note:
(i)The value added by marketing was proxied by Net Returns from fish marketing activities [11];
(ii)Total marketing cost was proxied by cost of marketing activities.
(iii)Marketing cost is the sum of transport cost, storage cost, labour cost and other costs associated with moving the commodity from point of purchase to the next buyer or final consumer [12].
The Net returns was estimated following cost route model as follows:

Net Returns = TR minus TC....................(4)

where:
TR= Total revenue (Naira);
TC= Total Cost (Naira).
The implicit models of Ordinary Least Square techniques used were used to determine factors influencing supply of fish feed by feed millers and marketers in Ikeja, Lagos. The models were specified as follows:

$Y= F(X_1, X_2, X_3,X_4, X_5, X_6, X_7, X_8, ei)$ – **Feed Millers**..(5)

where:
Y= Monthly Quantity fish feed supplied (Kg)
X_1 = Price per Kilogramme of raw materials (resource);
X_2 = Price of 25kg bag of produced fish feed (Naira);
X_3= Price of 25kg bag of poultry feed (close substitute) (Naira);
X_4= Feed transportation cost (Naira);
X_5= Annual Excise duty paid (Naira);
X_6=Annual cost of feed storage (Naira);
X_7= Annual depreciation of Machinery and Buildings (technology) (Naira);
X_8= Credit Access (Access=1; No Access=0);
e_i. =Stochastic error term.

$Y= F(X_1, X_2, X_3,X_4, X_5, X_6, X_7, X_8, ei)$- **Fish feed Traders**...(6)

where:
Y= Monthly Quantity of fish feed supplied (Kg)
X_1 = Number of years of trading on fish feed (yrs);
X_2 = Price of 25kg bag of sold fish feed (Naira);
X_3= Price of 25kg bag of poultry feed in market (close substitute) (Naira);
X_4= Feed transportation cost (Naira);
X_5= Annual trading tax paid (Naira);
X_6=Annual cost of feed storage (Naira);
X_7= Other fish feeds trading costs (Packaging materials, rent on stalls);
X_8= Credit Access (Access=1; No Access=0);
e_i. =Stochastic error term.

RESULTS AND DISCUSSIONS

Socio-economic Characteristics of Fish Feed Marketers and Feed Distribution

Table 1 shows trade-related socioeconomic characteristics of fish feed traders in Ikeja, Lagos Nigeria.
The Table revealed that one-third each of wholesalers (33.33%) and retailers (34.92%) have traded on fish feed for between 6 and 10 years. The least proportions (9.52%) of the wholesalers and (11.11%) of retailers had at least 16 years and 21 years' fish feed trade experience respectively.
Further, more of the wholesale fish feed meal traders (57.14%) had access to credit than the retailers (31.75%) of the fish feed in the area. These proportions of the traders having access to credit suggest poor access and signify limited access to farm input trading credit. This conforms to the findings of Okonkwo (2013) on poultry feed marketing in Imo State, Nigeria and [10] on fish marketing in Ebonyi State, Nigeria. Improved access to credit enables marketers to increase marketing scale and derivable income.
[8] observed that credit facilitates adoption of innovations, creates opportunities, encourages capital formation, improves efficiency, leads to increased productivity and income.

Table 1 Distribution of Fish Feed Marketers By Trade-related Socio-economic Characteristics in Ikeja, Lagos Nigeria

Socioeconomic Characteristics	Wholesalers		Retailers	
Trading Experience (Years)	**Freq.**	**%**	**Freq.**	**%**
1 - 5	3	14.29	12	22.22
6 - 10	7	33.33	22	34.92
11- 15	6	28.57	9	14.29
16 -20	2	9.52	11	17.46
Above 21	3	14.29	7	11.11
Total	21	100.00	63	100.00
Mean	12.36		10.25	
Std. Dev.	4.44		3.61	
Access to Credit				
Yes	11	57.14	20	31.75
No	9	42.86	43	68.25
	21	100.00		100.00
Source of Operating Capital				
Personal Saving	17	80.95	59	93.65
Friends/Relatives	6	28.57	19	30.16
Cooperative societies	3	14.28	12	19.05
Local Money lenders	1	4.76	7	11.11
Commercial Banks	4	19.05	1	1.59
Microfinance Banks	8	38.10	9	14.29
Bank of Agriculture	1	4.76	3	4.76
	21	100.00	63	100.00

Source: Field Survey, 2019.

These socioeconomic characteristics facilitated fish feed distribution in the area such that fish feed millers sold the fish feeds to wholesalers, and the wholesalers sold to the relatively many retailers. The retailers in turn sold to fish farmers who use the feeds in feeding fishes in their various ponds. This is the major or popular route of fish feed delivery in the area. However, the fish millers sometimes under some agreements or public relation obligations or as part of their Corporate Social Responsibilities (CSR) sold fish feeds to retailers and fish farmers. The wholesalers on their part also sold some fish feed to fish farmers under similar agreements.

Marketing Margins and Marketing Efficiency of Fish Feed Marketers

The marketing margins in naira shared by the fish feed traders (wholesalers and retailers) and the marketing efficiency of the fish feeds in Ikeja as estimated was shown in Table 2.0. The marketing margins are the differences between the unit selling prices paid by the final buyer and the unit purchase prices paid by the marketer. Table 2.0 showed that the fish feed wholesalers earned ₦68.12 and the retailers earned ₦66.94 per kilogramme of fish feed transacted on. The marketing efficiency was ₦306.92 and ₦204.05 to wholesalers and retailers respectively. These values of efficiencies were very high indicating high profits to the traders at the expense of the fish farmers.

Marketing efficiency ratio should range from zero to infinity and figures less than 100.00% indicates inefficiency [14]. This means that more is spent on value-addition compared to the margin received after the value addition. A market efficiency ratio of 100.00% shows the market is perfectly efficient meaning that a price increment is just high enough to cover the cost of marketing. Where marketing efficiency value is greater than 100.00% it indicates excess profit for the marketers [3, 12, 16]. Table 2 revealed that the fish feed wholesalers had higher marketing efficiency than the retailers and could have achieved such by trading on larger monthly quantities of fish feed and had enjoyed relatively better economies of scale from the feed sales.

Table 2. Marketing Margins and Marketing Efficiency of Fish Feed Marketers in Ikeja, Lagos State, Nigeria

Margin Variable	Wholesale Prices (₦)	Retail Prices (₦)
Selling Price per kilogramme	358.32	425.31
Purchase Price per Kiligramme	290.25	358.37
Marketing Margin (Selling Price minus Purchase price)	**68.12**	**66.94**
Marketing efficiency (%)	**206.92**	**204.05**

Source: Own calculations, 2019.

Profitability of Trading on Fish Feeds by Marketers

The profitability of trading on fish feeds in Ikeja area was estimated and shown in Table 3.

The Table showed that some of the feed traders traded on branded feeds while others traded on unbranded fish feeds in the area. Recognizing this and adding the returns eventually, a mean revenue of ₦997,172.15, and variable cost of ₦823,685.93, was posted by the wholesalers while the retailers posted a mean revenue of ₦298,148.54, and variable cost of ₦256,417.67. These gave Gross margins shares of ₦171,486.22 to wholesalers and ₦41,730.87 to the retailers. In their cost outlay, the wholesalers incurred total fixed costs of ₦31,925.22 and posted net returns of ₦139,561.00 while the retailers incurred total fixed costs of ₦139,561.00 and made Net returns of ₦33,061.26 from fish feed sales.

These computations showed that fish feed marketing in Ikeja was profitable to both the wholesalers and the retailers in the area. This finding corroborates with observations of [9] in Ahiazu Mbaise, Imo State Nigeria with respect to marketing of chicken poultry feeds. The chicken poultry and aqua culture fishes are fast growing and maturing enterprises that produce animal protein, consumed by many households. Inmates of households consuming these animal proteins are guaranteed food security and good health. These protein sources can be considered as farm product substitutes as market forces operate on them in similar forms and they obey economic theories as close substitutes in farm input markets.

Table 3. Profitability of Fish Feed Marketing in Ikeja, Nigeria

Items	Wholesalers			Retailers		
	Unit Cost (₦)	Qty (Kg)	Value (₦)	Unit Cost (₦)	Qty (Kg)	Value (₦)
A. **Revenue**						
Av. Selling price of branded fish feed	358.37	1,614.10	578,445.02	425.31	476.2	202,532.62
Av, Selling Price unbranded fish feed	310.12	1,315.21	418,727.13	380.47	251.31	95,615.92
Total Revenue(TR)			**997,172.15**			**298,148.54**
B. Variable Costs						
AV. Purchase price of branded fish feed	290.25	1,614.10	468,492.53	358.37	476.2	170,655.79
Av. Purchase Price of unbranded fish feed	238.51	1,,359.21	322,038.59	305.62	251.31	76,805.36
Transportation Cost			18,900.64			4,900.57
Labour(Loading/offloading)			11,499.09			3,000.10
Packaging Cost			4,755.08			1,055.85
Total Variable Cost (TVC)			**823,685.93**			**25,6417.67**
C. Gross Margin (GM)= TR-TVC			**171,486.22**			**41,730.87**
D. Fixed Costs						
Rent			18,200.7			5,208.80
Interest on loan			6,223.6			1,320.00
Market Dues (Tax)			2,400.02			1,020.21
Asset Depreciation			5,100.9			1,120.60
Total Fixed Cost (TFC)			**31,925.22**			**139,561.00**
Total Cost (TC)= TFC +TVC			**857,611.15**			**265,087.28**
Net Return= GM - TFC			**139,561.00**			**33,061.26**

Source: Own calculations, 2019.

Factors Influencing Supply of Fish Feeds By Marketers

Fish feed marketers (feed millers n=21, wholesalers n=21 and Retailers n=63) supplied fish feeds separately at different levels of the feed value chain. The Ordinary Least Square (OLS) estimators revealed best factors influencing fish feed supplies by Feed Millers and Wholesalers with Linear functional form and for Retailers with Exponential functional form (Table 4).

Fish Feed Millers: Table 4.0 shows that for the Feed Millers, the price of Maize and other resource prices had inverse influence in the supply of fish feed. This was in line with a priori expectations that increases in price(s) of inputs/resources used in manufacturing lead to increases in the cost of production which lower the profit margin of the manufacturers and functioned as a disincentive to the quantities of fish feed supplied by the feed millers in Ikeja. This finding was in line with the findings of [6] and [17] in production of poultry products in Nigeria and Ghana respectively.

The coefficient of price of related product (price of pelleted poultry feed) was negative (-0.393) and highly significant (p<0.01), suggesting that a unit increase in the price of pelleted poultry feed reduces supply of fish feeds by 0.393%. This was plausible because when price of poultry feed increase, feed millers produced and supplied more of poultry feeds, - the close substitute. The production of more poultry feed consumes more of raw materials especially maize which the fish feed production competes for and therefore forced down production of fish feed as well as its supply by the millers. The increase in unit price of fish feed was directly proportional and highly influential (p<0.01) in determining the its increased quantity supplied. The cost of transportation had a positive but lower influence (p<0.10) on the quantity of the feeds supplied in the area. In an opposite (negative), taxes/levies on the millers had lower influence (p<0.10) on the quantity of fish feeds supplied. Access to credit was a factor that had positive and high influence (p<0.01) on the quantity of fish feeds supplied in the area.

Feed wholesalers: The lead equation revealed that price of the fish feed, transportation cost, and the traders access to credit were factors that positively and highly influenced supply of fish feed by the wholesalers. This revelation confirms the findings of [2] that availability of credit significantly impacts on production decisions of poultry farmers that enabled them expand their production scale and their product supply. The storage cost of the fish feeds had negative and high influence (p<0.01) on the supply of feeds by the wholesalers trading on it in the area.

Feed Retailers: The Price of related product (Pelleted Poultry Feed), taxes and levies had negative and moderate influences (p<0.05) on quantity of fish feed supplied by retailers in the area.

Table 4. OLS Lead Equations Estimate of Factors that Influenced Fish Feed Supplies By Stakeholders (Feed Millers, Wholesalers, and Retailers) in Ikeja, Nigeria

Variablrs	Feed Millers (n=21)	Wholesalers (n=21)	Retailers (n=63)
	Lead Functional forms		
	Linear	Linear	Exponential
Constant	4.498*** (3.213)	411.492*** (3.892)	41.674 (0.735)
Maize/Resource Price	-0.327*** (-3.147)	N.A	N.A
Price of related product(Pelleted Poultry Feed)	-0.393*** (-2.727)	-0.736 (1.552)	-0.261** (-1.985)
Price of Fish Feed	0.464*** (4.108)	0.927*** (3.616)	1.561*** (3.341)
Level of Education	N.A	2.932 (1.322)	0.224 (0.910)
Marketing Experience	N.A	0.089 (1.214)	0.323* (1.713)
Transportation cost	0.361* (1.726)	0.147*** (3.689)	0.674 (1.037)
Taxes/Levies	-0.438* (-1.698)	1.14e-06 (1.542)	-1.062** (1.964)
National/Religious festival Months	0.043 (1.062)	N.A	N.A
Production Technology	0.043 (1.350)	N.A	N,A
Storage Cost	N.A	-1.275*** (-3.727)	-0.425 (-0.624)
Credit Access	0.460*** (3.456)	0.274*** (3.614)	0.310** (2,204)
R-Square	0.703	0.6705	0.7151
Adjusted R-Square	0.683	0.6325	0.6921
F-Value	42.730***	9.756***	17.564***

Source: Own calculations, 2019.

***, **, and *, indicate variables significant at 1.0%, 5.0%, and 10.0% alpha levels of probabilities respectively.

Figures in parentheses are t-ratioS.

Another factor (Access to credit), had a moderate and positive influence on the quantity of fish feed supplied by the retailers in the area.

The only factor that highly and positively influenced (p<0.01) the supply of the fish feed by retailers in the area was price of the product- the fish feed.

To enhance supplies of fish feed and other livestock feeds in Ikeja, there is need to reduce taxes, rents on sales stalls and warehouses, and prices of maize the major raw materials livestock production as well as encourage sources of loans to easily lend millers and traders.

CONCLUSIONS

This study concluded as follows:
(i)Branded and unbranded fish feeds are sold by wholesalers and retailers in Ikeja feed markets;
(ii)Fish feed marketing was profitable to both wholesalers and retailers in Ikeja, Nigeria;
(iii)Bulk transportation of raw materials, feeds and humans were done at high prices in the area;
(iv)The wholesalers and retailers exploited the fish farmers as both posted marketing efficiencies of far above 100.00% in the area;
(v)High marketing efficiencies suggested relatively high prices being charged on the fish feeds sold in Ikeja.
(vi)Landlords of stalls and warehouses in the area are charging highly for the use of their facilities in the area.
To encourage fish feed marketing in Ikeja we recommended as follows:
(i)Both wholesale and retail trade on fish feeds should have easy access to trade loans. Commercial Banks, and Bank of Agriculture should extend easy loans to these traders to enhance their trade;
(ii)Lagos State government should focus and bring down transport costs and make fish feed traders enjoy cheap transport for their wares. Transportation costs can be reduced by subsidizing cost of fuel, providing cheap input delivery vans, and repairing damaged roads;
(iii)Landlords should charge moderate prices for the use of their facilities as stalls and warehouses in the area. Buildings that are relatively old in service in the area should charge relatively lower rents in the area to provide cheap accommodation as sales stores and warehouses.

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TRENDS IN ORGANIC RASPBERRY MARKET IN UKRAINE AND WOLRDWIDE

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Abstract

The purpose of the paper is the analysis of the main trends in organic agriculture, based on the research of the world markets of organic agricultural products and specificities of the organic raspberry cultivation in Ukraine. Definitely Ukraine has credible prospects for gaining leading positions on global market of the organic production. In the paper there were determined the main risks in doing business, which is related to the organic raspberry cultivation, and which could be classified into three main groups: natural and climate risks;manufacturing risks and market risks.

Key words: *organic production, organic raspberries, agriculture, organic lands, the world market of organic products*

INTRODUCTION

In recent years, Ukraine and the World have experienced a growing dynamics of an agricultural branch development, such as fruit and berry crops cultivation on industrial scale [9].

It is worth highlighting that the current experience of the Ukrainian agrarian enterprises in the sphere of organic berries cultivation is not enough. The factors which determine the efficient level of use and increase of agricultural enterprises' potential for developing the organic berries cultivation business, particularly of raspberry, in Ukraine and worldwide, need more thorough scientific research.

Organic farming is an opportunity for Ukraine to pass to the Green economy [10].

MATERIALS AND METHODS

Dialectic method of knowledge and systemic approach to studying economic phenomena and processes serve as a theoretical and methodological basis of the research. There have been utilized the following methods of scientific research, as: induction and deduction for the sake of attaining objectives set by the scientific research, in particular, in order to study and calculate the impact of the relevant factors on the possibilities for cultivating organic berry. Analysis and synthesis have been utilized for detailing the object of research by means of dividing it on separate parts. Classification was used for systematizing the factors of impact on the given branch potential forming. In addition to that, the economic and statistic methods (in particular, dynamic lines, analytical aggregating etc.) have been used for determining the trends of changes of the separate indicators in this branch. Table methods have been used for the visual representation of the research's outcomes. Comparison, as a method, has been utilized during the analysis of the situation with prices on the markets of agricultural products in Ukraine and worldwide.

RESULTS AND DISCUSSIONS

The general indicators of the world raspberry markets. Ukraine's positions.

Berries cultivation comprises about 6 percent of the corresponding products value in the general structure of fruit and berry crops production in Ukraine. Growing demand on foreign markets, primarily, on the markets of the European Union countries, favors the berry cultivation enlargement.

Researching the geography of places, employed for raspberry cultivation, it would be right to underline that its production is the most common in the European countries, specifically in Poland, Germany, France, United Kingdom, Serbia, Montenegro, Hungary and Ukraine. The relatively new countries with rather favorable conditions for raspberry cultivation and, consequently growing volumes of its production, can be found in North America, in particular USA and Canada, where berries consumption as a flavoring to other types of products, for instance, milk ones, is popular, given the high purchasing power of the local citizens. In addition, raspberry cultivation is being started in countries, which are situated in other climate zones and even latitudes, for example in subtropical Mediterranean region of Europe, particularly in Spain, Portugal and Southern Italy, and also in arid regions of the tropical zone of North Africa, specifically in Morocco and Algeria. Raspberry has become quite popular also in East Asia, primarily in China and South Korea. In South America, raspberry is the most popular in Chile, and among the countries of Africa in the South from Sahara, raspberry is cultivated in Kenya. Besides that, raspberry is cultivated in Turkey, Cyprus, Israel, Azerbaijan, Iran, in Fergana valley region (Eastern Uzbekistan, Kyrgyzstan and Tajikistan) and also in Taiwan and in even in New Zealand [5, pp. 145-179].

According to the Food and Agriculture organization (FAO), the worldwide harvest of raspberry has reached 795 thousand tons in recent years. More than 75 percent of that volume being produced by top-5 countries of the world raspberry production list.

Table 1. Top 5 countries in the World by raspberry production (thousand tons)

	2014	2015	2016	2017	2018	2018 to 2014, %
Russian Federation	144.0	137.8	151.7	133.2	165.8	115.1
Mexico	35.6	65.4	112.7	120.2	130.2	365.4
Serbia	61.7	97.2	113.2	109.7	127.0	205.8
Poland	125.9	79.9	129.1	104.5	115.6	91.9
United States of America	103.5	119.3	117.2	102.8	99.3	95.9

Source: Calculated by authors based on the data from [8].

Among the EU countries, the largest producer of raspberry is Poland with 115.6 thousand tons. The biggest producer of raspberry in the Western hemisphere is the USA, which produces 95.9 thousand tons. Mexico, situated in the tropical climate zone, is the second largest producer of raspberry in the world. It produces more than 130 thousand tons of raspberry. Russia and Serbia carried out 165 and 127 thousand tons, occupying the 1st and 3rd places for raspberry production in the world.

Nowadays, the total cultivation of berries in Ukraine amounts to 130-135 thousand tons. However, only 15 percent of berries in Ukraine is being produced at industrial facilities. The cultivated areas with raspberry in Ukraine account for only 20 thousand hectares. Mostly, they are used for planting strawberry, raspberry and current. The average yield of berries in Ukraine is equal to about 6,000 kg per hectare. The largest producers of berry in Ukraine are Vinnyts'ka, Dnipropetrovs'ka, Donets'ka, Zhytomyrs'ka and Kyivs'ka regions.

Raspberry is one of the most popular berries in Ukraine taking into account the production level. In recent years, Ukraine has surpassed 31 thousand tons of raspberry annually, and occupies the 7th position in the world list with 4 percent share of the global market. In 2018, Ukraine produced 35,150 metric tons of raspberry, having the average yield of 7,170 kg per hectare. Besides this, in 2018 China reached the top position of raspberry production, having collected 75 thousand of it with an average yield of 5 tons per hectare. It is worth underscoring that the productivity of the Ukrainian lands, occupied for raspberry cultivation, is in the top, but for Mexico, England and Scotland and, though not by much, however still surpasses the level of most other great producers by the productivity per square unit.

The export price for the Ukrainian raspberry is relatively lower in comparison to the producers from other countries and is about US $1,000-1,100 per ton. For instance, the price tag per ton of the exported raspberry from one of the most dynamic competitors of Ukraine, which is Bosnia and Herzegovina has been about US $1,600 – 1,700 per ton of berries. Meanwhile, the producers from Poland has priced their raspberry at approximately US $1,300-1,400 per ton, while the German export raspberry price has comprised US $7,000.

The recent most dynamic production growth of raspberry has been seen in Mexico, USA, Bosnia and Herzegovina, also raspberry production has been growing in a bit smaller scales, but by an annual dynamics of 40 percent, in Bulgaria, Belgium, Norway, the Netherlands, Moldova and Finland.

According to the outcomes of 2018 the official international raspberry market reached the volume of 480 thousand tons. In terms of physical production, the volume of the international raspberry market had grown by 23 percent during 2013-2018, and the average price tag for it had decreased by 27 percent for that period.

The world markets of organic agricultural products and specificities of the organic raspberry cultivation in Ukraine

The development of organic raspberry production in Ukraine is taking place within the context of the national organic products market growth on the backdrop of this type of agricultural products getting more popular globally. In particular, in pursuance to the data from the Federation for the organic movement of Ukraine, since 2002, when the development of the organic production began in this country, the number of the corresponding certified enterprises has grown 100 times until nowadays and the total area of the certified lands has tripled.

By the results of 2019, there were 72.29 million hectares of organic lands cultivated worldwide (Table 2). Australia is a leader for the surface of the organic lands in the world, having 35.7 million hectares.

Table 2. Top 10 countries of the World by the square of organic lands in 2018 (million hectares)

	2008	2017	2018	2019	2019 to 2008, %	2019 to 2017, %
Australia	11.96	35.65	35.69	35.69	298.41	100.11
Argentina	4.08	3.39	3.63	3.67	89.95	108.26
China	1.74	3.02	3.14	2.22	127.59	73.51
Spain	1.17	2.08	2.25	2.35	200.85	112.98
Uruguay	0.67	1.88	2.15	2.14	319.40	113.83
France	0.39	1.74	2.04	2.24	574.36	128.74
United States of America	1.96	2.03	2.02	2.33	118.88	114.78
Italy	1.06	1.91	1.96	1.99	187.74	104.19
India	1.02	1.78	1.94	2.3	225.49	129.21
Germany	0.8	1.37	1.52	1.61	201.25	117.52
World	34.25	69.49	71.51	72.29	211.07	104.03

Source: Calculated by authors based on the data from [8].

By the results of 2019, the square of the organic lands in Ukraine constituted 468 thousand hectares, which put it on the 20th position by that indicator among the countries of the world. During the last decade, the respective lands square has grown 2.5 times and for the last 5 years the corresponding numbers have increased by 50 percent. Approximately 48 percent of these lands are used for crops cultivation, 16 percent for oil seeds and 4.6 percent are used for beans, while only 2 percent of them are occupied by vegetables and merely 0.6 percent are allotted for cultivating fruits, encompassing organic raspberry. It is worth noting that Ukraine has got some potential for the enlargement of the organic lands square, as the country has 550 thousand of the certified wild terrains.

The Law of Ukraine "On the agricultural products and raw materials production and turnover", issued in 2013, provisioned the basic points of functioning and regulated the market of organic agricultural products. The adoption of the Law of Ukraine "On the fundamental principles and requirements for the organic production, turnover and branding of the organic products" in 2018 became a supplement to the legislative essentials with the clarification of many aspects for its development [3].

One of the key factors, which impacts the organic farming success in the current conditions of its development is the people's purchasing power. Purchasing power of Ukrainian customers is considerably lower than in the EU countries, and this translates into statistics of the organic products consumption per capita. Such level of the organic products consumption in the EU member countries, in average, yields to 53.7 euros per capita, while in Ukraine the corresponding number constitutes only 3 euros per capita. According to the other data, the respective figure for Ukraine is merely 68 cents, whereas, in average, in the European countries, it yields to 40.8 euros, while in the EU members, it amounts to 60.5 euros. However, the internal Ukrainian market of the organic products has been actively growing. In 2019 the internal market of the organic products aggregated US $ 24.3 million, and if we compare that with the 2005 figures, it may be seen that then there was sold US $200 thousand of organics. However, if we compare these figures with the ones from the leading countries of the world in the sphere of organic production in 2019, in Germany, the volume of the organic products on the internal market reached approximately US $13 billion.

Export to the foreign markets, primarily to the EU member countries remains to be the main driver for the national agricultural organic production growth. In 2019, the export of the organic products from Ukraine to foreign markets summed up to about US $189 million. The export structure comprised crops, beans, oil cultures and berries. Organic butter, cereals and dairy products were exported in a less extend. Wheat and corn were the main organic exported crops and the EU countries and Switzerland were most export markets. The USA, Canada and the Middle East countries constituted only 2 percent of the respective export markets.

The global market of the organic products was estimated at approximately US $100 billion 2018-2019. Whereas, 39 percent of that market belonged to the USA, 12 percent were constituted by Germany, 10 percent by Switzerland, Austria 9 percent and the PRC amounted for 8 percent, respectively. Predominantly, price tags for environmentally friendly (green) products are as much as two or three times as expensive as they are for the common foods and products. Berry cultivation is one of the most prospective niches of the organic production in Ukraine. In average, the total production of berries has been growing by 4 percent in Ukraine annually. The annual global market of berries' consumption has been growing by 3 percent, in average.

Market's conjecture: production and sale of organic raspberry in Ukraine and abroad

Currently, in Ukraine, 90 percent of farms, which deal with organic berry cultivation, have an average area of 10 hectares. In Ukraine, the largest organic plantation for growing berries reaches about 85 hectares of square. The total surface cultivated with raspberry in Ukraine amounts for 6 thousand hectares. It is worth highlighting that the frozen raspberries export volume has been steeply growing in recent years, as actually, in 2017 it yielded to 8 thousand tons and in 2019 it amounted to 12 thousand tons, and in 2020 it has reached 21 thousand tons. The main markets for its exports were Poland, Germany and Czechia. It is worth saying that the organic raspberry cultivation in Ukraine is considered to be relatively the most profitable if to compare it with strawberry and current, which are considerably less profitable. There are 51 farming businesses, which are cultivating organic raspberry in our country and generally possess the total area of 280 hectares of land, which yield 2,240-2,800 tons of the organic raspberry. Thus, the average productivity of the organic raspberry in Ukraine constitutes 8-10 tons per hectare, or when planting 6-7 thousand of seedlings per hectare, then one seedling can yield from 1.2-1.3 to 1.6-1.7 kilograms of the organic raspberry. In Ukraine, the agrarian experts suppose that the organic raspberry productivity, which, as the experts underline is usually one and a half or two times lower than the common one, in favorable conditions, can vary from 6 to 12 tons per hectare.

The organic raspberry is the most commonly planted organic berry, which is being cultivated by organic farms in Ukraine, nowadays. For comparison, organic strawberry and garden strawberry are being cultivated by 19 farms, using 25 hectares of land and collecting 200-250 tons, correspondingly, blueberry is being planted by 10 farmlands with 25 hectares, blackberry is being planted by 6 farms with 15 hectares, current is being produced by 6 farms with 5 hectares, collecting 50-60 tons of berries, consequently [7].

Based on their financial calculations, some Ukrainian consulting companies have made conclusions that expenses for buying seedlings take the largest part, about 45 percent, within the structure of capital investments for planting organic berries. Whereas, 19 percent, more than twice less, are spent for buying technical equipment, while constructing works require approximately the same expenses, specifically, 18 percent, and refinancing money flow for doing business takes 14 percent.

From year to year, the prices for the organic raspberry fluctuate, however, mostly the price tag for purchasing this organic berry is two, or sometimes, three times higher than the prices for the common raspberry. Wholesale prices for the common raspberry in 2019-2020 were changing within the range from ₴35 to ₴45 UAH per 1 kilogram. In retail, raspberry was traded at prices above ₴20 UAH on the food (open) markets and from ₴40 to ₴70 UAH at supermarkets, depending on the class and the sort of the product. In Poland, the retail prices for raspberry amounted to 140-150 in hryvnia equivalent and they even reached 260-270 in UAH equivalent in network stores. In Ukraine, purchase prices for the organic raspberry may comprise to €2-2.5 euros per kilogram, which is equal to ₴65-80 UAH per kilogram, in conditions favorable to the producers and provided there is no overproduction on the market.

According to the experts' evaluations, the pace of the national organic production growth is 5.5 times higher than the corresponding paces in the European countries and in 4.9 times as high in dynamics as they are worldwide.

If to compare the scales of the organic agricultural products manufacturing development in different Ukrainian regions, it could be assumed that the L'viv region is one of the leading among others in this branch. In spite of that, the most organic farmlands are located on the territories of Kyiv, Odesa, Kharkiv, Kherson, Kropyvnyts'kyi, Chernihiv, Zhytomyr and Khmelnitsky regions. Consequently, convenient transport location and recent inflow of capital into the regional economy, especially into its agricultural business, are not bad prerequisites for the organic products cultivation, including raspberry, on the farmlands of the L'viv region [2].

CONCLUSIONS

Thus, assuming the outcomes of the research, it is worth highlighting that Ukraine has credible prospects for gaining leading positions on global market of the organic production. In particular, it relates to the organic raspberry cultivation, however, for doing business effectively in this direction, it is necessary to take into consideration that berry products have short expiration time and are very demanding to the storage and transportation conditions, so when dealing with it the main risk lies in considerable losses of the processed goods. Apart from that, it is worth noting that there is also a risk of sharp price volatility for the berry products, as on the national and on the foreign markets, as well. In general, organic raspberry cultivation is a risky business from the point of view of the natural and climate phenomena, manufacturing and market factors [1; 4; 6].

The negative impact of natural phenomena can be counted as the natural and climate risk for the organic raspberry cultivation. In particular, this factor is strengthened because the organic raspberry cultivation does not entail the use of any additional chemical means for protection. Eventually, there is growing a risk of harming the seedlings and already formed berries by the fluctuations of temperature, precipitations, diseases and pests.

To the manufacturing risks, we encompass a probable low yield of the organic raspberry because mineral fertilizers and growth stimulators are not used in the organic products cultivation.

To the market risks of the organic raspberry production, we include the fact that the organic berry products manufacturing structure is constituted by raspberry per more than 50 percent and its share is constantly growing. This culture overproduction can eventually cause decline in the average level of its market prices, what can be a hindrance for getting revenues necessary for profit.

The complex strategy of the organic market development in Ukraine, for the sake of minimizing the mentioned risks, could serve as a subject for further scientific researches.

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LOCAL ACTION GROUPS AND THEIR INFLUENCE ON LOCAL RURAL DEVELOPMENT. CASE STUDY: LAG "VEDEA GĂVANU BURDEA", OLT COUNTY, ROMANIA

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Abstract

Over time, the LEADER Program has brought a number of positive changes to rural areas and has played an innovative role in addressing many of the problems facing the rural environment. Since its launch in 1991, the LEADER axis has sought to provide rural communities in the European Union with an effective method of involving local partners in guiding and managing the future development of the area covered by LAGs. The main aim of the paper is to demonstrate the usefulness of Local Action Groups at regional level for the sustainable development of rural areas through its actors: local communities, existing economic agents in the LAG, local public administrations or constituent members of the LAG, public and private. A series of methods were used such as: comparative analysis, both in terms of quantity and quality, as well as the method of the questionnaire applied to a number of 340 inhabitants in the LAG area "Vedea - Găvanu - Burdea". The implementation of the questionnaires resulted in a series of conclusions and recommendations aimed at increasing the income of the inhabitants of the LAG territory, as well as improving the quality of life, stabilizing it, as well as ways to make better use of local agricultural products. In the opinion of local actors, the LAG must continue to maintain the current line of evolution and capitalize on the rural, natural and ethno-cultural potential of the area, by developing and increasing added value, by innovative approach to tourism, agriculture, food industry and diversification. rural economies. Public administrations in the region covered by the LAG are of the opinion that the directions in which investments should be directed are public utility infrastructure. Another recommendation is to simplify bureaucracy, for most respondents the main obstacle to accessing European funds is bureaucracy.

Key words: *Local Action Group, Rural Development, LEADER Program*

INTRODUCTION

Rural Development Programs (RDP), at the level of each Member State of the European Union, are a very important component of agricultural policy, promoting the sustainable development of rural areas in Europe and addressing socio-economic as well as environmental issues. The RDP is the instrument through which each Member State attracts the financial resources allocated by the EU for agriculture and rural development, which is structured in priority axes, each addressing a specialized area of intervention [6], [13]. The LEADER program is Axis 4 of the NRDP, but differs from it in its specific approach [15].

At the same time, about 90% of the EU's territory is located in rural areas, where more than half of Europe's inhabitants live [16]. In this sense, LEADER, whose name comes from "Links between rural development actions", has had and still has, for the rural development policy of the European space, an innovative approach [10], [4], [9].

The LEADER approach, through its specific actions, will lead to the improvement of local governance and the promotion of the endogenous potential of the territories [1], [5], [8]. Also, the LEADER approach implies the consolidation of territorial coherence and the implementation of integrated actions, which can lead to the diversification and development of the rural economy, for the benefit of the communities [12], [14].

One of the main advantages of a local action group in a region is to focus, together with the actors that make it up, on the problems of that territory and to be able to make guides of the proposed measures in order to solve the identified needs. in the territory of the LAG [2]. The community has an important role in determining the needs, but also the strategic directions of local development of micro-regions, as only those who live here can identify these needs because they face them daily [3], [11].

In order to correctly identify the needs of the members of the LAG "Vedea - Găvanu - Burdea" it was necessary to evaluate the community within the LAG, the economic agents in this region, the local public administration, as well as the active members of the LAG. already existing.

MATERIALS AND METHODS

In order to achieve the main purpose of the paper, a series of methods were used such as: comparative analysis, both quantitatively and qualitatively, but also the method of the questionnaire applied to actors in the region to identify the needs of LAG "Vedea - Găvanu - Burdea".

In order to correctly identify the needs of LAG members, an assessment was required at the community level within the LAG, of the economic agents in this region, of the local public administration, as well as of the active members of the already existing LAG, and to identify the needs. community, a questionnaire was completed for 340 respondents.

The format of the proposed questionnaire followed the logic imposed by the rigors of a research and started from relatively simple questions, the complexity of which increased over time. Another approach to the questionnaire considered neutral questions containing non-specific or personal questions.

The sample, in any survey, is a defining element and represents a very important and laborious technical operation, but it depends on the homogeneity and / or heterogeneity of the population. In the case of applying the questionnaire at LAG level, this element of population homogeneity is met because, by definition, any LAG has a unitary structure, it pursues territories that have common socio-cultural values.

The drafting and application of the questionnaire aimed to determine the success of the survey and the emphasis had to be on validity and to provide as accurate information as possible on the objectives set.

In the process of completing the questionnaire we aimed to determine the need for questions to cover the subject under investigation and to correspond to the research objective; determining the type of questionnaire (structured, unstructured, etc.), formulating the content of the questions (depending on the type and quality of the questions) and ordering them, in a logical sequence, from simple to complex); determining the dimensions and format of the questionnaire, writing in a formula as attractive as possible; coding and elaboration of completion instructions.

RESULTS AND DISCUSSIONS

Presentation of the Local Action Group “Vedea Găvanu Burdea”

The territory covered by the “Vedea Găvanu Burdea” Local Action Group includes 19 localities, of which 18 are part of Olt County (Drăgănești-Olt town and Coteana, Crâmpoia, Dăneasa, Ghimpețeni, Gostăvățu, Izvoarele, Mărunței, Mihăiești, Movileni, Nicolae Titulescu, Radomirești, Schitu, Seaca, Șerbănești, Stoicănești, Vâlcele și Văleni), and a locality - Dobrotești - is part of Teleorman County.

In accordance with the recommendations on financial allocations, the indices of component A (area and population of the LAG), respectively 985.37 Euro/km² and 19.84 Euro/ inhabitant, resulted in obtaining a financial allocation of 2,317,360 Euro for the LAG „Vedea Găvanu Burdea”. Regarding the value related to the quality level (Component B), the LAG obtained a budget of 679,550.31 euros following the evaluation and selection process. Subsequently, following the approval of the Report on the outcome of the evaluation of the SDLs, as a result of the supplementation of the financial allocation, the LAG's budget was increased by 128,759.03 Euro (Table 1).

Table 1. Financial allocation of the "Vedea Găvanu Burdea" LAG

Specification	Area (km^2)	Population	Inhabitants/km^2	Financial allocation (euro)
Component A	1,084.98	62,916	57.98	2,317,360
Component B	-	-	-	679,550.31
Financial supplementation of the LDS	-	-	-	128,759.03
TOTAL				3,125,669.34

Source: [7].

Following the consultations carried out by the “Vedea Găvanu Burdea” Local Action Group with all the important actors in the territory, based on the diagnostic analysis and the SWOT analysis, the objectives, priorities, areas of intervention and measures introduced in the Strategy were identified. local development of the LAG.

From a budget of over EUR 3.1 million, the Vedea Găvanu Burdea LAG has chosen to provide funding for 3 priorities (P1 - Encouraging knowledge transfer and innovation in agriculture, forestry and rural areas, P2 - Increasing farm viability and the competitiveness of all types of agriculture in all regions and the promotion of innovative agricultural technologies and sustainable forest management and P6 - Promoting social inclusion, poverty reduction and economic development in rural areas), which included 9 measures, the highest financial allocation being directed the measure of development of villages (33.85%), followed by the measure of development of the non-agricultural sector (21.78%) and the measure of development of agricultural holdings (10.62%) (Table 2).

Table 2. Financial plan broken down by priorities of the "Vedea Găvanu Burdea" LAG

Priority	Measure	Financial resources (EUR)	The amount allocated (%)
P6	M7 / 6B Village development	1,058,130.09	33.85
	M6 / 6A Development of the non-agricultural sector	680,836	21.78
	M8 / 6B Social infrastructure for marginalized / at-risk-of-poverty / social exclusion communities	100,000	3.20
	M9 / 6A Support for the creation of new economic activities in the non-agricultural sector	35,000	1.12
TOTAL P6		*1,873,966.09*	*59.95*
P2	M4 / 2B Renewal of generations of farmers	240,000	7.68
	M2 / 2A Development of agricultural holdings	331,968.67	10.62
	M3 / 2A Supporting small farms	10,000	0.32
	M5 / 2A Supporting legally constituted associative forms	22,600.35	0.72
TOTAL P2		*604,569.02*	*19.34*
P1	M1 / 1C Vocational training of actors involved in the agricultural sector	22,000.37	0.70
TOTAL P1		*22,000.37*	*0.70*
TOTAL PRIORITIES		*2,500,535.48*	*80.00*
Operating and animation costs for SDL		625,133.86	20.00
TOTAL GENERAL		*3,125,669.34*	*100.00*

Source: [7].

The Local Development Strategy (LDS) of the Local Action Group "Vedea Găvanu Burdea" through the measures introduced in it, contributes to the mission of the Europe 2020 Strategy, by promoting sustainable rural development within the LAG territory, obtaining a more balanced agricultural sector from territorially and ecologically, more beneficial for the climate, more competitive and more innovative.

Identifying the needs of LAG members "Vedea Găvanu Burdea" - case study

In order to correctly identify the needs of the members of the LAG "Vedea - Găvanu - Burdea" it was necessary an evaluation at community level within the LAG (100 respondents), of the economic agents from this region (100 respondents), of the local public authorities (19 respondents), as well as active members of the existing LAG (121 respondents). In this sense, questionnaires were completed and applied to a number of 340 respondents and from which a series of needs of these actors emerged.

As a characteristic of the area, the main source of income is income from agricultural activities. We can see that the role of agriculture is very important, 69% of respondents obtaining the main income from this activity (Fig.1).

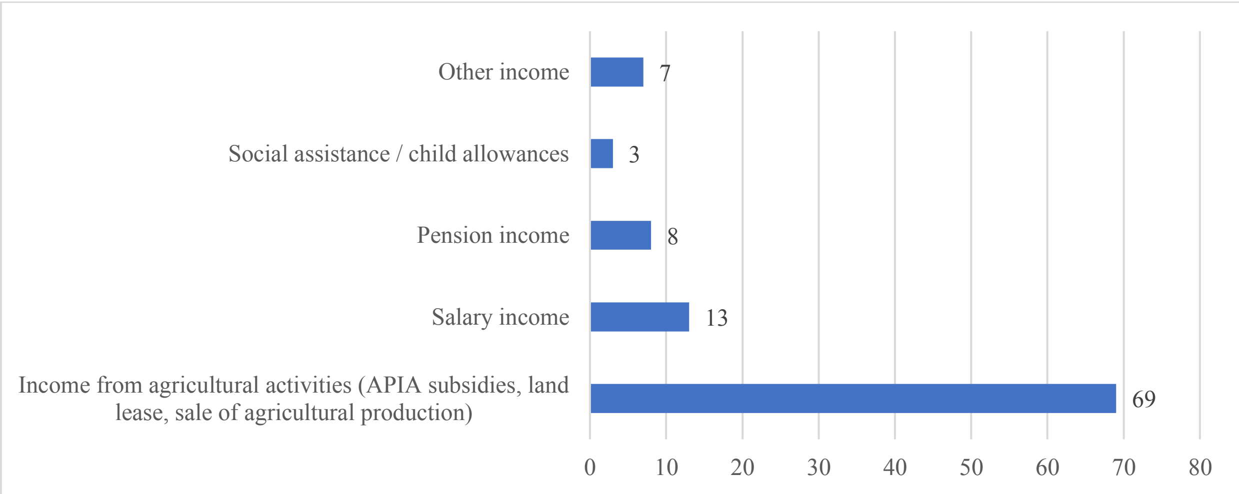

Fig. 1. What is your family's main source of income?
Source: Own design based on questionnaire output data.

Most of the population of this region wants to stay in the area in the next period, but there is a percentage of 28% of respondents who said they want to leave the locality where they live in favor of an urban center (6%) or abroad (13%), or are still undecided (9%) what to do in the next period (Fig. 2).

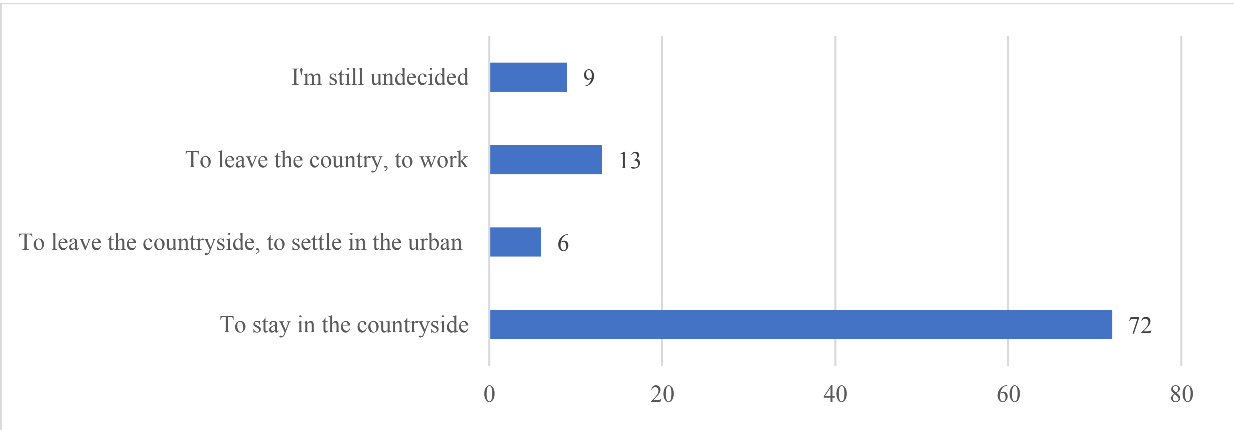

Fig. 2. What do you propose in the next period (maximum 1 year)?
Source: Own design based on questionnaire output data.

The main disadvantage of the area where they live and which causes dissatisfaction among the rural population is the aging population (21.3% of respondents), lack of jobs (20.2%), which forces the labor force to migrate to areas who offer jobs even if they have to commute or settle in another country. On the other hand, the lack of economic development perspective of the area (18.2%), the low standard of living (17.2%), the lack or insufficiency of the number of public utility units (15%) is an important problem for the population in the region. targeted. It is important to note that none of the respondents stated that there are disadvantages in the area where they live (Fig. 3).

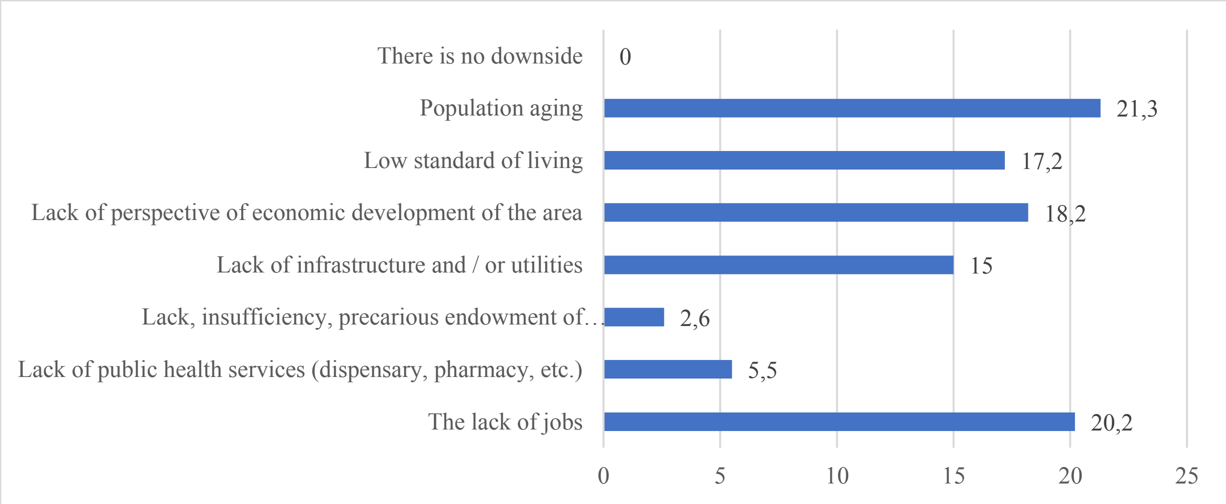

Fig. 3. What do you think is the main disadvantage of the area where you live?
Source: Own design based on questionnaire output data.

Regarding future investments to help the development of the area, 45.5% of respondents believe that the direction in which investments should be directed would be the one aimed at creating new jobs, followed by the introduction of utilities in the area. (29.3%) which would lead to an increase in the standard of living and quality of life of the inhabitants and implicitly to their stabilization in the area and the reduction of migration to urban areas (Fig. 4).

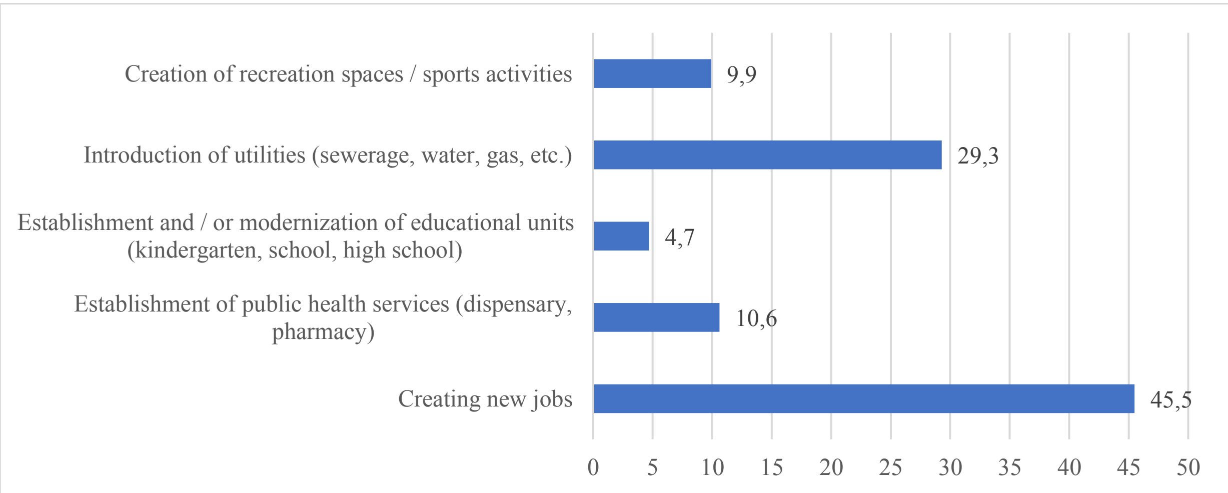

Fig. 4. In which direction should future investments be directed?
Source: Own design based on questionnaire output data.

From the point of view of the inhabitants of the LAG area, the sub-measure considered to be best suited to the needs of the respondents, with a weight of 20% is mentioned sub-measure 6.3, followed by sub-measure 6.1. The too strict conditions necessary to access European funds, the lack of information, the excessive bureaucracy have the most significant share among the respondents, having a value of 38%, regarding the main impediment related to accessing European funds (Fig. 5).

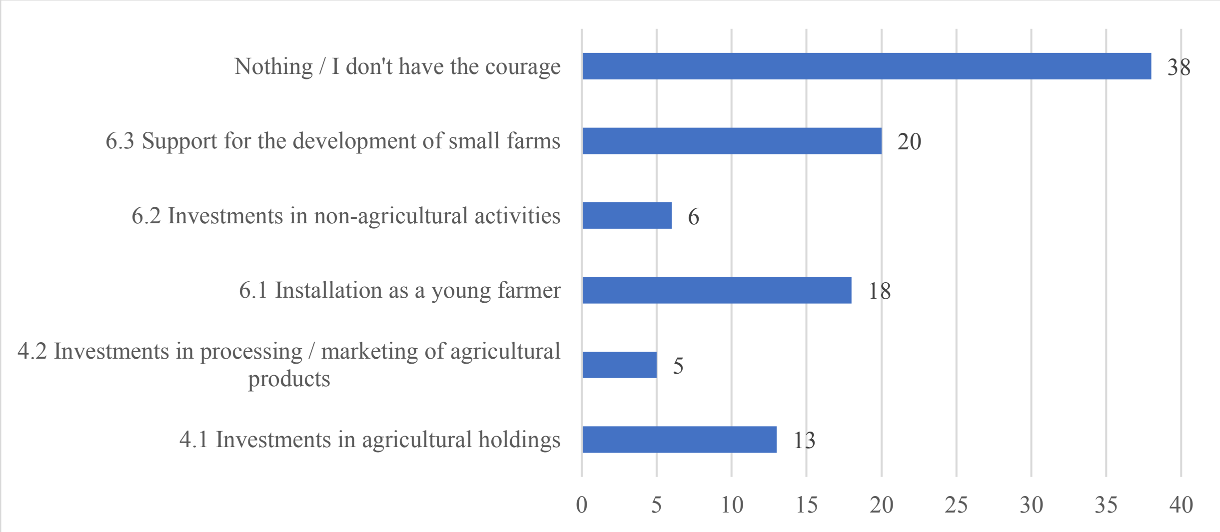

Fig. 5. What activities would you like to develop in the future through European funds?
Source: Own design based on questionnaire output data.

At the level of economic agents in the LAG, the sub-measure of investments in agricultural holdings is considered the most attractive for them (19%), followed by the sub-measure of investments in the creation and development of non-agricultural activities (15%) and the sub-measure for investments in processing/marketing of agricultural products (14%). It should be noted that 29% of respondents do not consider that PNDR measures can produce beneficial changes in their economic activity and implicitly do not want to access any measures (Fig. 6).

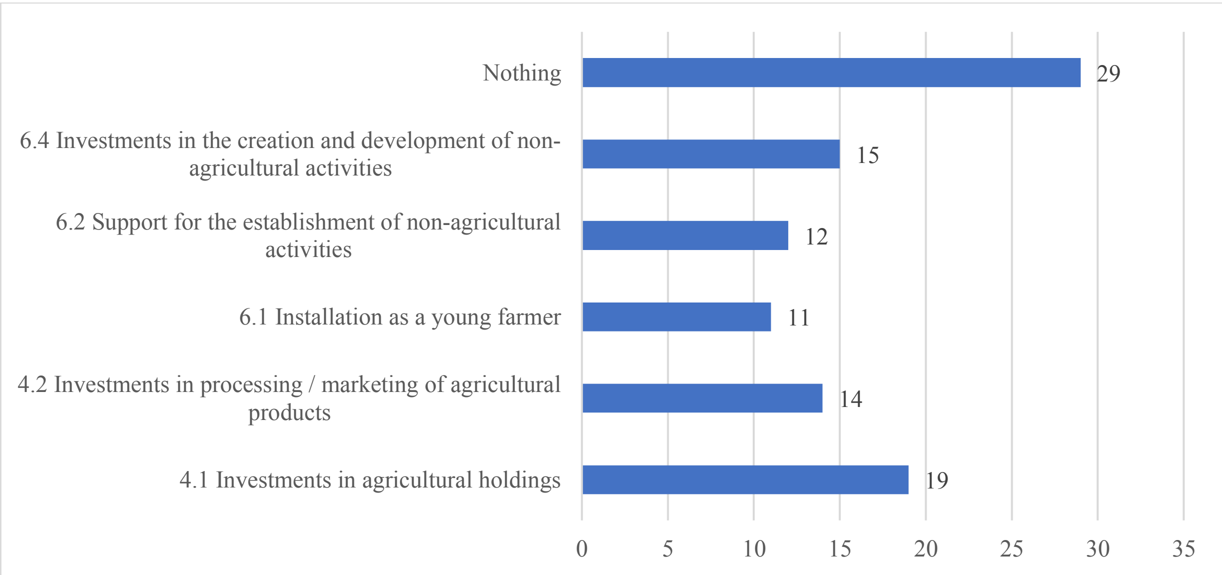

Fig. 6. What measures in the NRDP are you considering to access European funds?
Source: Own design based on questionnaire output data.

The main obstacles considered by the economic agents interviewed in accessing European funds are: bureaucracy - too many required documents (43%), lack of possibilities to co-finance the investment (31%), strict conditions for accessing European funds (20%). It should be noted that none of the interviewees stated that they had not heard of European funds (Fig. 7).

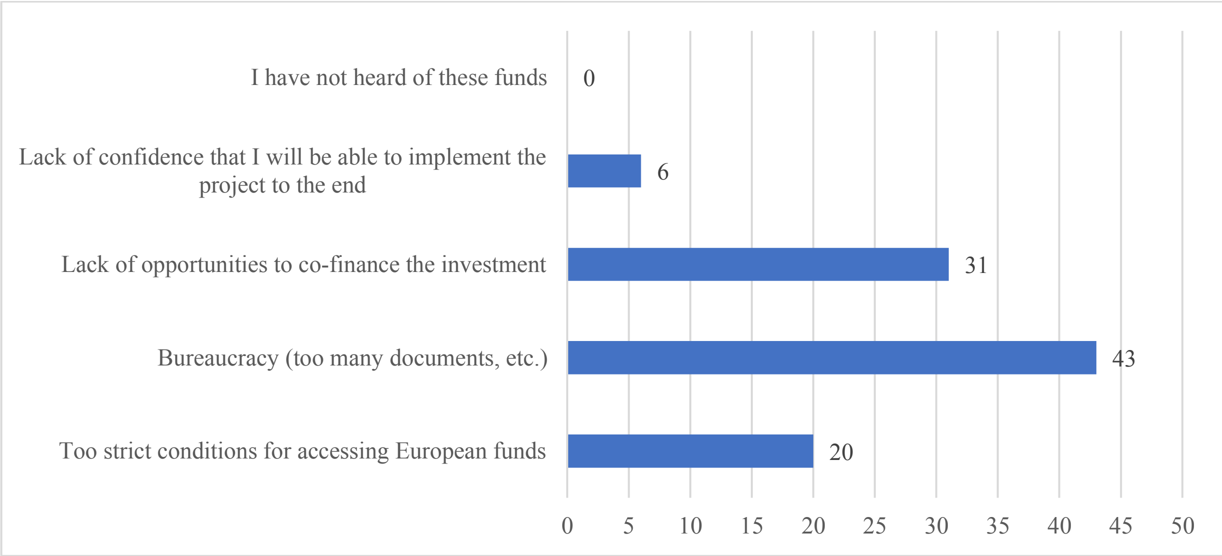

Fig. 7. What do you think is the main obstacle to accessing European funds?
Source: Own design based on questionnaire output data.

At the level of local public administrations in the region covered by the LAG (applied on a sample of 19 representatives - town halls), they are of the opinion that the directions to which the locality they belong to and represent should go, are the investments in infrastructure. public utility units with a share of 94.7% of the total respondents. They consider that the main problem identified at the community level is the lack of infrastructure and / or utilities: sewerage, drinking water, natural gas (68.4%), as well as the lack of perspective of economic development of the area (26.3%) and the endowment precarious educational units: kindergarten, school (5.3%).

Most consider that the main obstacle in accessing European funds is the bureaucracy, this being recognized by 52.6% of respondents, followed by those who consider the access conditions as too strict (47.4%).

Regarding the active members (applied on a sample of 121 representatives from the “Vedea Găvanu Burdea” LAG) 44.6% of them stated that the activity carried out by the LAG is very good, reaching most of the objectives of the Local Development Strategy, 33.9% consider the activity as good and 21.5% of them consider the activity as satisfactory. The main strength of the LAG they consider is that the LAG was able to identify the specific needs facing the micro-region (43.8% of respondents), and then easier access to European funds through the LAG. compared to national competition (24.8%) and proximity to the community (16.5%).

The main impediments to accessing European funds in the 2014-2020 programming period according to the active members of the LAG were: insufficient budget to cover all project applications (35.5%), excessive bureaucracy (33.1%), too strict conditions necessary to access European funds (17.4%), lack of opportunities to co-finance investments (14%).

In order to make the activity more efficient, the active members consider that a more accentuated promotion of the LAG in the territory is necessary (37.2%), a more active involvement of the representatives of the business environment (30.6%), but also of the representatives of the civil society. (16.5%) and last but not least of the public partners (15.7%).

The community within which the "Vedea - Găvanu - Burdea" LAG is located has an extremely important role in determining the needs, as well as for establishing the strategic directions for local development of the micro-region, because only those who live here can identify the needs of the place. especially because they face them daily.

CONCLUSIONS

Given that the resources of the subsoil, the industrial tradition and the degree of urbanization are limited, the main development potential of the area is related to the rural environment. In these conditions, the development strategy of the Local Action Group "Vedea - Găvanu - Burdea" must continue to maintain the current line of evolution and capitalize on the rural, natural and ethno-cultural potential of the area, by developing and increasing added value, through the innovative approach of tourism, agriculture, food industry and diversification of rural economies.

Increasing added value in these traditional sectors - labor-intensive but less capital-intensive and technology-intensive - depends on creating a brand image of the area with a number of clear, easily recognizable consumer characteristics that create positive associations. with traditional, area-specific life and to lead consumers to prefer area-specific products compared to other alternative products and to make them pay an appropriate price. In this sense, a special importance must be given to the definition of brand images, both for tourist products and for agricultural products, food of origin or traditional that can be used as tourist attractions.

In this context, the revitalization and exploitation of traditional crafts, of local traditional products is necessary to follow the same logic, of integration, in relation to the development of tourism as for agricultural and food products. Moreover, traditional crafts can be, insofar as they are integrated in commercial circuits, vectors for the diversification of rural economies dependent on agriculture, thus contributing to increasing the incomes of the rural population and stabilizing it, as well as high value-added ways to capitalize on local agricultural products.

The implementation of the questionnaires resulted in a series of recommendations aimed at both increasing the income of the inhabitants of the LAG territory and improving the quality of life. Thus, the public administrations in the region covered by the LAG are of the opinion that the directions towards which the localities should be directed should be the investments in the infrastructure of the public utility units. Another recommendation is to simplify bureaucracy. Most believe that the main obstacle to accessing European funds is bureaucracy. At the same time, the access conditions should be more relaxed as they are too strict in the opinion of the respondents.

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EFFECT OF INFRA-RED AND ULTRAVIOLET RADIATION ON STERILIZATION AND TRYPSIN INHIBITOR DEACTIVATION OF COWPEA SEEDS

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Abstract

Experiments were carried out through summer season 2019 in the Rice Mechanization centre at Meet El-Deeba, Kafr El-Sheikh Governorate to study the effect of infra-red radiation and ultraviolet radiation on protein, trypsin inhibitor and total microbial count of cowpea seeds as pre- conditioning methods prior to storage process. 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/m2) 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/cm2) were used. For the IR conditioning method, irradiation intensity of 882.67 W/m2 at exposure time of 15 min is recommended. 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 the irradiation intensity of 3.538 mW/cm2 at exposure time of 40 mins is recommended for UVC irradiation pre-treatment to get total microbial count 2 Log CFU/g., protein content 28.15%, trypsin inhibitor 0.57 TIU/mg and moisture content 10.95%.

Key words: *cowpea, infra-red radiation, ultraviolet radiation, protein, trypsin inhibitor, total microbial count*

INTRODUCTION

Cowpea seeds (*Vigna unguiculata*) is a legume that is used in several parts of the world as a high- value plant protein source. Cowpea is an necessary nutritious food in the human diet because of its high protein and carbohydrate content, low fat content, and complement amino acid pattern to cereal grains [1]. Cowpea has gained more interest from researchers and consumers all over the world because of its exerted health useful properties excluding anti-hyperlipidaemia, anti-diabetic, anti-inflammatory, anti-cancer and antihypertensive properties [7]. Cowpea is cultivated through the world on an estimated 14.5 million ha of land planted every year and the total yearly production is 6.2 million metric tons and in Egypt is 1,853 hectares with production 7,180 tons [11].

Cowpea seeds are similar to other pulses in terms of nutrition, with a low fat content and a high total protein content. Cowpea is a nutrient-dense food with a low energy content. Legumes have higher protein content than cereals, ranging from 17 to 30 percent. Since the protein content of legumes is roughly equivalent to that of some meats, they are regarded as the meat of poor people [9]. Moreover, the Cowpea protein is high in amino acids corresponding tryptophan and lysine, making it a perfect supplement to carbohydrates tubers and cereals. Cowpea protein, on the other hand, is low in cysteine and methionine as compared to proteins of animal [6]. Owing to the existence of anti-nutritional factors, protein digestibility in pulses varies, but it is usually lower than in cereals and proteins of animal [21] [25] legumes have much higher concentrations of antinutrtional than cereals, trypsin inhibitor activity, is considered anti-nutritional factor that has a strong relationship with protein digestibility.

The infrared region of the electromagnetic spectrum lies between visible light and microwaves, with wavelengths ranging from (0.5 to 100 μm). Near-IR (NIR) rays have wavelengths ranging from (0.75 to 1.4 μm) at temperatures below 400°C, mid-IR (MIR) rays have wavelengths ranging from (1.4 to 3 μm) at temperatures between 400 and 1,000°C, and far-IR (FIR) rays have wavelengths ranging from (1.4 to 3 μm) at temperatures above 1,000°C [22, 23].Compared to conventionally processed mung bean (*Phaseolus aereus*) beans, the effect of infrared processing on crude protein and trypsin inhibitor resulted in a significant decrease of trypsin inhibitor although the crude protein did not change significantly [20].

Among X-rays (100 nm) and visible light (400 nm), UV-light spans a wide wavelength range in the nonionizing field of the electromagnetic spectrum. UV light is divided into three wavelength bands: UV-A, UV-B, and UV-C [5].

UV light is a physical method that has many benefits, including the absence of by-products that may alter the characteristics of the food, the absence of chemical residues, and the fact that it is a dry, simple and cold process, efficient, and low-cost process as compared to other sterilization methods. It also does not emit any form of ionizing radiation [12].

UVC light can also be used to inactivate a variety of organisms; it has been used as a disinfection medium in the pharmaceutical, electronic, and aquaculture industries for many years. Low-pressure mercury vapour germicidal lamps emit monochromatic UV light (254 nm) [3]. The UVC radiation absorbed by DNA has the potential to halt cell growth and cause cell death. UVC light absorbed by DNA induces a physical change of electrons, resulting in DNA bond breaking, cell death, or a delay in reproduction [3, 15, 26].

The current study aims at testing and evaluating two different conditioning methods (FIR-UVC radiation) for cowpea seeds sterilization and trypsin inhibitor deactivation.

MATERIALS AND METHODS

Materials - Cowpea seeds

The cowpea seeds var. (Dokki 126) were used for this experiment. The tested samples were obtained from EL Aiatt, Giza Governorate, Egypt. The pre-treating methods were conducted as follows:

Infrared heating unit

The infrared heating unit shown in Fig.1 was used as thermal treatment for the experimental work. The unit consists of a rotary cylinder (0.6 m diameter and 0.2 m long) made of 1 mm galvanized iron sheet enclosed by a fixed insulated cylinder (0.8 m diameter and 0.3 long), one side of the rotary cylinder connected to a driving mechanism consists of 0.15 m diameter steel flange fixed to the side cover of the rotary cylinder and welded to a steel bar riding with a heavy duty ball bearing. A 0.5 kW low speed motor with different sizes of bullies was used for power supply and speed control of the rotary cylinder. For heating and temperature control of the infrared heating unit, two ceramic infrared heaters (1 kW/each) were fixed over two iron blades and assembled into the centre iron bar of the rotary cylinder facing the cowpea bulk. For controlling the distance between the ceramic heaters and the cowpea surface two screw rods were welded to the iron blades to allow movement of the heaters up and down.

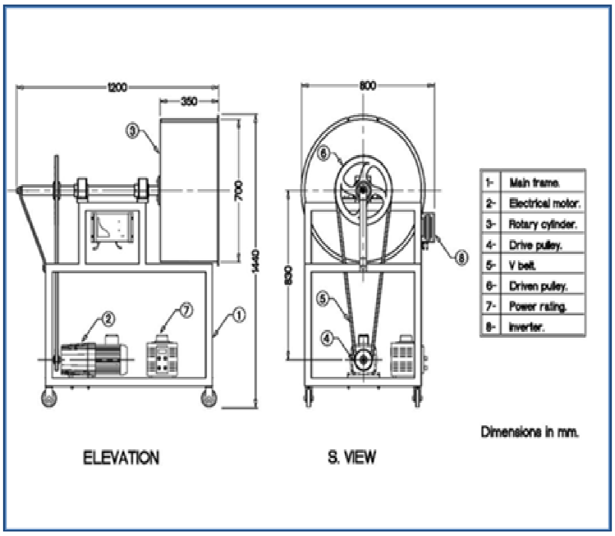
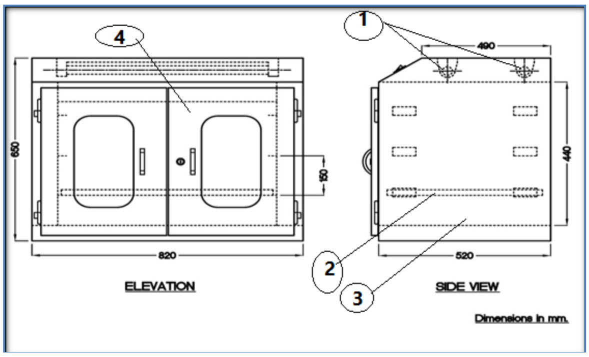


Fig. 1. The infrared heating experimental unit
Source: Author’s own illustration.

Ultraviolet treatment unit

Ultraviolet radiation treatment of Cowpea was conducted using an irradiator consisting of two UVC lamps (4136 G36T6-20W - 254 nm), the length of each lamp is 60cm as shown in Fig. 2. The unit body was made of metal sheet plated with electrostatic substances (820 mm length and 520 mm width), the inside surface of the unit was made of stainless steel 304 with a door made of poly carbonate for protection from uv-c radiation. The operation of the lamps was controlled by a timer which was set for various exposure times of 10, 20, 30 and 40 min. The cowpea seeds were placed horizontally in a uniform manner on a portable shelf and set in various distances from the ultraviolet source (150- 300 - 450 mm). The irradiation power was set at 10 mW cm^{-2}.



Legend:

NO	Part name
1	2 Lamps UVC 20W/once (254nm)
2	Portable shelf
3	The body of UVC unit
4	The door of the unit

Fig. 2. Experimental setup for UV-C radiation treatment.
Source: Author's own illustration.

Experimental method

(1) Infra-red pre-treatment

The rotary cylinder was operated continuously at the required level of irradiation intensity that controlled by powering rate and the treated sample was discharged through the removable sector of the rotary cylinder bottom after the tested exposure time. At the end of each treatment, the treated sample was left in a wooden frame until reaching room temperature. Moisture content, protein content, trypsin inhibitor and total microbial count were measured for each studied treatment.

(2) Ultraviolet pre-treatment

The UVC unit was operated at the recommended level of irradiation intensity and exposure time. After the tested exposure time, the irradiated samples were used for measuring protein content, trypsin inhibitor and total microbial count

Measurements:

-Determination of moisture content

The moisture content was determined by the standard oven method at 105°C for 24 hours [2].

The moisture content was calculated at wet basis (w.b. %) as following:

$$Mwb = [(mw - md) / mw] \times 100$$

where:
Mwb: Moisture content, %.
mw: Wet mass, g.
md: Dry mass, g.

-Bulk temperature of treated seeds

Data recorder model YEW 3057 was used to measure bulk temperature of cowpea seeds with thermocouple type T.

- Determination of total protein content

The total nitrogen was determined by using micro Kjeldahel method according to the method of A.O.A.C. (1990). Total protein was calculated by multiplying the total nitrogen by 5.57.

-Trypsin inhibitor (TIU/mg)

The trypsin inhibitor (TI) activity was calculated by incubating 50 µl of crude extract with 20 µl of commercial bovine trypsin (1 mg mL-1) for 15 minutes at 37°C, as defined by [13].

-Total microbial colony count (microbiological analysis), cfu/g.

Total microbial count activity was determined following the methodology; about 25 g from the samples was transferred in to a stomacher bag (Seward, London, UK), and homogenized with 225 ml of sterile salin peptone water (SPW:1g/1 peptone, 8.5g/l sodium chloride) for 3 min. A 10- fold serial dilution was made from each sample and used for quantitative microbiological examinations after treatment with Serial dilutions of sterile saline peptone water with samples was prepared, and duplicate of 1 ml samples of appropriate dilutions were poured on agar plates. Total bacterial count (TBC) was enumerated on plate count agar (Merck, 1.05463) at 30^0C for 48 h. All plates were examined for typical colony types and morphological characteristics associated to each culture medium.

RESULTS AND DISCUSSIONS

Infra-red pre-treatment:
Seeds moisture content

The effect of different irradiation intensity and exposure time on moisture content of seeds is shown in Fig. 3. The initial cowpea moisture content was 10.95 % w.b and the final moisture contents after the treating process were (8.86, 8.13, 5.72, 5.37, 5.28 % w.b) at different levels of irradiation intensity of (804.255, 882.67, 964.74, 1,050.45, 1,139.8 W/m^2.) respectively.

It was obvious that the moisture removal increased with the increase of exposure heating time under all levels of irradiation intensity. This condition may be due to the fact that, when the seeds are infra-red heated; the penetration of the infrared rays into the material causes the water molecules to vibrate which results in rapid internal heating of seeds moisture which arises the water vapour pressure inside the seeds with a corresponding loss of water to the surrounding air. The removal rate of water from seeds layers was higher during the initial stage of infrared heating and starts to decline with the heating time as mentioned by [10].

Change of bulk temperature of cowpea seeds at different irradiation intensity and exposure time

Cowpea bulk temperature as related to heating time is presented in Fig. 4. As shown in the figure, the temperature of heat treated samples depending on heating time and irradiation intensity. The bulk temperature of cowpea seeds approached 56.9°C, 69.9°C, 90.1°C, 101.3°C and 111.4°C at the maximum exposure time of 3 min and approached 89.5°C, 97.5°C, 111°C, 121.9°C and 130.5°C, at the maximum exposure time of 15 min for irradiation intensity levels of 804.25, 882.67, 964.74, 1,050.455 and 1,139.81 W/m^2 respectively.

The figure also shows that, seeds bulk temperature was lower during the early stage of heating and it was increased with longer exposure time. This means that during the initial stage of heating the temperature difference between the bulk temperature of cowpea and the heating temperature was relatively high which causes higher rate of heat transfer from the heating source (Infra-red) to the cowpea seed. This causing an increasing rate of bulk temperature during this early stage of heating. However, as the difference between the temperature of heating source and cowpea seeds decreased with increasing the exposure time the rate of heat transfer is also decreased.

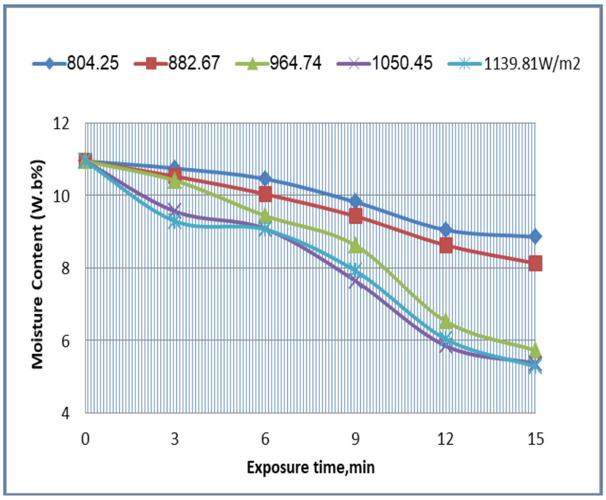


Fig. 3. Change of seeds moisture content at different irradiation intensity and exposure time.
Source: Authors' determination.

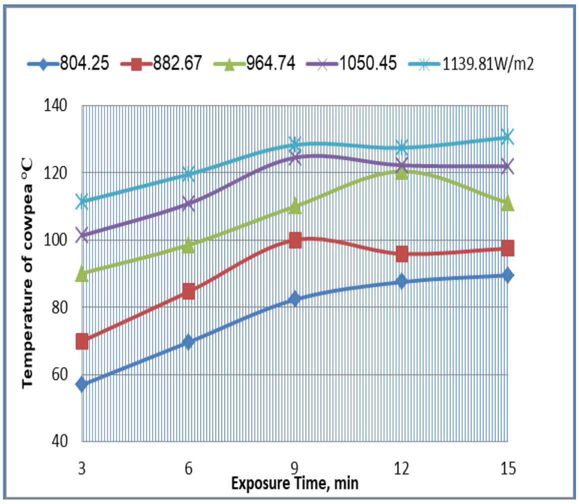


Fig. 4. Change of bulk temperature of cowpea seeds at different irradiation intensity and exposure time. Source: Authors' determination.

Protein content on cowpea seeds

The effect of different irradiation intensity and exposure time on protein content of cowpea seeds is illustrated in Fig. 5. The protein content was calculated by total nitrogen in cowpea seeds The protein content of raw seeds was 30.29% and reduced to 29.62%, 28.88%, 27.89 %, 25.33% and 23.52% at the maximum exposure time of 15 mins and reduced to 30.2%, 30.1%, 29.94%, 28.71% and 28.14% at the min exposure time of 3 mins for irradiation intensity of 804.25, 882.67, 964.74, 1,050.455 and 1,139.81 W/m^2 respectively.

When legume seeds are infrared heated, the protein becomes more vulnerable to denaturation and aggregation, lowering its solubility [17, 19]. As a result, the amount of total protein decreases. Meanwhile, when legume seeds are heated with infrared radiation at temperature of 150°C, extreme protein denaturation occurred [27].

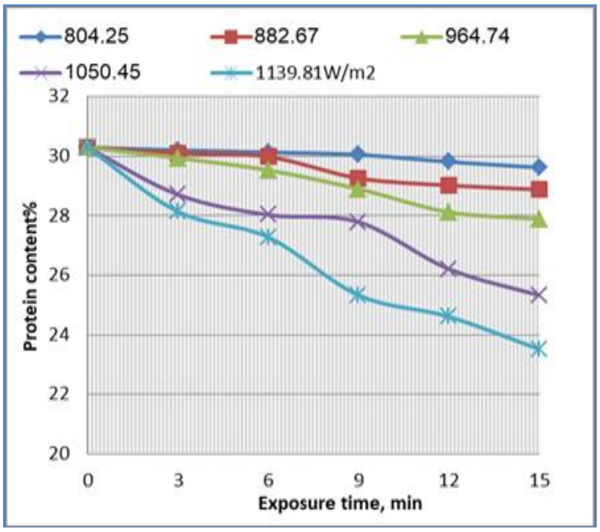


Fig. 5. Effect of different irradiation intensity and exposure time on Protein content of cowpea seeds.
Source: Authors' determination.

Trypsin inhibitor of cowpea seed

Figure 6 presents the effect of different irradiation intensity and exposure time on trypsin inhibitor of cowpea seeds. Trypsin inhibitor of raw seeds was 2.214 TIU/mg and reduced to 2.209, 2.112, 2.103, 2.103, 2.009 and 1.734 TIU/mg at the minimum exposure time of 3 min. while, it was and reduced to 1.734, 1.148, 1.142, 1.139 and 1.135 TIU/mg at the exposure time of 15 min for irradiation intensity 804.25, 882.67, 964.74, 1,050.455 and 1,139.81 W/m^2 respectively. When comparing the level of trypsin inhibitor for the non-treated cowpea seeds (2.214 TIU/mg) with that treated with infra-red, it can be said that, heat treatment with infrared decreased the trypsin inhibitor by 0.22% to 48.73% depending upon the level of radiation intensity and the exposure time. The above-mentioned results could be attributed to the heat denaturation of protein. Also, it has causes enhancement of protein digestibility mainly through the inactivation of thermo labile ant nutritional factors such as trypsin [4].

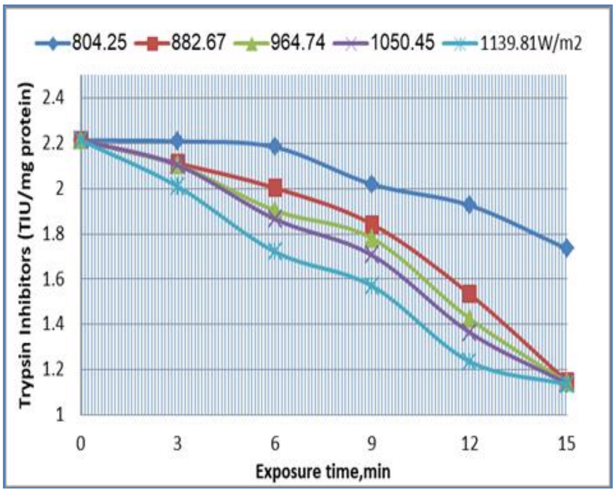


Fig. 6. Effect of different irradiation intensity and exposure time on trypsin inhibitor of cowpea seeds
Source: Authors' determination.

Total Microbial count (Log10 CFU/g) of cowpea seeds

Figure 7 presents the effect of different irradiation intensity and exposure time on total microbial count of cowpea seeds. As shown in the table, the total microbial count (TMC) reduced from 4.7 to 4.6 (Log10 CFU/g) at the minimum irradiation intensity of 804.255 W/m^2 and exposure time of 3 mins, while it was reduced from 4.7 to 2.3 at the maximum irradiation intensity of 1,139.80 W/m^2 and exposure time of 15 mins. The above mentioned results revealed that, absorbing energy from infrared radiation causes thermal effects, as it raises the temperature of the cowpea seeds to a level enough to stop the activity of microorganisms [24]. Meanwhile, the results did not detect any fungal count (TFC) for both heat treated and non-treated samples.

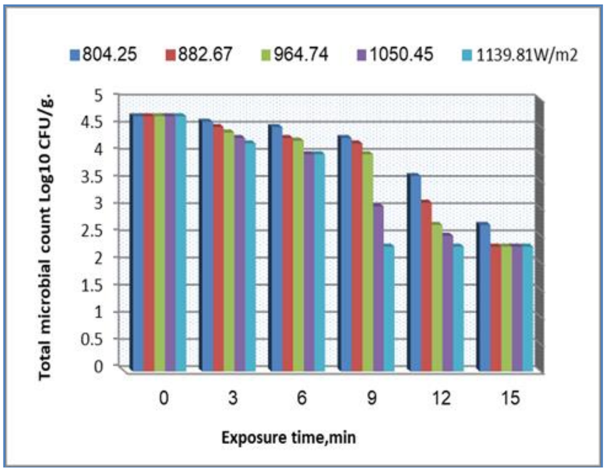


Fig. 7. Effect of different irradiation intensity and exposure time on total microbial count (Log10 CFU/g) of Cowpea seeds.
Source: Authors' determination.

Ultra-violet pre-treatment:
Protein content of cowpea seeds

The effect of different irradiation intensity and exposure time on protein content of cowpea seeds was illustrated in Fig. 8. At the highest radiation intensity of 7.077 mW/cm^2 and the maximum exposure time of 40 mins, the total protein content decreased from 30.29% to 24.92% leading to a maximum diminution of 17.7% for the initial protein.

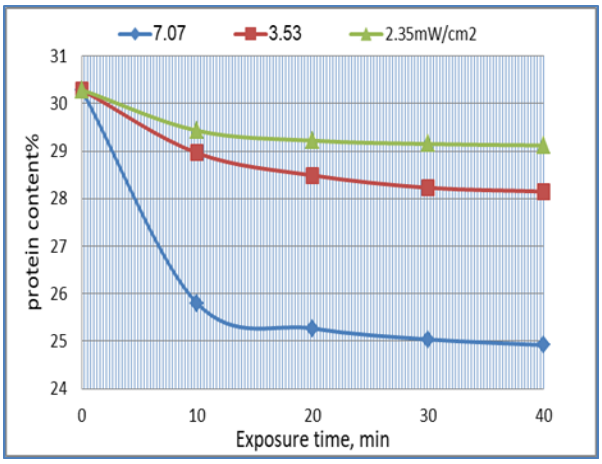


Fig.8. Effect of different irradiation intensity and exposure time on protein content of cowpea seed.
Source: Authors' determination.

The lowest radiation intensity of 2.359 mW/ cm^2 decreased the total protein content from 30.29% to 29.43 % at the minimum exposure time of 10 mins leading to the diminution of 2.84% of the initial protein. The reduction in total protein content upon UV radiation can be imputed to the formation of nitrogen-free radicals and released them from cowpea seeds in the form of ammonia or Nitrogen oxides through the irradiation process with UVC. The aromatic residue like tryptophan, tyrosine, or cysteine amino acids in protein was absorbed by UVC radiation [19]. UVC radiation allows proteins and amino acids to degrade and create ammonia gas, with non-peptide nitrogen-containing amino acids like histidine and tryptophan leading to the release gas of ammonia [14, 18].

Trypsin inhibitor of cowpea seeds

The effect of different UVC irradiation intensity and exposure time on trypsin inhibitor of cowpea seeds is illustrated in Fig. 9. The level of trypsin inhibitor in the raw cowpea seeds was 2.214 TIU/mg. As shown in the results, the highest UVC radiation intensity of 7.077 mW/cm^2 at maximum exposure time of 40 mins, reduced the activity of trypsin inhibitor to 0.694 TIU/mg. However, the lowest irradiation intensity of UVC of 2.359 mW/cm^2 at the minimum exposure time of 10 mins, reduced the trypsin inhibitor activity to 1.133 TIU/mg.

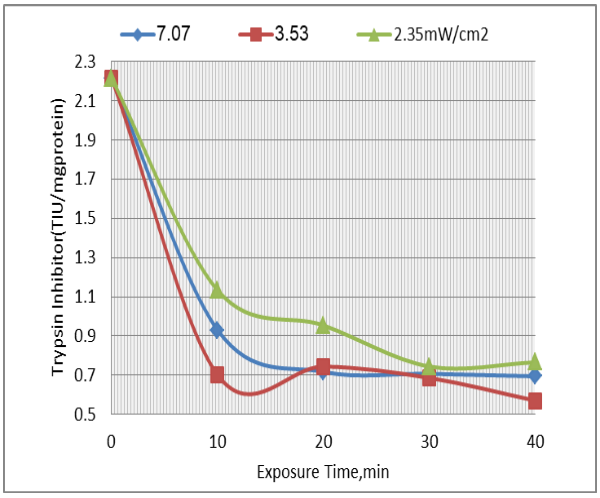


Fig. 9. Effect of different irradiation intensity and exposure time on trypsin inhibitor of cowpea seeds.
Source: Authors' determination.

From Fig. 9, it can be concluded that, the most effective irradiation intensity on trypsin inhibitor was 3.538 mW/cm^2 at exposure time of 40 mins as it reduced activity by 74.25%.

This mean that, UVC radiations is a very effective treatment for elimination of antinutritional elements (trypsin inhibitors), as mentioned by [8].

Total microbial count (Log10 CFU/g)

As shown in Fig. 10, the total microbial count decreased from 4.7 to 2 (Log10 CFU/g) at the highest irradiation intensity of 7.077 mW/cm^2 and the maximum exposure time of 40 mins. While it was reduced from 4.7 to 2.4 (Log10 CFU/g) at the minimum irradiation intensity of 2.359 mW/cm^2 at maximum exposure time of 40 mins. The germicidal properties of ultraviolet irradiation are due to the DNA absorbing of UV light, causing crosslinking between neighboring pyrimidine nucleoside bases (thymine and cytosine) in the same DNA strand [16]. The results also show that, Fungi count in cowpea seeds was not confirmed whether for treated or non-treated samples.

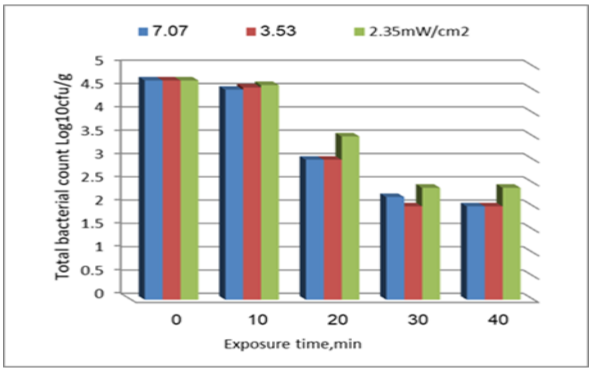


Fig. 10. Effect of different irradiation intensity and exposure time on total microbial count (Log10 CFU/g) of cowpea seeds.
Source: Authors' determination.

CONCLUSIONS

In general, the analysis of results showed that, For infra-red pre-treatment the irradiation intensity of 882.67 W/m^2 at exposure time of 15 mins is recommended. At this level of radiation intensity and exposure time, the total microbial count was 2.3 Log CFU/g., protein content 28.88 %, trypsin inhibitor 1.148 TIU/mg and moisture content 8.13 % w.b. Meanwhile, for the UVC pre-treatment, irradiation intensity of 3.538 mW/cm2 and exposure time of 40 mins is recommended to get total microbial count of 2 Log CFU/g., protein content 28.15%, trypsin inhibitor 0.57 TIU/mg and moisture content 10.95%.

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CONDITIONING AND SAFE STORAGE OF COWPEA SEEDS USING PLASTIC HERMETIC BAGS

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Abstract

Most important feature of the storage systems is to preserve the integrity of the grain for a given period with minimal loss in quality and quantity. The main objective of this study was to evaluate the effect of seed conditioning prior to storage process using infrared heating at the optimum radiation intensity of 882.67W/m^2 and exposure time of 15 min and the ultraviolet radiation at radiation intensity of 3.538mW/cm^2 and exposure time of 40 min on storability of cowpea seeds using different types of plastic hermetic bags in comparison with pp woven bags. The changes in cowpea seeds quality during storage of pre-treated cowpea seeds in terms of moisture content, protein content, total microbial count and insect detection were also determined. The results show that, the moisture content of seeds stored in pp woven bags increased in contrast with both types of studied hermetic bags, oxygen concentration for hermetic bags decreased during storage period and carbon dioxide increased unlike pp woven bag, The rate of seeds infection with microorganisms and weevils was lower for the samples stored in both types of hermetic bags and crude protein content of seeds stored in hermetic bags reduced at a very slight rate in comparison with that stored in woven bag.

Key words: *Hermetic storage, cowpea seeds, seeds quality, infra-red treatment, ultra-violet treatment, protein content, total microbial count and insect detection*

INTRODUCTION

The quality of stored grain depends on four important factors: initial condition of the grain, environmental conditions during the period of storage, biotic factors, such as insects, rodents and microorganisms; and various treatments applied on the grain during the storage period [13]. Stored grains and legumes are subject to insect infestation and deterioration from molds and bacteria. At the developed countries the average minimum overall losses from biological degradation is 10%, while in developing countries that estimate may be up to 20%. Stored food products are highly prevalent in developing countries, especially among smallholder farmers [14]. Among sub-Saharan African countries and other developing countries, these losses come as a result of inadequate use of highly improved post-harvest technologies during storage. Faced with such devastating losses, many farmers do not want to risk their cowpeas [1]. Instead, they sell them at harvest time when prices are the lowest. Mapping up strategies to reduce these losses will ensure food security, lead to rapid economic growth, and improve nutrition on the continent [3] [10].

Hermetic storage (HS) technology is a non-chemical-based system of storage. Its basic principle is the generation of oxygen depleted, carbon dioxide and or nitrogen enriched interstitial atmosphere caused by either the natural respiratory activities of living organisms in the bulk, or enhanced and accelerated by artificial means in an air tight storage structure [9]. About 30% of cowpea stored on-farm was in potentially hermetic containers, but much of that also was treated with insecticide because farmers did not trust the efficacy of hermetic storage alone. Data collected in 2010 in Niger and Burkina Faso indicated that over 70% of farm-stored cowpea was in hermetic containers and from 7% to 38% of farm-stored cowpea was in Purdue Improved Cowpea Storage (PICS) bags [11]. The effect of hermetic and non-hermetic storage of cowpea in plastic containers in the tropics was studied The cowpeas were stored in hermetic and non-hermetic containers over a period of 12 weeks. The parameters evaluated were the moisture content, insect infestation, usable proportion, and 1,000 grain mass in both hermetic and non-hermetic systems. The results showed that the moisture content in the hermetic containers increased slightly from 11.7 to 11.9% compared to a sharp increase from 11.7 to 17.2% in the non-hermetic plastic containers. From the fourth week to the twelfth week, the number of live insects drastically reduced to zero in the hermetic system. In the case of the non-hermetic containers, the population of live insects/100 g of grains increased from 5 on week 0–71 on the twelfth week. Also, the mass of 1,000 grains reduced from 156.50 g on week zero to 145.21 g in the non-hermetically stored grains, while the hermetically stored grains recorded a decrease to 148.95 g. Finally, the usable proportion of grains in the hermetic system declined from 98.55 to 94.80% after 12 weeks of storage as compared to the drop to 85.69% seen in the non-hermetic system [2].

The current study aims at testing and evaluating the effect of cowpea seeds pre-treatment with infra-red and ultraviolet and storage in different types of hermetic bags on safe storage and quality prevention of the stored seeds.

MATERIALS AND METHODS

The experiment work was carried out through season 2019 in the Rice Mechanization Centre at Meet El-Deeba, Kafr El-Sheikh Governorate, Egypt to study the effect of hermetic bags (three layers bags – seven layers bags) and PP woven bag on storage of pre-treated and non-treated cowpea seeds

Two different types of barriers films were developed for the experimental work. The developed films were formed into a shape of bags with capacity of 20 kg/bag. The produced bags were filled by non- treated cowpea seeds at initial moisture content of (10.95%) w.b% and pre-treated cowpea seeds at the optimum intensity and exposure time of 882.67W/m^2 and exposure time of 15 min for the infrared heating at the radiation intensity and radiation intensity of 3.538mW/cm^2 and an exposure time of 40 min for the ultraviolet treatment.

The filled bags were stored in a proper storage room at three groups (three layers- seven layers-woven bags). Each group contain three different types of seeds (Non-treated-treated seeds with IR and treated with UV). Measurements for carbon dioxide, oxygen gas, temperature and relative humidity inside the stored bags of each group were taken monthly. Also, quality evaluation tests for the stored seeds including moisture content, protein, total microbial count and insect detection were measured for all the examined treatments.

Measuring procedure

-***Temperature and RH:*** Stainless professional probe with thermocouple type K was used for temperature measurement inside and outside the bags. Also Professional humidity content probe was used to measure the humidity content in the bulk of Cowpea seeds inside and outside the hermetic bags.

- ***Moisture content: The*** moisture content was determined by the standard oven method at 105°C for 24 hours [6].

The moisture content was calculated at wet basis (w.b. %) as following:

$$Mwb = [(mw - md) / mw] \times 100$$

where:
Mwb: Moisture content, %.
mw: Wet mass, g.
md: Dry mass, g.

- ***O_2 and CO_2 concentration***: was monitored every month using ***CO_2*** and ***O_2*** sensor (VI GAZ "Gas analysis- model Box 121, (VI GAZ Company, France).

- ***Insect detection (insect/kg):*** The cowpea seeds were sieved and the weevils were identified according to (AOAC, 2000).

-***Total microbial colony count (microbiological analysis), cfu/g:***

Total microbial count activity was determined following the methodology; about 25 g from the samples was transferred in to a stomacher bag (Seward, London, UK), and homogenized with 225 ml of sterile salin peptone water (SPW:1g/1 peptone, 8.5 g/l sodium chloride) for 3 min. A 10- fold serial dilution was made from each sample and used for quantitative microbiological examinations after treatment with serial dilutions of sterile saline peptone water with samples was prepared, and duplicate of 1 ml samples of appropriate dilutions were poured on agar plates. Total bacterial count (TBC) was enumerated on plate count agar (Merck, 1.05463) at 30^{0}C for 48 h. All plates were examined for typical colony types and morphological characteristics associated to each culture medium.

-Total protein content

The total nitrogen was determined by using micro Kjeldahel method [5]. Total protein was calculated by multiplying the total nitrogen by 5.57.

RESULTS AND DISCUSSIONS

Ambient air temperature and relative humidity

Fig. 1 illustrated the recorded data of air temperature and relative humidity during the storage process. The storage process started from March to October 2020. As shown in the figure, over the studied storage time, the highest and lowest ambient temperature were 29.7°C and 18.2°C with an average of 25.65°C. Meanwhile, the highest and lowest ambient relative humidity were 66% and 56.5% with an average of 61.3 %.

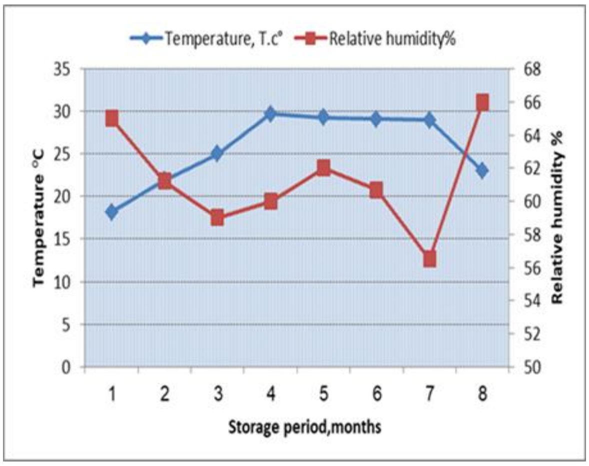

Fig. 1. Ambient air temperature and relative humidity during the storage period
Source: Authors' determination.

Bulk temperature and relative humidity inside the storage bags

Temperature is considered a critical factor for seed storage. During the storage period the values of temperature and RH inside the bags are shown in Fig. 2. The recorded bulk temperature of the non- irradiated cowpea seeds ranged from 19.6 to 31.8, 19.6 to 29.6 and 19.1 to 29.5°C with an average of 27.4, 25.85 and 25.9°C for the pp woven bags, three layers hermetic bags and the seven layers hermetic bags respectively. The recorded relative humidity inside the non-irradiated bags ranged from 57.9% to 61% with an average 59.8% for woven bags, and ranged from 56.2% to 61.4% with the average 59.12% for the three layers bags whilst at the seven layers bags, the minimum relative humidity was 53% and the maximum was 58.6 % with an average 55.46%. Meanwhile the bulk temperature of irradiated seeds with infra- red pre-treatment ranged from 18.9 to 31.2, 18.3 to 28.9 and 18.4 to 28.5°C with an average of 26.86, 25.11 and 24.9°C for the pp woven bags, three layers hermetic bags and the seven layers hermetic bags respectively. However the relative humidity ranged from 59.1% to 61.7 % with an average 60.26% for woven bags, while the three layers bags recorded minimum relative humidity of 55.3 % and maximum of 58.8% with an average of 56.76%.Whereas the seven layers bags showed minimum relative humidity 53 % and maximum of 57.6% with an average 55.32 %.On the other hand the recorded bulk temperature of cowpea seeds irradiated with ultraviolet pre-treatment ranged from 18.5 to 30.9, 18.2 to 28.8 and 18 to 28.5°C with an average 26.4, 25.025 and 24.56 °C for the pp woven bags, three layers bags and the seven layers bags respectively. Meanwhile, the minimum relative humidity of 58.5% and maximum of 61.5 % with an average 59.65% was recorded for the woven bags. The three layers bags, recorded a relative humidity ranged from 54.3% to 56.9% with an average 55.87%. The seven layers bags, showed a relative humidity ranged from 51.1 % to 55.5 % with an average 53.6%.

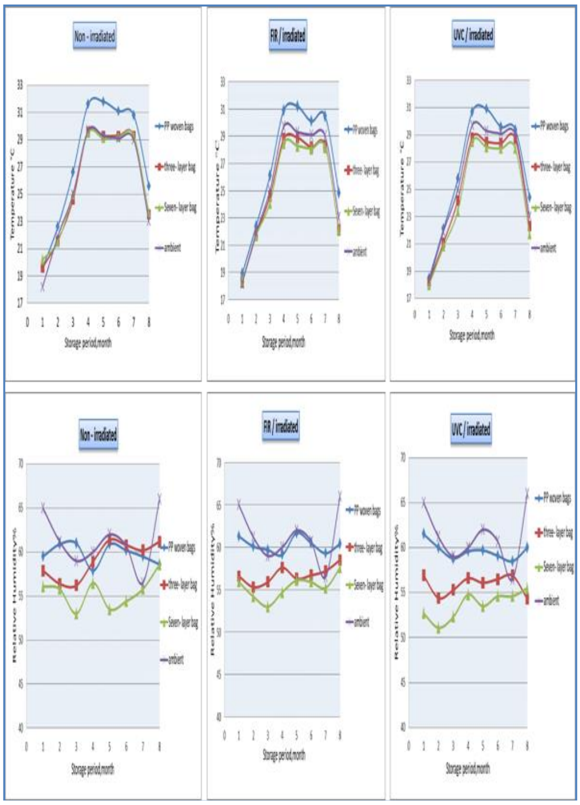

Fig. 2. Bulk temperature and relative humidity inside the storage bags.
Source: Authors' determination.

Moisture content of stored seeds

The change in moisture contents of cowpea seeds during storage process depends on the initial moisture content, the relative humidity surrounding the seeds, growth of insects, microorganisms and respiration rate of seeds, where both of seeds respiration rate and insects released water.

As shown in the Fig. 3, moisture content of the non-irradiated seeds, relatively decreased from10.95% to 10.21% W.b% at the first three months of storage, then starts to increase to 14.82% for the pp woven bag. However, the three layers and the seven layers hermetic bags showed very low changes in seeds moisture content for all studied treatments due to the water sealing effect of the plastic hermetic bags. The results also show that, there is a direct relationship between deterioration rates, insect infestation level, molds and yeast attack, storability and moisture content of seeds.

Generally the contaminated non treated seeds showed higher value of moisture content and bulk temperature compared with the treated seeds due to insect respiration [8].

In general, reduction of one percent moisture content of seeds doubles the life of the storage seed as mentioned in a technical handbook of seeds in emergencies (2010).

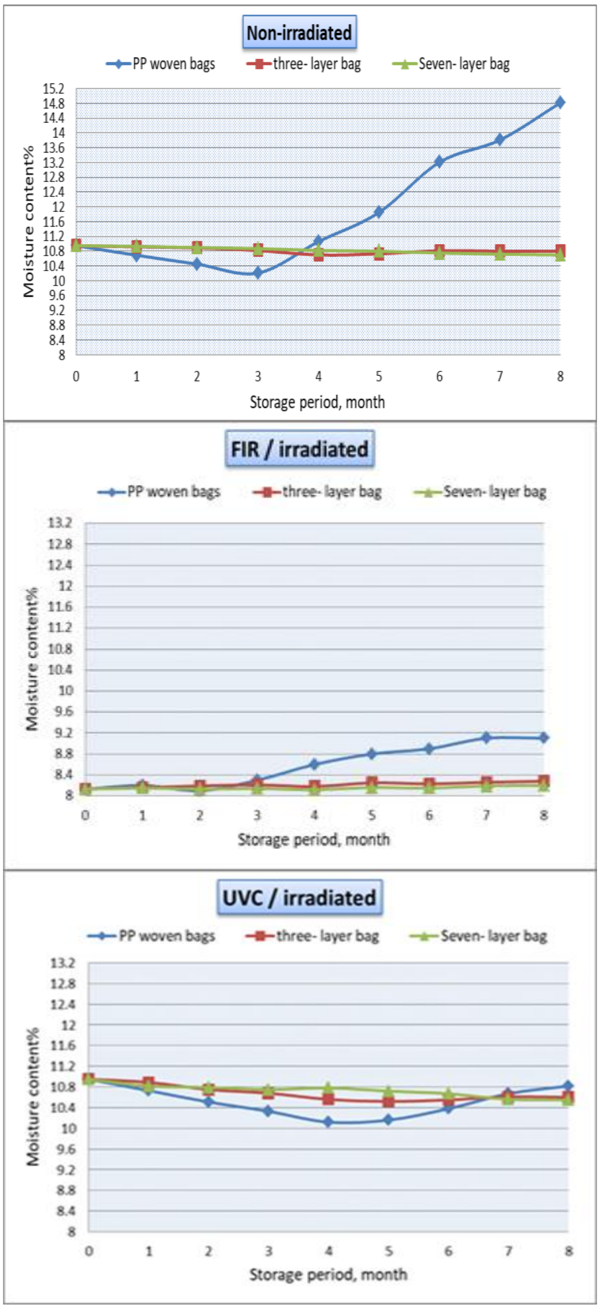

Fig. 3. Moisture content of stored seeds.
Source: Authors' determination.

Oxygen concentration inside the storage bags

Oxygen concentration was influenced by the type of bags and seeds condition as shown in Fig. 4. For the pp woven bags filled with irradiated or not irradiated seeds the Oxygen level fluctuated between 19.8% and 19.3% all over the storage period.

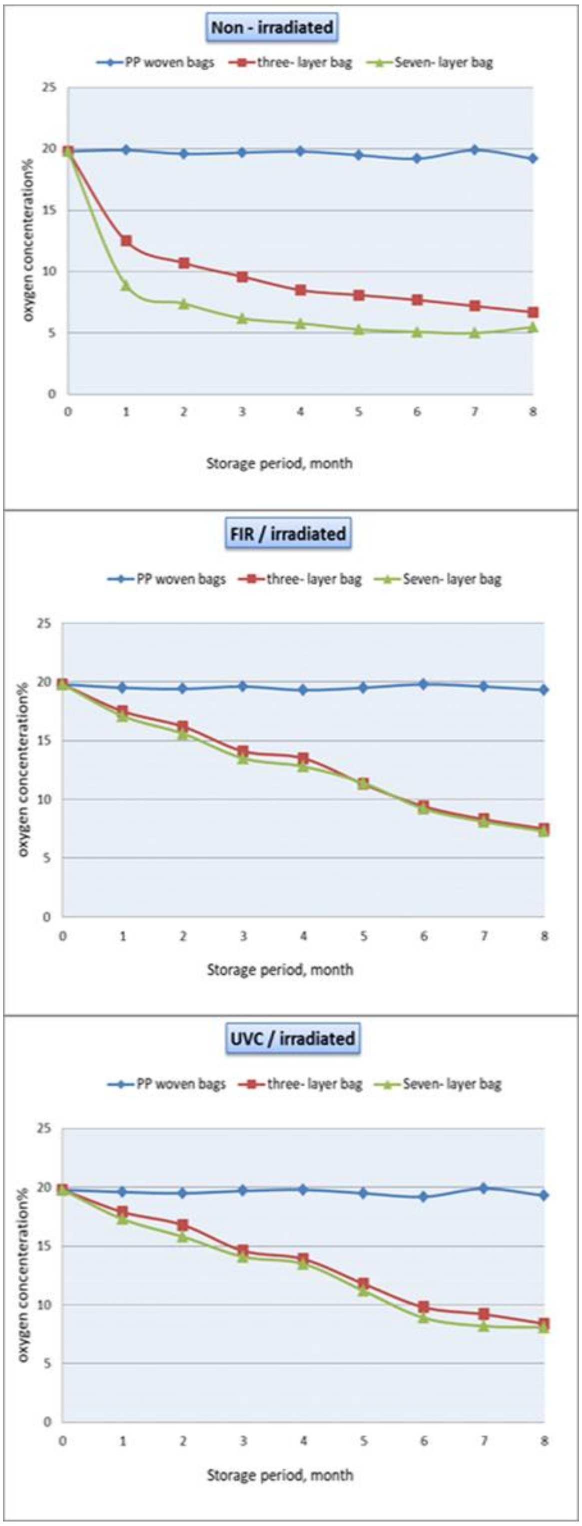

Fig. 4. Changes in oxygen concentration inside different types of storage bags.
Source: Authors' determination.

Meanwhile, the three layers bags filled with non-treated seeds showed a reduction of Oxygen concentration from 19.8% to 6.7, while in the seven layers bags, the Oxygen concentration decreased from 19.8% to 5.5%.

This means that oxygen concentration decreased by 66.16% and 72.22% for the non-treated seeds stored in three and seven-layer bags respectively.

For the bags filled with infra-red treated seeds, the Oxygen concentration decreased from 19.8 % to 7.5% for the three layers bags While, for the seven layers bags, it was decreased from 19.8% to 7.3%. Whilst the bags that filled with treated seeds with the ultraviolet radiation (UVC), the oxygen concentration decreased from 19.8% to 8.4% for the three layer bags likewise decreased from 19.8% to 8.1 % for the seven layers bags.

The above-mentioned results revealed that, depletion of oxygen concentration in the hermetic bags associated with lower metabolic activity of seeds and minimum rate of insects, bacterial and fungal growth, which consume the O_2 and release CO_2 required for safe storage of seeds [12].

Carbon dioxide concentration inside the storage bags

As shown in Fig. 5 seven layer bags recorded the highest levels of carbon dioxide concentration inside the bags which approached 24.8%, 20.9% and 20.5% at the end of storage period for the non- irradiated, infrared irradiated and ultraviolet irradiated bags respectively. While the average values of Carbon dioxide inside the three layer bags approached 19.7%, 16.9 % and 16.2% for the non -irradiated, infrared irradiated and ultraviolet irradiated treatments, respectively. In contrast pp woven bags in all conditions of seeds (irradiated or non-irradiated) recorded very low levels of CO_2 which ranged from 0.1% to 0.7%. In general, Oxygen concentration was dropped and carbon dioxide increased in the hermetic bags, due to respiration of stored seeds that cause releasing carbon dioxide and depletion of oxygen inside the hermetic bags.

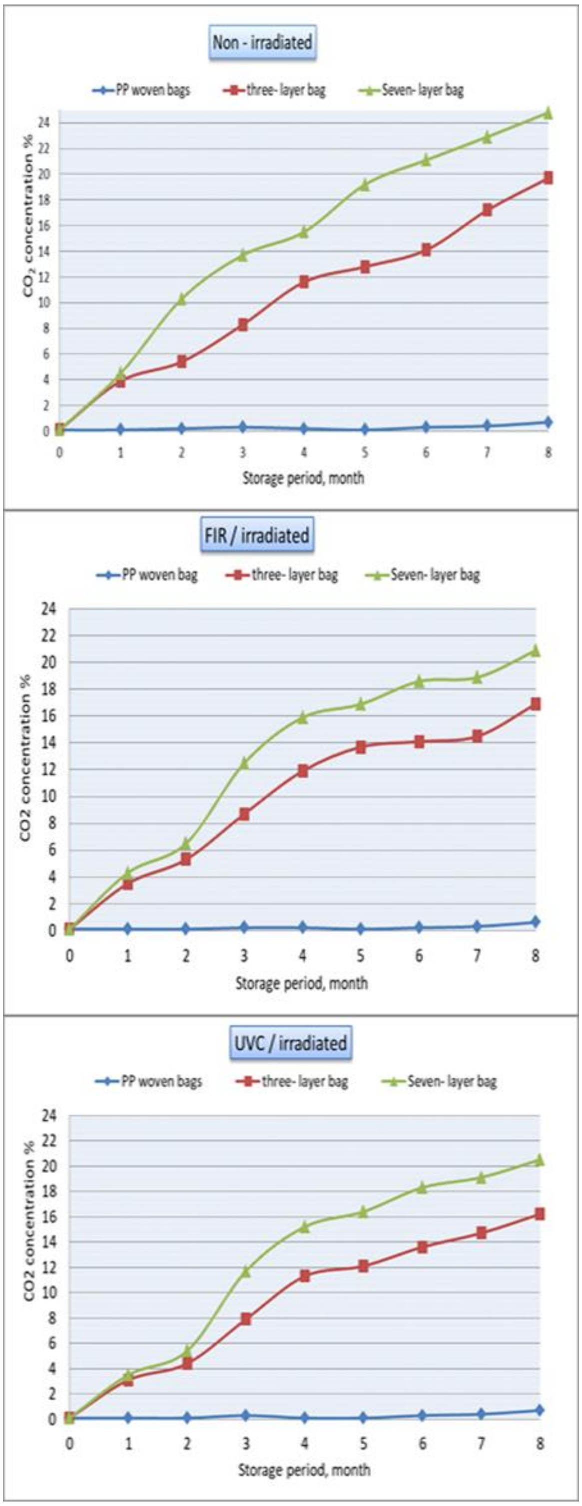

Fig. 5. Changes in Carbon dioxide concentration inside different types of storage bags
Source: Authors' determination.

Insect detection of cowpea seeds during storage

Insect detection of cowpea seeds (insect/Kg) during storage process inside different types of bags illustrated in Table 1. It was found that the non-treated and treated seeds stored on the pp woven bags contained live populations of cowpea weevil insect (*Callosobruchus maculatus*). The woven bags recorded 81, 13 and 11 insect/ kg for the non-irradiated. Infra-red irradiated and ultraviolet irradiated treatments. However, the hermetic bags when emptied, the weevils were found dead.

This means that, in case of using the hermetic bags, the produced carbon dioxide from seeds respiration approached levels not proper for continuous growth of insects.

Total microbial count during storage period:

Total microbial count (log cfu/mg) was influenced by the type of bags and seeds condition (Treated – non treated) as shown in Fig. 6. The total microbial count of seeds that not irradiated increased from 4.7 to 5.68 (Log cfu/g) for pp woven bags whereas the three layers bags and the seven layers bags recorded total microbial count of 3.1 and 2.8 (Log cfu/g) respectively.

For the FIR irradiated seeds stored in woven bags, the total microbial count increased from 2.3 to 3.7 (Log cfu/g) at the end of storage period. Meanwhile, it was decreased from 2.3 to 2.22 Log cfu/g for the three layers bags and from 2.3 to 2.1 Log cfu/g for seven layers bags. The irradiated seeds with ultraviolet showed total microbial count 3.8 (Log cfu/g) for pp woven bags in comparison with 1.9 and 1.7 Log cfu/g for the three layers and the seven layers bags respectively.

The obtained results show an increase in the infection of seeds stored in pp woven bags for the three conditions of seeds (not irradiated, FIR irradiated and UVC irradiated), whereas the rate of seeds infection was reduced in the hermetic bags (three layer bag and seven layer bag) for all conditions of seeds. The above mentioned results agree with [4], they reported that, hermetic storage make slightly change of moisture content during the period of storage, and keep lower levels of co2 beside sealing the seeds from moisture absorption which results in safe storage of seeds.

Table 1. Insect detection during storage period of bags (Insects/kg)

Storage period, month	Type of bag								
	PP Woven bag			3 layer bag			7 layer bag		
	N.IR	FIR	UVC	N.IR	FIR	UVC	N.IR	FIR	UVC
0	4	0	0	4	0	0	4	0	0
1	3	0	0	5	0	0	6	0	0
2	7	2	3	3	1(dead)	2(dead)	2(dead)	0	0
3	9	3	5	4	0	0	3(dead)	3(dead)	0
4	8	3	4	2(dead)	2(dead)	0	2(dead)	0	1(dead)
5	12	2	7	3(dead)	0	0	3(dead)	0	0
6	32	4	5	7(dead)	0	0	5(dead)	0	0
7	58	7	8	5(dead)	0	0	1(dead)	0	0
8	81	13	11	6(dead)	0	0	0	0	0

Source: Authors' determination.

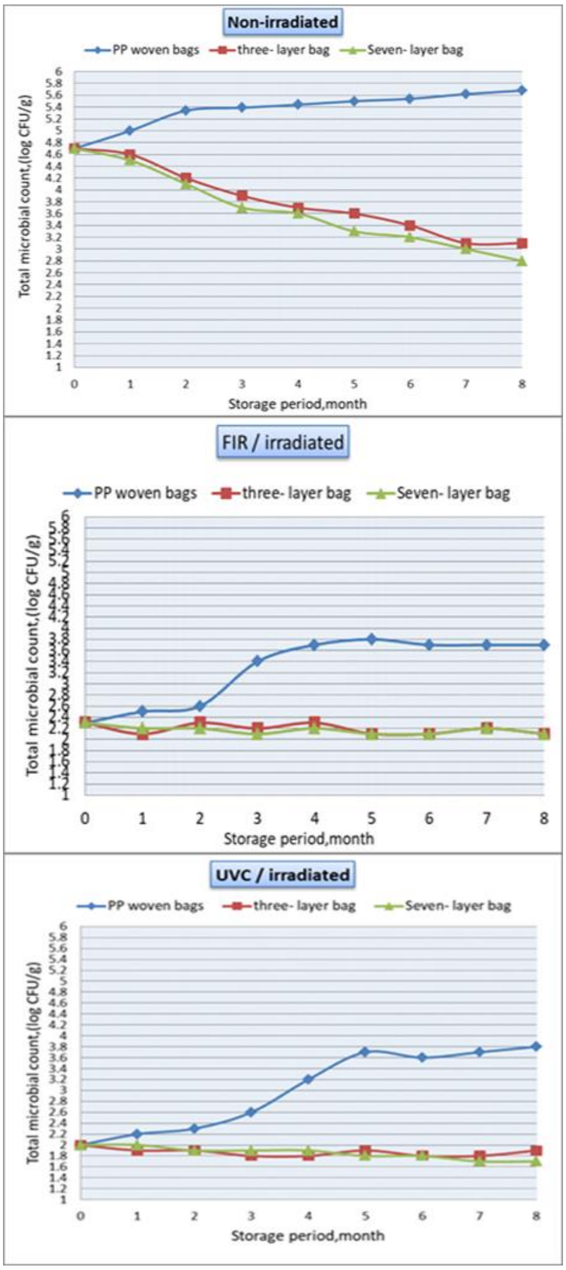

Fig. 6. Total microbial count during storage period of bags
Source: Authors' determination.

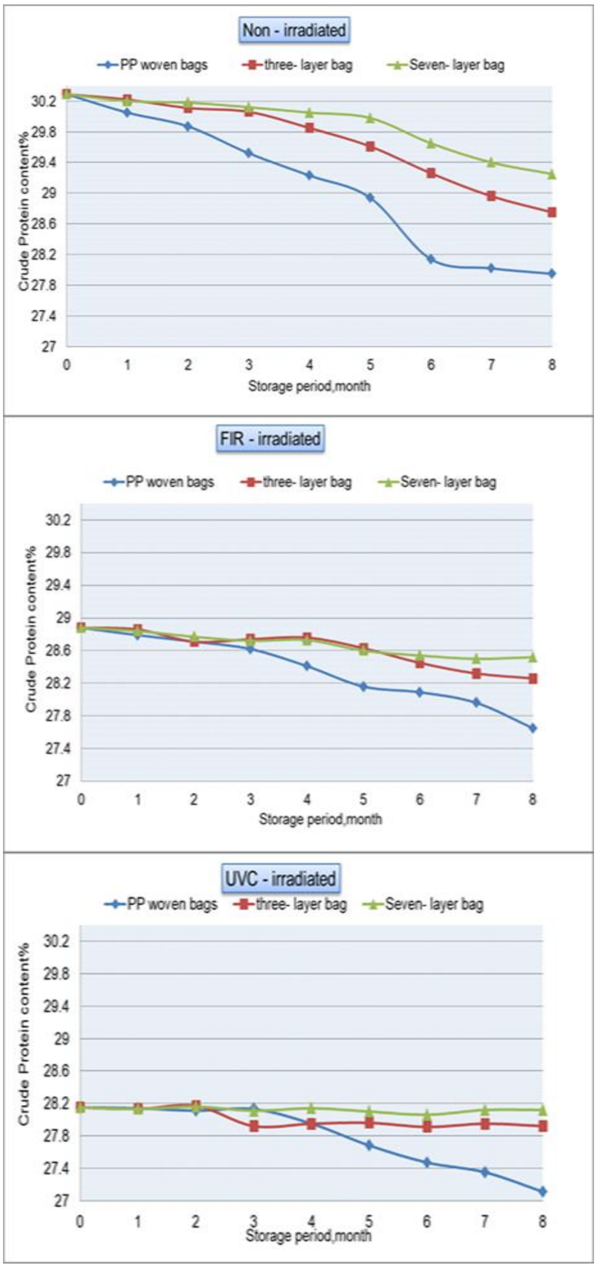

Fig. 7. Crude protein content of cowpea.
Source: Authors' determination.

Crude protein content of cowpea

Protein content of cowpea influenced by seeds condition (Pre-treated and non-treated) and type of storage bags as shown in Fig. 7.

For the non- irradiated woven bags, the crude protein decreased from 30.29% to 27.95%, while it was decreased from 30.29% to 28.75% and from 30.29% to 29.25% for the three layers bags and the seven layers bags respectively at the end of storage period. Meanwhile, the crude protein of the irradiated seeds with infra-red radiation decreased from 28.88% to 27.65%, 28.88% to 28.26 % and 28.88% to 28.52% for the seeds stored in woven bags, three layers bags and seven layers bags respectively.

For the irradiated seeds with ultraviolet it was decreased from 28.15% to 27.11%, 28.15% to 27.92% and 28.15% to 28.1% respectively.

The above mentioned results showed that the contaminated cowpea seeds recorded lower value of protein content.

The microorganisms and insects feed on the basic components of seeds for its grow; A. flavus uses protein and carbohydrates for its growth and aflatoxin production [7].

CONCLUSIONS

Conditioning cowpea seeds with infra-red heating of 882.67W/m^2 and exposure time of 15 min or UVC radiation of 3.538mW/cm^2 and an exposure time of 40 min and storage seeds in hermetic bags (three or seven layers) showed a safe storage results in terms of seeds quality and prevention of microorganisms and insects growth. In general, the UV pre-treatment and storage in 7 layers hermetic bag is recommended for safe storing cowpea seeds with keeping the final quality of seeds without deterioration.

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ISSUES OF CLIMATE VULNERABILITY IN ROMANIA - A SPECIAL MENTION FOR AGRICULTURE

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Abstract

This article analyses the concept, evolution and current situation of climate vulnerability in the European Union and highlights the needs for future developments in this sector, in the context of sustainable development and green recovery. The analysis of the current situation reflects some issues of the climate vulnerability in Romania compared with some other Member States, as well as within the development regions of Romania. There are also approached and highlighted some aspects regarding domains with higher vulnerability to climate change and the impact on the agriculture in Romania. The analysis of Romania's vulnerability to climate change was performed based on calculations present in global analyses, which followed the evolution of several composite indicators. The results place Romania in a relatively good position at global level, due mainly to the low exposure to sea level rise. On the other hand, the agricultural climate vulnerability is high due to droughts and floods, as manifestations of extreme weather events in Romania seriously exposed to damage in agriculture. The conclusions reflect the need for further analysis in this area and also provide some recommendations for improving further policy at national level.

Key words: *climate vulnerability, vulnerability quantification, agriculture vulnerability, sustainable development, impact*

INTRODUCTION

Climate vulnerability does not currently have a generally accepted definition. The literature on climate change and natural disasters uses this term to assess the degree of adaptation and exposure to climate variability.
The IPCC promoted a definition of vulnerability related to climate change events: Climate vulnerability is the level at which systems can no longer cope with the damage caused by climate change [13].
Economic analysis dedicated to assessing climate change vulnerability differ significantly by country and region because, at this level, the economic system is adjusted based on the analysis of push-pull factors, which can reduce importantly the direct manifestations of climate change.
In this respect, reducing the economic impact of climate change has become a permanent concern, especially in an attempt to promote a new development in the agricultural sector which has a key role in mitigating this impact.
On a global scale, agriculture is considered to be the largest single contributor to climate change and biodiversity loss, the sector consuming the most drinking water and fertile land and a major chemical pollutant. In order to comply with the planetary limits, this sector will have to transform from a carbon source into a natural reservoir of carbon by reducing the use of water in many basins and decrease the braking biodiversity.
Stakeholders in debates on climate change (public persons as politicians, private investors, the scientific community, and also the media) need to fully understand the dimension of this phenomenon. Since it is a very acute subject, new concepts are designed to help decision makers prioritize the best prevention measures. Until recently, the two basic notions of this field of research were mitigation and adaptation to climate change. In this paper, the authors are presenting two

equally important concepts increasingly present in the research horizon of this field: resilience and vulnerability to climate change. The latest, in order of occurrence, is climate vulnerability with the greatest importance in the process of preventing climate change, especially from an agricultural point of view [3].

MATERIALS AND METHODS

The objective of this paper is to highlight the necessity to develop and improve the climate vulnerability assessments in order to promote a green and circular economy.
The methodology used was as follows:
-Analyzing data and information existing on print and on line;
-Theoretical-methodological background, delimitation and analysis of concepts;
-Extracting data from cgdev.org database on vulnerability quantification;
-Processing the data extracted, creating tables and synthetic graphs;
-Analyzing and interpreting the processed data, tables and graphs;
-Drawing conclusions and recommendations.

RESULTS AND DISCUSSIONS

The importance of vulnerability in preventing climate change

In general terms, vulnerability, adaptation and resilience are beginning to be considered by various fields of research, mainly those related to sustainable development, as concepts of increasing use and relevance. In terms of economic and social systems, vulnerability is often associated with resilience, although not always considered as complementary.
The notion of vulnerability has become part of various institutional and organizational analyses, even if - taking into account specific differences of research methods - it has been defined in many different manners. In general, vulnerability includes the personal as well as group characteristics which allow people and systems to react and cope with disruptions. It applies to environmental systems also helping them to adapt to natural hazards.

Climate change and all extreme climate phenomena lead to economic vulnerability of a country. They are important issues that decision makers cannot address head-on and in a decisive, more or less predictable manner [14].
The type of vulnerability affects the way how the negative effects of climate change are perceived, as well as those related to climate variability and severe weather events. It depends on the scale and frequency of climate variability that defines the exposure of a system and its ability to adapt [1].
Climate change can increase potential vulnerabilities and also deepen existing socio-economic imbalances.
Every time the climate change cause damage to a region with low adaptation capacities, consequences will be severe, affecting territorial cohesion.

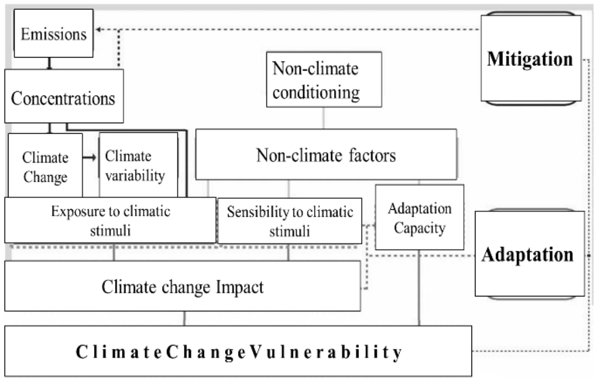

Fig. 1. Vulnerability to climate change framework assessment
Source: processing after Füssela and Klein, 2006 [11].

The analysis in figure 1 shows how important is the vulnerability to climate change when considering the possibilities of streamlining adaptation and mitigation measures [11].
The concept of vulnerability, initially used in the literature toward hazards, has gained increasing importance in the study of global environmental changes, climate change effects and also in sustainable development studies. Identification of climate change vulnerable regions and/or vulnerable groups in society can be done in order to prioritize resource allocation for development. Even if the regional impact of climate change depends on both exposure to anthropogenic and natural climate stimuli, the whole system is analyzed

in terms of specific vulnerability, to assess the aspects related to the adaptation component.

Regional climate vulnerability may be different, depending on particularities and location of systems. It can be assessed using indicators of economic development, such as the Human Development Index (HDI), Index of Sustainable Economic Welfare (ISEW) or the Index of Human Insecurity (IHI).

Global warming has already led to global, regional and local climate changes, while increasing risks, especially where vulnerability complicates the process of implementing adaptation measures. Thus, human systems and ecosystems in Europe are vulnerable to the effects of major climate change, such as floods or droughts, but depending on the region, a combination of different types of impacts can occur, which can exacerbate vulnerabilities [5]. Although differing very much in Europe, depending on local conditions, economic and social developments (demographic dynamics, wealth distribution and others), they are considered to be key factors for the local adaptation to climate change.

From an economic point of view, the adaptation aims at implementing measures corresponding to the current and potential impact of climate change, different from those to reduce vulnerability. Thus, benefiting from the restoration of resilience, the prevention of extremely negative effects of climate change, it will be acquired a natural orientation towards obtaining benefits, maybe as a result of following the implementation of the corresponding measures.

The adaptive cycle is another approach that draws attention to the importance of the cycle of destruction and reorganization of systems. It provides a clear picture of the processes that bring together systemic organization, dynamics, resilience and vulnerability. It presents a sequence of four phases of change in complex systems: exploitation, conservation, creative destruction and renewal and is framed as such or in various development policies aimed at increasing adaptability and resilience.

An assessment of climate change effects can be done, according to the phases of the adaptive cycle. This assessment takes into consideration that each of the four types of adaptation (planned, anticipatory, autonomous and reactive) corresponds to a certain degree of vulnerability, dictated by both territorial and economic conditions.

It must be acknowledged the distinction between:

(a) *the potential impact* - which refers to effects of climate change that will be fully felt by both ecosystems and human society as a result of future climate change, regardless of the effect of adaptation measures;

(b) *the residual impact* - which refers to the potential future effects of climate change, following the implementation of adaptation measures.

The analysis show that the potential impact of climate change is most likely to manifest itself mainly where the conditions of a particular vulnerability are not met (Table 1).

Table 1. Effects of climate change by type of adaptation

Adaptation	**Potential impact**	**Residual impact**	**Vulnerability**
Planned	x		reduced
Anticipative	x		normal
Autonomous		x	big
Reactive		x	very big

Source: synthesis after Boşneagu, 2010 [1].

This comparison shows a possible neglect of adaptation measures given that there is no threat from vulnerability.

It results that adaptation actions and measures will have to follow the requirements and issues of climate vulnerability, being able to influence even more the outcomes, as the adaptability corresponds more and more to the features of vulnerabilities.

Conceptual delimitations

In the view of the authors of this paper, the notion of "prevention of climate change" is not limited to the two classic phases (mitigation and adaptation), but extends to a complete cycle of prevention. The complete CC prevention cycle has four stages, including concepts of equal importance, such as climate vulnerability, as well as that of climate resilience.

However, the common understanding, which unfortunately is uncritically taken over at the level of some important programmatic documents for preventing negative effects of climate change, means the application of mitigation (or reduction) measures, as well as those of adaptation.

Even if the latter provide for measures that clearly belong to the category of reducing vulnerability or increasing resilience, as a rule, they are not highlighted as such.

Nevertheless, there are now salutary exceptions, putting things in their natural order. Among them is the latest report of the European Environment Agency, which signals the existence of four prevailing conceptions of environmental policies, interrelated and complementary, which can be equated by adaptation, reduction, avoidance and restoration. The report concludes that the transition to a green economy can be accelerated by the symbiosis of the four approaches, put together to implement current policies and design new ones [8].

Also, sharing the belief that it is equally important to prevent climate change by developing ecosystems, economic and social systems resistant to climate change, in this paper we take the previously developed theoretical model focused on restoring resilience, combining the need to adapt with identification of practical ways to reduce vulnerability to effects of climate change [4].

This global approach also considers the possibility of a disaster risk reduction assimilated to climate change. It recognizes that vulnerability to natural disasters and climate change are not only related to the severity of the events themselves, but also to the exposure and sensitivity of people and the economy to those events, as well as the ability of economies to adapt [10].

Consequently, in our view permanently promoted in this paper, unlike the classic notion of "climate change prevention", which includes in adaptation the components of reducing vulnerability and restoring resilience, in the category of measures to prevent climate change should be included all the four stages of prevention (mitigation, adaptation, vulnerability and resilience) which form an integrated cycle.

In each phase of this complete cycle, there are influenced the pillars of sustainable development, namely:

(i) the environmental quality - at the time of mitigation;

(ii) the social component, with predilection, at the time of vulnerability;

(iii) the economic component, mainly at the time of adaptation.

Finally, at the time of resilience, all three components are targeted, adding perhaps also the cultural component, for the need to ensure education for sustainable development.

Although previous papers [5, 4] have approached other phases, this paper focuses on the second phase of the complete cycle of climate change prevention, taking into consideration vulnerability issues.

Thus, reducing vertical (regional) and horizontal (sectoral) vulnerabilities is the second step in the process of preventing climate change, after the mitigation and before adaptation and resilience.

This process, being directly linked to the global efficiency of mitigation measures and the needs of the social environment, leaves in turn a wide range to be covered, which mitigation measures (due to limitations) cannot fully combat. The elements of vulnerability are complex covering issues related to multiple plans which are manifested as an emergency and are decoupled from mitigation efficiency (calculable, exclusively, in the long term) that must be completed with the next phase of climate change prevention.

When it comes to sustainable development, considering and applying the complete cycle of climate change prevention is becoming increasingly necessary and indispensable.

In short, the transformation of measures of climate change prevention into prerequisites for sustainable development takes place, in this complete cycle in four stages, as follows:

-Once mitigation measures are taken to contribute to the overall reduction of GHG emissions, it means that taking responsibility for sustainable development has given the necessary impetus to move to the implementation of everything that means preventing climate change, a process essential to ensuring sustainable development.

-Certainly, since they cannot cover the entire need for prevention, the second stage is set in motion, by covering measures dedicated to reducing climate vulnerability. At this stage, it is necessary to mobilize the energies of all stakeholders and place resources so that they can effectively continue the initial stage of mitigation, in cases and areas where locally focused measures are needed to complement global mitigation.

Climate Change impact on agriculture in Romania

Globally, climate change is particularly affecting agriculture, through the expansion of early flowering areas to the north and declining production yields for some crops due to heat waves and droughts (mostly in Central and Southern Europe). At the same time, the yield of other crops has increased, especially in northern Europe.

The most significant phenomena with economic and social impact, which occur as a result of climate change are: drought, extremely high temperatures - with an effect on the thermal comfort index - and floods.

At regional level, climatic conditions influence mostly the development and zonal specialization of agriculture, because each region is specialized in certain cereal crops or the breeding of certain animal species. The effects of climate change can become critical, where there is a high level of water pollution and limited access to aquatic resources for irrigation and quality drinking water, for example in southern Romania. The regional specificity becomes decisive both to establish the vulnerabilities and to the plan the level of support necessary to overcome the situation induced by the effects of climate change [5].

An analysis of the evolution of temperatures and precipitation, significant indicators for the impact of climate change at the national level, showed that temperatures are constantly rising and annual rainfall is relatively constant. However, the violent nature of rainfall (very large amount of water falling in a very short time) has a significant impact on the environment.

In our country, given the difficulty of identifying and calculating the economic costs associated with the effects of climate change, studies have focused on limited areas, especially in agriculture.

By correlating the information regarding the evolution of precipitations with those regarding the evolution of the multiannual average temperatures in Romania, it is possible to delineate the areas with the highest risk of aridization. Thus, as can be seen in Figure 2, the areas with a very high risk of drought are located in Oltenia, Bărăgan and less in the Moldavian Plateau. Several other areas with small surfaces that may develop an increased risk of aridization are in the Western Plain.

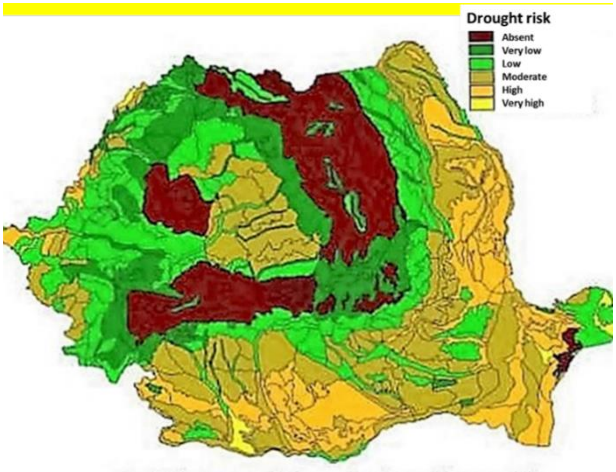

Fig. 2. Areas at risk of drought in Romania
Source: Constantinescu, 2018 [5].

In the category of moderate risk of occurrence of drought are large areas of Transylvania Plateau, the southeastern part of Wallachia (Bărăgan) and much of the Moldavian Plateau. All these areas are plain or plateau and have an agricultural specificity.

Considered one of the economic sectors most exposed to the negative effects of climate change, agriculture suffers due to both rising temperatures, extreme weather events and changes in rainfall regime. Preventing the effects of climate change is a priority in this domain.

Romania's agriculture sector faces inevitable effects of climate change, in turn, it is not only vulnerable but also a significant source of GHG emissions. A significant change of the temperate-continental climate of Romania is expected in the next decades, specifically a raise of the average annual air temperature and a decrease of the annual amount of precipitation, on average by 10-20%. In this context, vulnerabilities and risks caused by these changes must be taken into account in all strategies that provide measures to prevent climate change in the agricultural sector.

They must also take into account that impact is not uniform, as there are differences both geographically in terms of drought or torrential rains and in terms of the standard of living of the population, those in rural areas affected by these changes, having revenues lower than those in urban areas do. Therefore, these strategies provide for adaptation in accordance with sector-specific activities, promoting food security and sustainable development in rural areas.

The most important programmatic documents that discuss the prevention of climate change in agriculture, in the order of their topicality and, obviously, in the absence of a comprehensive strategy dedicated exclusively to the prevention of climate change in this sector are the following:

- National Rural Development Program for the period 2014-2020;
- Adaptation measures in Romanian agriculture, ANM, 2014;
- Romania's rural development strategy 2014-2020;
- National Strategy for Climate Change and Growth Based on Low Carbon, SNSC–CRESC 2016-2020.

It is necessary to mention that, although at EU level a new document in the field of climate change was launched on July 14, 2021, The European Green Deal, in Romania only the above mentioned documents are still in force.

On the other hand, we can say that actions in the field of agriculture contribute to a major extent to the prevention of climate change, especially through three types of measures:

- afforestation in order to retain GHG emissions;
- use of biomass to obtain energy;
- the contribution of organic farming to the preservation of biodiversity and water resources.

As a complex sector, agriculture needs to adapt the general measures on climate change present in the strategy papers to local needs. Prevention strategies in agriculture also take into account significant uncertainties, in particular as regards the direction and impact of climate change on agriculture and the affected community in rural areas. An approach is being sought to reconcile and integrate the challenges of the new climatic conditions into the requirements of achieving more resilient agriculture to climate change and improving living standards in rural areas.

Regarding agriculture in Romania, the combined effects of warming and rainfall variation are expected to lead to lower yields in different crops. This requires the choice of those adaptation options by farmers, in collaboration with the administration and other stakeholders, able to give the best yield, in changing irrigation practices and the use of land for crop production.

The strategies of this sector in Romania are based on specific studies made in all regions of the country, which are justifications for regional responses to the challenges of climate change. GHG emissions from the agricultural sector, in 2010, represented approximately 52.80% compared to 1989, representing 14.28% compared to total national GHG emissions [5]. In order to achieve the priority objective of integration and harmonization of adaptation measures for agriculture, those economic and social factors that influence the adaptation potential of farmers must be taken into account.

In addition, SNSC 2013-2020 advances a series of measures aimed at reducing GHG emissions and promoting organic farming, both by modernizing agricultural holdings and supporting the development of SMEs, and by helping farmers through agri-environment payments and the use of new technologies for renewable energies, biofuels, as well as the exploitation of other local energy sources.

The agricultural sector is a key sector for Romania, extremely vulnerable to climate change. It is responsible for approx. 30% of employment in Romania (by far the largest share in the EU).

The CRESC strategy 2016-2030 shows that the impact of climate change on agriculture can sometimes be positive, but it is usually mostly negative.

The agriculture and rural development sector in Romania is currently experiencing a mainly negative impact, manifested primarily, as follows [5]:

- Changes in agricultural productivity (by changing the growing seasons of crop plants);
- Increasing flood frequency has become an increasingly common problem in agriculture;
- Increasing the frequency and intensity of drought periods - leading to aridization, especially in the southern regions of the country;
- Risk of soil exposure to erosion and desertification - due to increasing drought;
- Increasing the frequency of severe weather events (storms and hail) with a direct influence on the increase of damage recorded in agriculture.

PNASC 2015, a detailed document containing measures and solutions for the implementation of the CRESC Strategy 2016-2030, presents Romania's contribution to preventing the effects of climate change in two directions: reducing GHGs according to quantifiable targets in line with EU 2030 aspirations and adapting to climate change to promote protection of the economic and social environment. Agriculture has a contribution of 15.31% to the total GHG emissions at national level (at the level of 2016). The proposed investments in agriculture within PNASC are of 4,845 mil. Euro. These are planned to take place both in the period covered by PNASC, respectively 2016-2020, and in the next period, 2011-2022. Investments will be relatively constant (approximately 800 million Euros per year), as all planned measures are expected to cover the same period, respectively 2016-2022. The financing of the investments will be made from the available budgets and from the FC 2014-2020, POIM and ERDF.

Corroborating the previously analyzed data, regarding the evolution of temperature and precipitation, we can see that agriculture is one of the sectors that will suffer the most from the loss of productivity in certain crops and by changing the specifics of land use.

Quantifying Romania's Climate Change Vulnerability

In this section, there will be analyzed some recent outcomes of quantifying the climate change vulnerability, by taking into consideration the particular case of Romania and the regions in Romania, and the main issues of concern here.

According to the doctoral research conducted in [5], in relation to climate change events, the most vulnerable region of Romania is considered to be the South-East (a climate vulnerability index score 60), followed closely by South Muntenia (with score 56, Table 2).

Table 2. Exposure of Romania's regions to climate change

NUTS II regions	Climate change vulnerability index*, regional score
Northeast	38
Southeast	60
South Muntenia	56
Southwest Oltenia	41
West	39
Northwest	33
Center	30
Bucharest-Ilfov	39

Source: Own processing based on data from the Regional Development Plan 2014-2020, South East Regional Development Agency (Agentia de Dezvoltare Regionala Sud-Est Romania), 2020 [12].

* Index based on changes related to the population affected by floods, the population in coastal areas below 5m, potential risk of drought, vulnerability of agriculture, fishing and tourism, taking into account changes related to precipitation and temperature.

Nevertheless, at European level, 26 EU regions are more vulnerable than the South East Region of Romania [15].

This long-term forecast becomes all the more important if we take into account the ease with which one or another item on the public agenda is lost. For example, according to the latest European barometer of opinion, Romanians admit that they do too little to fight climate change. The lack of civic culture in this regard is also evident in the high percentage (69%) of those who admit that they have done nothing to combat climate change [7].

Vulnerability to climate change still raises questions about the method of analysis. One of the newest methods exposed [15] involves determining risk indicators for three critical issues:
-Increasing the number of disasters related to extreme weather events;
-Decreased agricultural productivity;
-Sea level rise.
To determine the vulnerability of a region or a country to climate change, a specific methodology has been created, based on classic statistical indicators. The methodology can be applied easily and with good results for any country, for all three problems analyzed or for any of them individually.

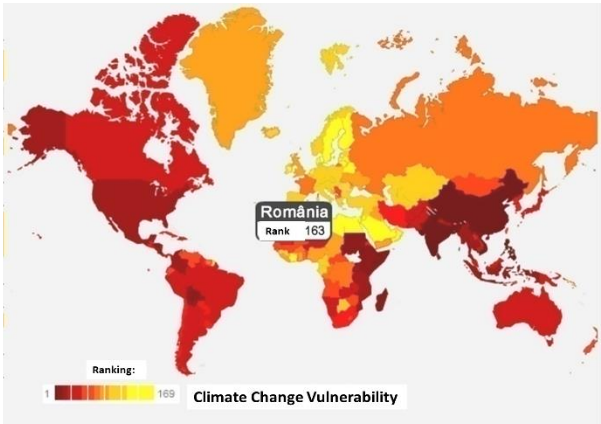

Fig. 3. Romania's position according to vulnerability to climate change in the world
Source: own selection from Wheeler D., 2016 [15].

The model analyzes the risk of climate impact depending on the accumulation of CO_2 in the atmosphere. Data on the number of inhabitants and per capita income are from the World Bank database.
The model includes the following variables:
-Increasing concentration of CO_2 in the atmosphere;
-Per capita income;
-Transparency of information;
-Compliance with regulations (legislation).
Per capita income has a significant influence, directly proportional to the reduction of vulnerability to climate change: for every percentage (1%) of a per capita income increase, the risk due to extreme climate phenomena decreases by 1.2%.
As expected, the increase in greenhouse gas (GHG) concentration has the greatest influence on climate vulnerability: a 1% increase in the GHG concentration in the atmosphere leads to a 30% increase in the risks due to extreme weather events.
The period used for this particular model was 1995-2008, because the data existing in the database (www.em-dat.be) before this period are not very accurate. The above analysis was performed for 233 countries worldwide [6].
In a classification according to the vulnerability to climate change (Figure 3), Romania is on the position 163.
This score and the light color (yellow) on the map shows the ranking of Romania in a very favorable position regarding the vulnerability to climate change, compared to the other nations presented in this classification [15].
However, it must be highlighted that, depending on the specific issue analyzed, the degree of vulnerability varies significantly as shown in Table 3:

Table 3. Quantification of vulnerability to climate change

Country	Climate Vulnerability Indicator TOTAL **(CVI)**	Extreme Temperature Vulnerability Indicator **(WCVI)**	Sea level rise Vulnerability Indicator **(SCVI)**	Damage in agriculture Vulnerability Indicator **(ACVI)**
Bulgaria	4.019	0.002	0	14.31
China	100.000	100.000	6.56	4.99
Germany	1.310	0.003	4.62	4.83
Hungary	2.635	0.009	0	8.32
India	90.783	49.755	5.44	61.90
Romania	**4.884**	**0.0004**	**0.60**	**10.98**
Serbia	6.815	0.153	0	14.31
USA	4.027	2.702	3.78	7.49
Turkey	8.322	0.012	5.08	26.96

Source: own data processing from www.cgdev.org, [2].

(1) For exposure to declining agricultural productivity (ACVI), Romania has an extremely high climate vulnerability indicator (10.98). Therefore, this column is highlighted red in Table 3;
(2) For exposure to extreme weather phenomena (WCVI), Romania has an extremely low climate vulnerability indicator (of 0.0004);
(3) For exposure to sea level rise (SCVI), Romania has a climate vulnerability indicator of 0.6.
The total climate vulnerability indicator for Romania is 4.884, sharing quite the same level with other East-European countries (Bulgaria, Serbia). This level of climate

vulnerability indicator (CVI) may not be very high; still it is higher than the CVI of other EU countries, such as Germany.

Nevertheless, it can be stated that Romania has a relatively low degree of vulnerability to overall climate change.

Out of the three climate vulnerability issues indicators analyzed, only one has worrying values for Romania, namely the one that assesses agricultural productivity.

Although it has a really high and concerning value, the *exposure to declining agricultural productivity* indicator is quite comparable to neighboring countries (Hungary, Serbia and Bulgaria). This means that the decreasing agriculture productivity due to climate change in not a local problem, not even a national one. It can be considered a serious regional problem, at European level.

According to the analysis, in Romania the predominantly suffering regions are located in the southeast and south, where the increase of average annual temperatures, lack of forest protection curtains and violent meteorological phenomena (storms) will result in large losses in agricultural productivity. Therefore, it is necessary that horizontal strategies to prevent climate change not be limited to the sustainable use of resources, but take into account the two-way relationship between climate change and sustainable, green economic development.

As highlighted in previous research, green economy involves a sustainable management of environmental resources, taking into consideration the complex biosphere as a closed system with important renewable and non-renewable natural resources but with a limited capacity for self-regulation and self-renewal. Only a green, climate-neutral and circular economy model may be the ideal solution for relaunching more sustainably the European economy, which has suffered in recent years and was also considerably hit by the Covid-19 pandemic [9].

Within the European Green Deal, the EU has assumed most ambitious commitments, such as becoming the first climate-neutral continent by 2050. This also involves first measures of climate change mitigation such as the decision to reduce greenhouse gas emissions at least by 55% (by 2030 compared to 1990 levels).

The European Union also aims to reach resilience to climate change, reverse biodiversity loss and degradation of the environment and to leave nobody behind in the process. In this purpose, the current EU policy of green recovery and transition to a sustainable, green and circular economy should address efficiently the climate vulnerability issues according to the gravity of each issue in each EU country.

CONCLUSIONS

All actions dedicated to restoring the quality of the environment can be assimilated to the joint effort to reduce vulnerability and exposure to the dangers of climate change. Evaluated together with all mitigation measures, the measures dedicated to saving the quality of environmental factors are the first two stages of the complete cycle of prevention. Their proper application gives new impetus to the idea of rational use of resources, despite conflicting interests that make both mitigation and reduction of vulnerability to fall under the clear incidence of sustainable development.

The complete cycle of climate change prevention is the only approach that recognizes that vulnerability to climate change is not only related to the severity of weather events, but also to the exposure, sensitivity and ability of people and of the economy to adapt to these events.

Thus, prevention measures taken at the level of the economy will lead to positive feedback from sustainable development, provided that the mix of policies to prevent the effects of climate change and sustainable development allows a unified perspective of all economic sectors. In the particular case of Romania, all these aspects are related to the model of economic and social development that will be followed. The climate change has not been one serious aspect of concern and of action in Romania but it must become in order to comply with the opportunities and transformations requested by the European

Union Green Deal and sustainable development strategy.

Agriculture is one the most active and important economic sectors in Romania and the real threat of agricultural climate vulnerability resulting from this paper`s analysis, should be taken into very serious consideration by the decision-makers.

Such a perspective influences the conditions for international development, especially in the European Union, as the connections that exist at the institutional and governmental levels in terms of reducing the impact of climate change and severe weather events aim to apply the most effective methods of rebuilding resilience and reduce climate vulnerability in Romania.

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CORRELATION-REGRESSION MODEL OF MIGRATION FLOWS OF EMPLOYED RURAL POPULATION IN SARATOV REGION, RUSSIAN FEDERATION

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Abstract

The problems of the migration outflow of the able-bodied population in the Russian Federation are reflected on the example of the Volga Federal District, which is leading in terms of these indicators. For a monographic study from the group of rural areas of the Saratov region, which is part of the Volga Federal District, the areas with high average and low levels of outflow of the able-bodied population were selected. Using the method of correlation analysis, the influence of a number of factors on the mechanical movement of the population of the three studied districts of the region was determined. For these districts of the Saratov region, a regression model of the influence of factors on the migration flows of the able-bodied population has been developed. Based on the regression model for regional and municipal authorities dealing with the development of rural areas, heads of agricultural organizations and peasant farms, a list of possible management decisions aimed at reducing the migration outflow for each group of districts was compiled.

Key words: *labor migration, migration balance, outflow of working-aged rural population, correlation-regression model, rural area development*

INTRODUCTION

At present, in Russia as a whole and in the region in particular, the ratio of fertility, mortality and migration processes cause a steady decline in the population. This tendency is especially pronounced in rural areas, due to the fact that the socio-economic, engineering, household and cultural conditions of their development lag significantly behind cities of regional importance and from large industrial agglomerations.
Insufficient knowledge of the impact of socio-economic factors on the demographic development of rural areas, as well as the high scientific and practical significance of the development and implementation of models of socio-demographic development in the countryside served as the basis for the research [4].
The theory and methodology of socio-economic processes affecting the development of demography are disclosed in the works of many Russian and foreign scientists - economists, sociologists and demographers. Problems of migration dynamics taking into account socio-economic aspects were researched by G. Borias G. Borjas [1], W. Zelinsky [18], E.S. Lee [5], W.A. Lewis [6], D. Massey [7], E.E. Petras [8], S. Sassen [11], A. H Sjaastad [12], R. Skeldon [13], O. Stark [14], M.P Todaro [16].
In this context, the purpose of the paper was working out correlation-regression model of migration flows of employed rural population in Saratov region, Russian federation.

MATERIALS AND METHODS

To research the reasons for the migration of the able-bodied rural population, the method of correlation-regression analysis was used. When selecting independent variables, we relied on the network theory of migration by D. Massey [7], in which the level of wages is not the leading factor determining the intensity of migration flows, but is only one of many. The advantages of using this theory are that the author takes into account both the economic conditions and the well-being of the population's life, focusing on the provision of social and household benefits. A peculiarity is that from a migration point of view, it is not a single person, but a household that is considered, that is, the basis for making a decision on migration is not only income maximization, but also minimization of risks for running a household.

Also, to systematize the variables that affect the migration balance, the theoretical and methodological provisions of T.I. Zaslavskaya [17], in which the influencing indicators are subdivided into factors-regulators and factors-conditions, L.L. Rybakovsky [10] - emphasis is placed on the provision of the rural population with the necessary objects of social infrastructure, and the works of R. Piras [9], I. Etzo [2], S. Ghatak and others [3] - the levels incomes of the population, social payments, the development of public consumption funds, etc.

In the correlation-regression model, the set of independent variables is made up of factor-regulators - indicators that determine the economic well-being of the rural population (the level of wages and disposable income, indicators of the development of agricultural production, the development of public consumption funds, etc.) and factor-conditions - indicators of the already achieved level development of social infrastructure (condition of the road fund, provision of medical specialists, etc.). The output data of the model made it possible to select those indicators that most closely influence the reduction of the outflow of the able-bodied rural population, to propose to the state authorities and the management of agricultural enterprises the sequence of effective management decisions.

RESULTS AND DISCUSSIONS

Over the past 20 years, until the active outbreak of the coronavirus pandemic in 2020, the trend in the migration inflow of labor migrants, mainly from the CIS countries, began to be noticeably traced in the Russian Federation (Table 1). Migration flows from Tajikistan, Ukraine and Armenia increased several times from the year 2000 to 2020.

Table 1. Dynamics of the migration balance of the Russian Federation with the CIS countries

Countries	Balance of interstate migration (persons)				
	2000	2010	2018	2019	2020
Total	246,051	150,734	129,076	256,000	118,864
1. Azerbaijan	11,719	13,389	8,737	17,005	10,893
2. Armenia	14,432	19,192	14,358	35,109	-1,844
3. Belarus	-3,002	1,995	7,191	6,283	-1,404
4. Kazakhstan	106,990	20,533	26,516	39,166	8,437
5. Kyrgyzstan	13,679	20,260	8,978	15,106	1,401
6. Moldova	9,415	11,197	7,688	5,385	3,493
7. Russia	9,885	17,494	31,028	48,374	39,420
8. Tajikistan	6,062	2,178	2,951	6,198	777
9. Uzbekistan	37,724	23,266	6,807	19,129	4,922
10. Ukraine	39,147	21,230	14,822	64,245	52,769

Source: calculated on the basis of data [15].

Along with the noted trend, it can be noted that from 2015 to 2019. stable migration flows within the country are traced from the Volga, Far Eastern, Siberian, Ural and North Caucasian Federal Districts to the Central and Northwestern Federal Districts. The Volga Federal District is in the lead (Table 2), in which the Saratov region makes a significant contribution to the outflow of the working population - from 2015 to 2019 the migration balance increased from - 4,368 to - 6,934 people. Consequently, part of the shortage of jobs is compensated by visiting migrants from the CIS countries.

Table 2. Dynamics of migration flows in the Russian Federation

Federal Districts (FD)	Migration gain (decline in population) in absolute expression, (persons)				
	2015	2016	2017	2018	2019
Central Federal District	119,382	126,734	85,226	124,902	90,511
Northwestern Federal District	35,771	38,351	38,537	45,072	39,263
Southern Federal District	18,234	20,117	36,989	17,373	16,243
North Caucasian Federal District	- 28,027	- 31,549	- 25,411	- 29,058	- 15,670
Volga Federal District	- 50,458	- 60,813	- 46,774	- 62,095	- 43,520
including Saratov region	- 4,368	- 7,169	- 5,609	- 7,810	- 6,934
Ural Federal District	- 13,432	- 20,450	- 15,879	- 20,013	- 20,508
Siberian Federal District	- 45,795	- 48,480	- 47,420	- 51,815	- 40,275
Far Eastern Federal District	- 35,675	- 32,816	- 25,268	- 24,366	-26,062

Source: calculated on the basis of data [15].

For this reason, the Saratov region was chosen as the object of a detailed study of the reasons for the outflow of the able-bodied population, including from rural areas. For a monographic study, from the group of rural districts of the Saratov region, districts with high (Piterskiy), medium (Ivanteevsky) and low (Voskresensky) levels of the outflow of the able-bodied population were identified. Using the method of correlation analysis, the influence of a number of factors on the mechanical movement of the population of the three studied districts of the region was determined.

As a result, the size of disposable income and official employment of the able-bodied population are significant indicators influencing the migration outflow of the population (direct correlation dependence - correlation coefficients from 0.5 to 0.8). In an area with a low migration outflow (Voskresensky district), disposable incomes increased by more than 2 times during the study period; with the middle (Ivanteevsky district) - almost 1.5 times; with intensive (Piterskiy district) - by 11%.

The following pattern was revealed: the smaller the outflow of the working-age population in the regions, the greater the number of factors that have a close or significant correlation with the migration balance. In Ivanteevsky and Voskresensky districts, in addition to the factors that determine the level of well-being of the population, there is a close connection between the dynamics of annual capital investments in agricultural production, gross regional product, the number of social benefits, the staffing of medical specialists, the state of the road fund, and budgetary spending on education.

For these districts of the Saratov region, a regression model of the influence of factors on the migration flows of the able-bodied population has been developed (Table 3).

We used linear regression model, which calculate on the base of formula:

$$Y(x,b) = b0 + b_1 x_1 + b_2 x_2 + \ldots + b_k x_k,$$

where:

b_k – regression coefficients, x_k – model factors, k – quantity of factors.

The indicator of the migration balance was taken as the dependent variable (Y). When selecting multicollinear independent variables from the model, multiple correlation matrices were compiled for each of the regions. Variables were excluded from the calculation of the regression equation according to the following principle: if they had a strong or noticeable relationship with other variables (correlation coefficients - more than 0.6 in absolute value), the remaining factors are the input data of the regression and are re-numbered. The models have a high level of statistical reliability: the determination coefficients were 95-98 %, the Fisher's calculated criteria exceeded their critical values. Based on the regression model for regional and municipal authorities dealing with the development of rural areas, heads of agricultural organizations and peasant farms, a list of possible management decisions aimed at reducing the migration outflow for each group of districts was compiled.

Table 3. Correlation-regression model of migration flows of the able-bodied rural population (based on materials from the Saratov region)

Piterskiy district (high dynamics of migration outflow)		
Independent variables: x1 - average monthly size of disposable income of the population; x2 - the level of official employment of the population,%; x3 - gross regional product per capita; x4 - amount of state aid agricultural enterprises; x5 - capital investments in agricultural enterprises.	**Regression equation:** $y = –418.35 + 9.08x_1 + 9.02x_2 + 0.86x_3 + 4.67x_4 – 1.53x_5$ **Reliability parameters:** $R^2 = 0.95$; $F_{critical} = 0.18$; $F_{fact} = 5.82$	**Conclusions on the results** high response y to an increase in xi by 1 unit: x1 will reduce y by 9 units, x2 - by 9 units; moderate response y to an increase in xi by 1 unit: x3 will reduce y by 1 unit, x4 - by 5 units; negligible or negative response y on variables: x5
Expected effect: reduction of the migration outflow from 270 to 179 people by 2025		
Ivanteevsky district (average dynamics of migration outflow)		
Independent variables: x1 - average monthly size of disposable income of the population; x2 - the level of official employment of the population,%; x3 is the share of private business; x4 - investments from the municipal budget; x5 - capital investments in agricultural enterprises	**Regression equation:** $y = –312.18 + 4,55x_1 + 9,30x_2 + 4.85x_3 + 0.64x_4 + 0.15x_5$ **Reliability parameters** $R^2 = 0.70$; $F_{critical} = 0.15$; $F_{fact} = 10.30$	**Conclusions on the results:** high response y to an increase in xi by 1 unit: x1 will reduce y by 4 units, x2 - by 9 units, x3 - by 5 units; moderate response y to an increase in xi by 1 unit: 10X4 will reduce y by 6 units; 10X5 - for 2 units.
Expected effect: reduction of the migration outflow from 162 to 100 people by 2025		
Voskresensky district (low dynamics of migration outflow)		
Independent variables: x1 – average monthly size of disposable income of the population; x2 – the level of official employement for the population, %; x3 is the share of private business; x4 - investments from the municipal budget; x5 – amount of state aid agricultural enterprises x6 - capital investments in agricultural enterprises	**Regression equation:** $y = –43.01 + 0.60x_1 + 2.11x_2 + 0.19x_3 + 0.02x_4 + 1.87x_5 + 0.50\ x_6$ **Reliability parameters** $R^2 = 0.98$; $F_{critical} = 0.17$; $F_{fact} = 68.00$	**Conclusions on the results:** high response y to an increase in xi by 1 unit: x1 will reduce y by 1 unit, x2 - by 2 units; moderate response y to an increase in xi by 1 unit: 10X6 will reduce y by 5 units, x5 – by 2 units; negligible or negative response y on variables: x3,x4
Expected effect: reduction of the migration outflow from 25 to 11 people by 2025		

Source: calculated by authors.

In areas with a high and medium migration outflow, in addition to universal solutions (using the reserves of available vacancies, developing standard and non-standard forms of employment, subsidizing part of the cost of paying interest on loans, as well as maintaining the existing growth rates of disposable income of the population), it is advisable to introduce tax incentives, strengthen support all types of businesses (including small ones), self-employed citizens who create jobs, and diversify the rural economy.

Forecast calculations of the expected effect from a decrease in migration outflow show that due to the reserves for the growth of disposable incomes of the population in the Piterskiy district, this indicator will decrease by 91 people or 33.7%; in Ivanteevsky district - by 62 people (by 38.3%); in the Voskresensky district - for 14 people (by 56%).

CONCLUSIONS

Correlation analysis of the influence of factors-regulators and factors-conditions on the mechanical outflow of the rural population according to foreign and domestic methods of their selection, carried out in three studied districts of the Saratov region of the Russian Federation, showed that the size of wages and official employment of the able-bodied population is the main indicator of decision-making on the population's residence in the countryside.

As a result of constructing a correlation-regression model, reflecting the influence of regulating factors and factors-conditions on the migration outflow of the working-age population of rural areas of the Saratov region, it was revealed that in all the studied regions the greatest response of the dependent variable to the independent ones was found in terms of growth in disposable income and the level of official employment. As predicted calculations show, by 2025 the migration outflow will decrease by 14-91 people, depending on the analytical gradation. Also, according to the simulation results, it was found that for a more radical solution to the problem and achieving a positive mechanical increase in the economically active population in rural areas, a more extensive list of management decisions is needed, especially in areas with a high and average outflow of the able-bodied population, it is necessary to reduce the tax burden of producers and processors of agricultural products through the introduction of property tax incentives in order to increase the volume of the regional product, as well as to strengthen support for all types of businesses and self-employed citizens.

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TRENDS IN THE FORMATION AND CORRELATION OF CURRENT AND NON-CURRENT ASSETS OF AGRICULTURAL ENTERPRISES: A CASE STUDY OF UKRAINE

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Abstract

The study aims to identify trends in the formation of the structure of assets of agricultural enterprises in Ukraine and the ratio of their individual groups. In preparation of work the complex methods of economic research used in this study were: monographic, critical analysis, structural and trend analysis, correlation-regression analysis, etc. The study found that in the current economic conditions, the technical potential and repair and maintenance base of the agricultural sector of Ukraine does not meet the requirements of scientifically sound needs of agricultural production. The supply of machinery to most agricultural producers in Ukraine is approaching a critically insufficient level. It is substantiated that the main agricultural machines of agricultural enterprises of Ukraine are provided only by 45-65%. The article proves that more than 90% of the technical means of agricultural enterprises of Ukraine have already served their depreciation period; their technical readiness for fieldwork does not exceed 60-70%. The article substantiates that due to malfunctions and physical wear and tear, a quarter of tractors and combines are not used in Ukraine every year, and the technical service system operates at minimum capacity.

Key words: *agricultural enterprises, asset management, current assets, non-current assets, structure of assets of agricultural enterprises*

INTRODUCTION

Production and financial activity of any agricultural enterprise depend on the availability and optimality of the asset structure, which is formed under the influence of a number of factors: specialization, production volumes, technology, and technical support of production processes, providing the enterprise with material resources and so on.

In conditions of instability and variability of the external environment of economic entities, there is an objective need to develop a set of measures to strengthen the level of their economic security. One of the most important components of this process is the management of the asset structure of agricultural entities, the efficiency of the formation and use of which depends on the final results of economic activity, uninterrupted circulation of capital, and financial condition of enterprises.

The transition of agricultural production to an industrial basis, the emergence of new equipment, technologies, organizational innovations are determined by the quantitative and qualitative composition of non-current and current assets that would meet the realities of modern production needs of agricultural enterprises.

The urgency of solving the problem of the ratio of current and non-current assets for the agricultural sector is determined by the strategic importance for each country, the spread of large-scale production, constant changes in the agro-industrial complex, and

Ukraine`s entry into the world community.
Therefore, the methods and tools for analyzing the processes of formation and use of assets, methodological issues of optimizing the ratio of their individual parts require further scientific study.
A significant contribution to the development of theoretical and methodological principles and issues of asset management was made by such leading scientists as, in particular, O. Agres [1], O. Apostolyuk [2], O. Binert [4], F. Butynets [5], I. Chukhno [7], M. Dziamulych [8-12], Marcuta et al [13], P. Nosov [14], O. Parkhomenko [15], A. Poddierohin [16], A. Popescu [17-26], A. Rymarchuk [27], T. Shmatkovska [28-30], R. Sodoma [31-32], V. Sopko [33], O. Stashchuk [34-36], I. Yakoviyk [38], Ya. Yanyshyn [39], O. Yatsukh [40], I. Zhurakovska [41].
In our opinion, the issues of asset management, the ratio of their current and non-current components in agricultural formations, their analytical evaluation, and methodological justification in the economic literature are covered insufficiently, and therefore need further study, what justifies the relevance of our study.

MATERIALS AND METHODS

The study aims to identify trends in the formation of the structure of assets of agricultural enterprises in Ukraine and the ratio of their individual groups.
To achieve this goal in the study solved a set of the following tasks:
– the structure of assets of Ukrainian enterprises in the studied period as of the end of the year by types of economic activity was assessed;
– the size and dynamics of the share of assets of the agricultural sector in the assets of all sectors of the economy of Ukraine;
– the dynamics of changes in the ratio of non-current and current assets of agricultural enterprises of Ukraine in the study period;
– the tendencies of formation of the ratio of current and non-current assets at the end of the year concerning agricultural enterprises of Ukraine are revealed and investigated.

In preparation of work, formation of analytical developments, conclusions, and recommendations the complex methods of economic research was used, among which: monographic; critical analysis; structural and trend analysis, correlation-regression analysis, etc.

RESULTS AND DISCUSSIONS

Dynamic and proportional development of the national economy, the formation of its rational sectoral structure can be achieved only by ensuring a balanced relationship between intermediate and final products of all industries and between the volume and structure of production and final consumption.
The solution to this problem requires the development of a comprehensive approach to the study of the composition of assets of agricultural producers in the system of macroeconomic relations.
The importance of studying the property base of agriculture as a component of the economic complex is determined by its place in the national economy of Ukraine, the content and nature of economic and social functions.
Thus, in Fig. 1 we studied the structure of assets of Ukrainian enterprises in terms of their economic activities in 2011-2019.

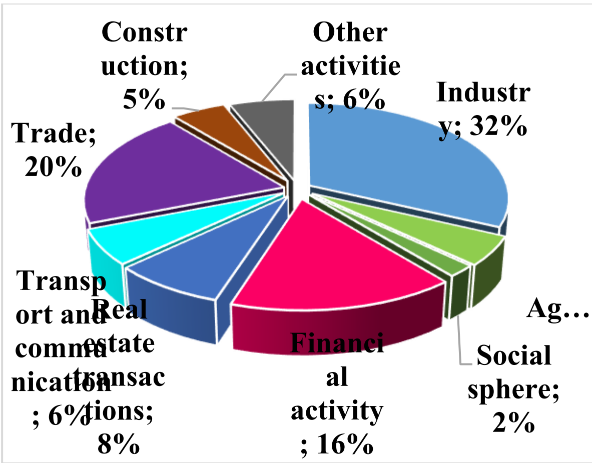

Fig. 1. The structure of assets of enterprises of Ukraine by type of economic activity for 2011-2019, on average, as of the end of the year, %
Source: Own development based on [37].

According to the results of the analysis of Fig. 1, note that the largest amount of investment coming into the economy of Ukraine goes to industrial assets – 32%, trade – 20%, and the development of financial activities – 20%. The share of social assets (education, health care, art, sports, entertainment and recreation, social services) in their overall structure during 2011-2019 was at a very low level – 2%.

According to the analysis of Fig. 1, it was found that agricultural assets cause much less interest in investing in them. The share of the agricultural sector in the structure of assets in the study period was about 5%. This indicator in comparison with other branches of Ukraine is rather low. Its value also indicates the unattractiveness of investors in the agricultural sector of the economy.

With the right choice of investment policy by state and local authorities, the share of investment in agriculture in Ukraine, according to forecasts, may increase to 25.0%.

The analysis of the structure of assets by type of activity in Ukraine gives grounds to claim that the volume of investment in the agricultural sector does not meet global standards due to the constant shortage of financial resources. Therefore, it is expedient, in our opinion, to study the dynamics of the share of agricultural assets in the assets of all sectors of the economy. To do this, in Fig. 2 we have developed and presented a polynomial trend line of the share of industry assets.

Herewith the regression equation has the form:

$$y = 0.0637x2 – 0.5086x + 5.0438$$

and shows that the average share of agricultural assets in the assets of all sectors of the economy of Ukraine in 2011-2019 was 5%. Every year, the share of agricultural assets has a slowdown of 0.5%, and the dynamics of growth acceleration are low (0.0637). The coefficient of reliability of the approximation (R^2) is 0.825, i.e., the reliability of the generated conclusion is quite high.

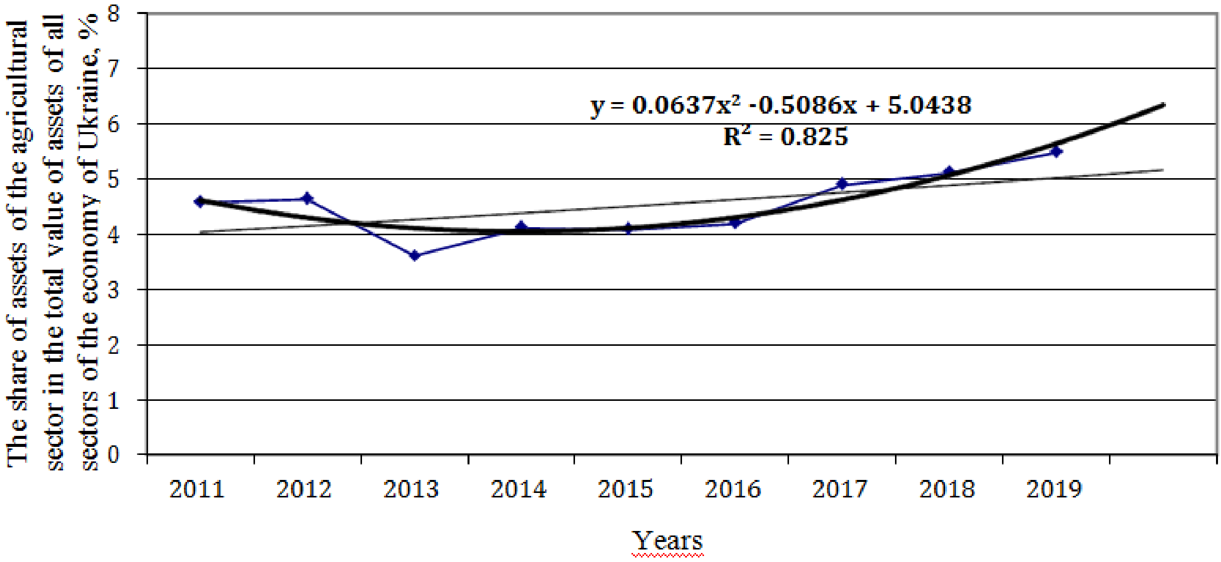

Fig. 2. Polynomial trend model of the share of agricultural assets in the assets of all sectors of the economy of Ukraine for 2011 – 2019
Source: Own development based on [37].

The current situation is not good enough for the Ukrainian economy, as agriculture plays an important role in shaping economic growth. Agricultural producers ensure the country`s food security and make a significant contribution to export flows. In 2011-2019, 12% of gross value added was created in this agricultural sector, 19.7% of the total employed population of the country works here, so, in our opinion, at the state level, it is advisable to develop a set of measures to stimulate investment incentives in the agricultural sector.

It is well known that the relationship between non-current and current assets plays an important role in the process of managing them. From the point of view of a systematic approach to the management of agricultural enterprises, the composition and structure of their assets are of great importance. On the one hand, the lack of current assets leads to periodic failures in the enterprise, reduced liquidity, and reduced financial stability, on the other hand, the lack of non-current – to non-fulfilment of planned production, lack of equipment and premises, and, consequently, to the lower market value of agricultural enterprises [3]. In addition, the excessive volume of current assets leads to the presence of agricultural enterprises temporarily free, inactive assets, excessive financing costs, as a result – a decrease in profits of such enterprises; and excessive non-current assets – to the deterioration of their useful life and reduce the value of agricultural enterprises.

The dynamics of changes in the ratio of non-current and current assets of agricultural enterprises of Ukraine in the study period are shown in Fig. 3. According to the results of the study, we found that in the overall structure of assets during 2011-2019 there is a steady trend to increase the share of current assets while reducing non-current. In particular, as of the end of 2019, the share of non-current assets was 38% against their share of 56% at the end of 2011, thus decreasing by 18% in the study period. The absolute reduction in their share during 2011-2019 averaged 2% per year. Accordingly, the share of current assets of agricultural enterprises increased annually during the analyzed period by an average of 2% per year.

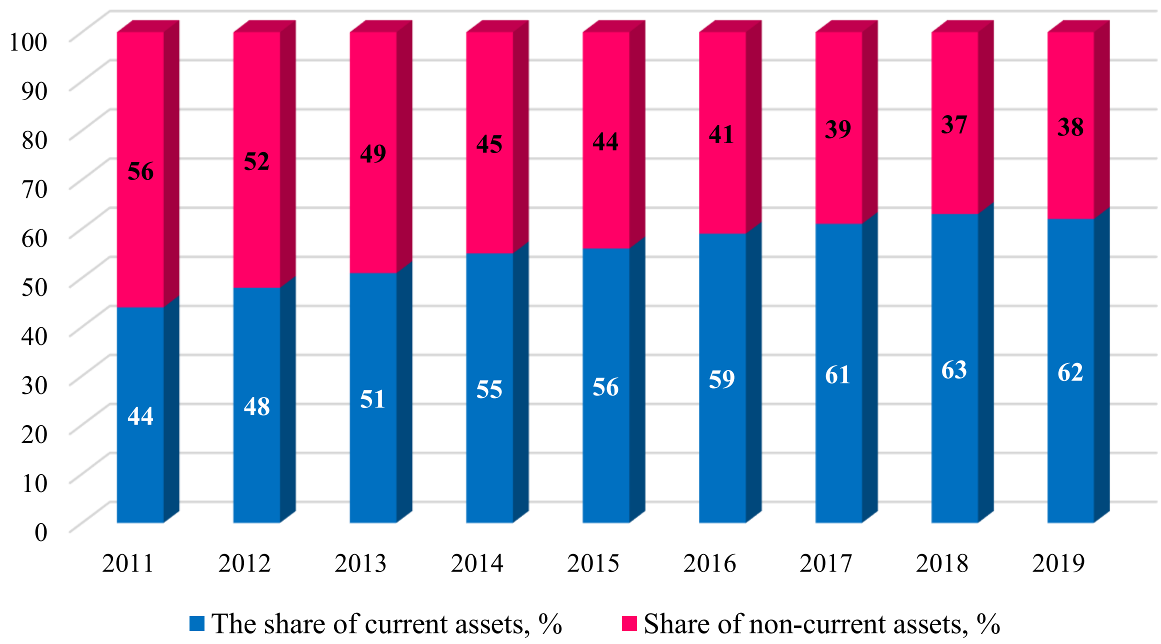

Fig. 3. Dynamics of change in the ratio of non-current and current assets of agricultural enterprises of Ukraine for 2011 – 2019, as of the end of the year
Source: Own development based on [37].

We found that in the study period, the largest share in the structure of assets of agricultural enterprises of Ukraine accounted for current assets at the end of 2018 (namely – 63%), which indicates the formation of a fairly mobile structure of assets and accelerates their turnover. The so-called “heavy” structure of assets is more typical for agricultural enterprises, so this trend cannot be considered a completely positive phenomenon, as the share of non-current assets decreases mainly due to the fact that most agricultural enterprises are unable to replace assets of obsolete and depreciated fixed assets (machinery, equipment, etc.) new, as well as unstable price situation in the market of material resources, which forces agricultural producers to create greater reserves. At the same time, there is a tendency to increase the total value of assets of agricultural enterprises in Ukraine during 2011–2019 as a whole (Fig. 4).

According to the results of construction and analysis of the linear trend model, it is established that in the studied period there is a clear tendency to increase the value of assets of agricultural enterprises. The regression equation y = 32,538x + 1,949.4 shows that for the period 2011–2019 the average value of assets of agricultural enterprises increased by UAH 32.5 billion annually. Note that the reliability of our conclusion is high because the coefficient of reliability of the approximation is close to 1.

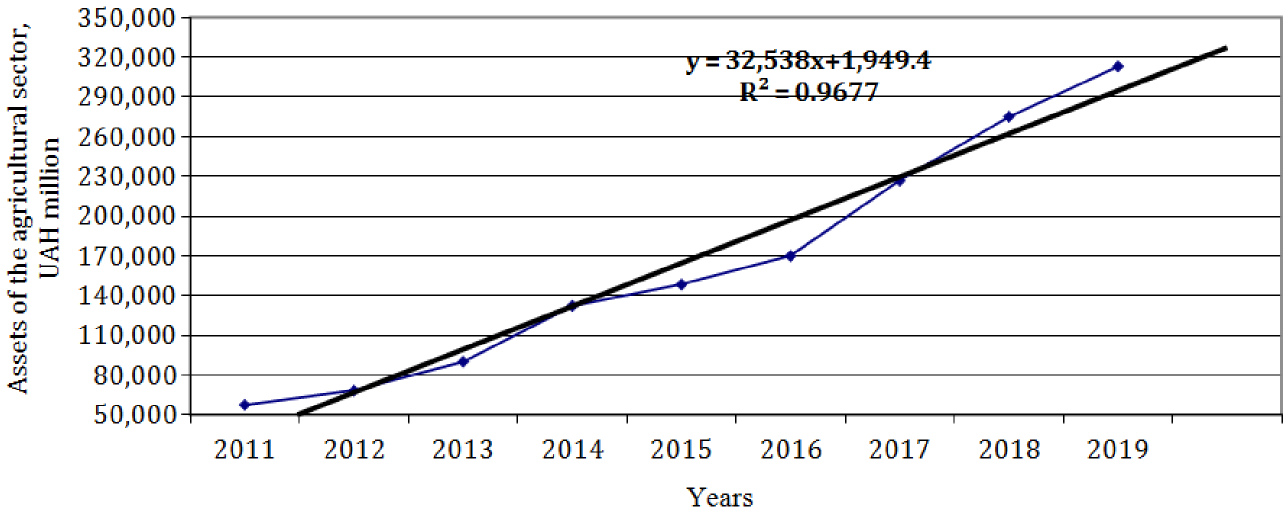

Fig. 4. Linear trend model of the value of assets of agricultural enterprises of Ukraine for 2011 - 2019, as of the end of the year

Source: Own development based on [37].

Thus, the increase in the value of assets of agricultural enterprises in the study period was due to their turnover. Significant financing problems do not provide an opportunity to invest in the restoration of non-current assets of agricultural producers, which leads to a gradual decrease in their share in the overall structure due to depreciation. It is established that the specified decrease in the value of non-current assets occurred mainly due to fixed assets, reduced the volume of construction in progress. At the same time, the growth of current assets was mainly due to inventories. The current situation indicates the presence of problems in the calculations of agricultural enterprises. In addition, agricultural enterprises in Ukraine limit, in particular, the sale of crop products of the new harvest, expecting a further increase in market prices, which reduces the turnover of working capital.

We support the opinion of Y. Chaliuk, who notes that the most accurate overall structure of assets is characterized by the ratio of current and non-current assets, the value of which should take into account the sectoral characteristics of the assets of agricultural enterprises [6].

This indicator in asset management is of great importance for the strategic management of the enterprise as a single system. We have studied its dynamics at the macroeconomic level in Ukraine with the help of a power curve, which sufficiently smoothes the indicators that monotonically increase or decrease over time. In fig. 5 shows the power trend line of the ratio of current and non-current assets for agricultural enterprises of Ukraine in 2011–2019.

The regression equation has the form: = $0.7732x^{0.311}$ and shows that the initial level in the ratio of assets for agricultural enterprises of Ukraine in the study period is 77 kop. current assets per UAH 1 non-current. On average, in 2011-2019, the ratio of current and non-current assets of agricultural enterprises in Ukraine increased annually by $1^{0.311}$ times.

Summing up, we note that the results of our research found that in the current economic conditions, the technical potential and repair and maintenance of the agricultural sector of Ukraine do not meet the requirements of scientifically sound needs of agricultural production. The supply of machinery to most farmers is approaching a critically low level. It is established that the agricultural enterprises of Ukraine are provided with the basic agricultural machines only by 45-65%. In addition, it was found that more than 90% of technical means of agricultural enterprises of Ukraine have already served their depreciation period, their technical readiness for fieldwork does not exceed 60-70%.

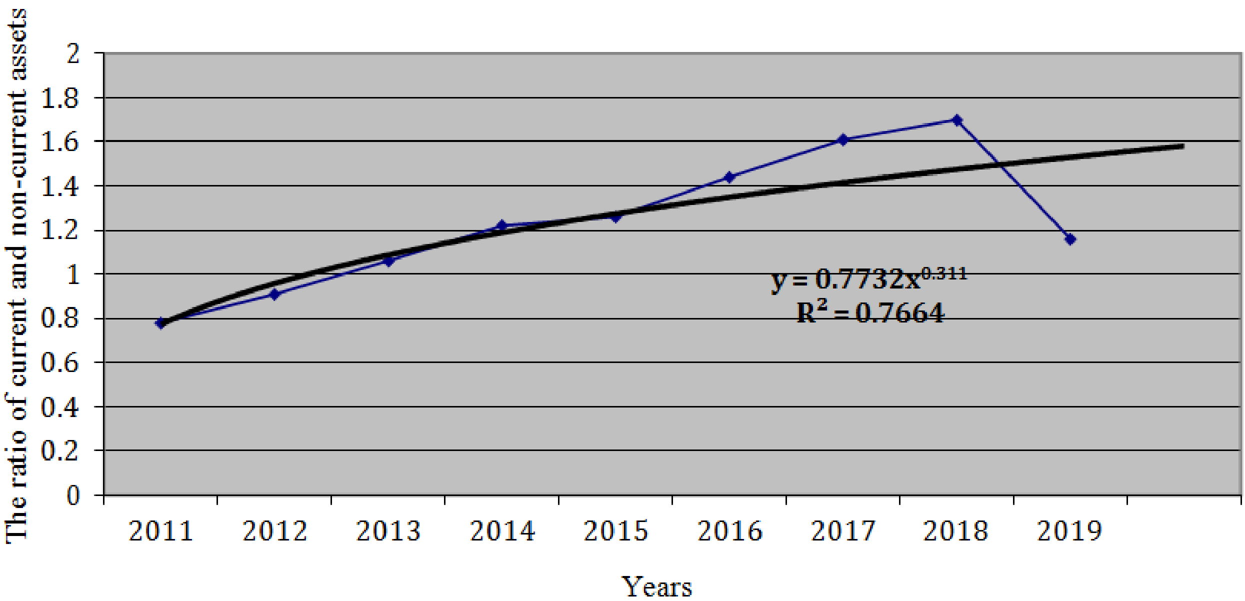

Fig. 5. Power trend model of the ratio of current and non-current assets of agricultural enterprises of Ukraine in 2011–2019, as of the end of the year
Source: Own development based on [37].

The rate of annual write-off of worn-out machinery in the agricultural sector of Ukraine in the study period is several times higher than the rate of its purchase. The results of the study revealed that due to malfunctions and physical wear and tear, a quarter of tractors and combines are not used annually, and the technical service system operates at minimum capacity.

CONCLUSIONS

Thus, the study found that the average share of assets of the agricultural sector of Ukraine in the sectoral structure of assets for the period 2011-2019 was quite low - about 5%, which indicates its unattractiveness for investors operating in the agricultural sector. In our opinion, given the prospects and significant export potential of the industry, state and local authorities need to develop a prudent investment policy at all levels.

Every year the share of agricultural assets in Ukraine is characterized by slow growth, and the dynamics of accelerating growth is low, which is not evidence of the formation of positive trends, as agriculture plays an important role in ensuring its economic growth.

In the general structure of assets of agricultural enterprises of Ukraine during 2011-2019, there is a steady tendency to increase the share of current assets, which indicates the formation of a more mobile structure of assets. It is established that the current trend cannot be considered positive, as the share of non-current assets decreases mainly due to the fact that most agricultural enterprises are unable to replace obsolete and worn-out fixed assets with new ones.

The most important factor in ensuring the continuity of the production process of agricultural enterprises is the availability of the required amount of inventories, so the policy of current assets management begins with minimizing the total cost of inventories of agricultural enterprises. When the size of inventories is insufficient, the timeliness and completeness of the implementation of production processes of the enterprise are violated, the timely reproduction of current assets is not provided. This is one of the reasons for the decline in recent years in the efficiency of the use of current assets of agricultural enterprises in Ukraine. The problem is to minimize the total costs associated with ordering the next batch of any of the resources and their storage in the warehouse. There is a clear relationship between the value of these costs and the factors that affect them, namely the more often companies make orders to purchase the resources they need, the greater the cost of such orders they incur, but the cost of storing a unit of such current assets.

Under such conditions, in our opinion, the optimization of the asset structure should be based on the use of controlling and budgeting. In particular, the main areas of improving the asset structure of agricultural enterprises may be the rationing and budgeting of current assets; introduction of a sufficient frequency of revaluations of fixed assets; formation of preconditions for the growth of specific weight of fixed assets of production sphere; inventory of assets in order to identify unused objects; optimization of sources of asset formation by increasing the role of lending and financial leasing; taking measures to reduce receivables and improve the sales process, which will increase the share of working capital in the field of production and strengthen the economic security of enterprises as a whole.

As a result, it should be noted that the technical potential and repair and maintenance base of the agricultural sector of Ukraine do not meet the requirements of scientifically sound needs of agricultural production. That is why the implementation of state and regional investment policy, as well as in the development of financial strategy of large agricultural enterprises of different forms of ownership and different specialization will be promising research to justify the relationship between current and non-current assets as a strategic guideline based on their business.

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THE MANAGEMENT OF LAND USE CHANGES IN PERI-URBAN AREA OF TIMISOARA CITY USING GIS AND REMOTE SENSING TECHNOLOGIES

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Abstract

Land cover and Land use monitoring is a very complex process for a better understanding of the dynamics of the landscape over a long period of time. Such monitoring cannot be performed without using geospatial methods in the field of remote sensing and Geographic Information Systems (GIS). In this paper was analysed the use of land in the Periurban area of Timisoara in the period 1990-2018 based on data provided by the Copernicus program of the European Union. From the analysis of the data from 1990 to 2018, based on the GIS spatial analyses, it can be concluded that approximately 5,700 hectares have changed their destination. The most significant changes were those in the category Pesterers in Non irrigated arable land (21.8% - 1,256 ha) and the change in the category Non irrigated arable land in Discontinuous urban fabric (18.9% - 1,087 ha), leading to the conclusion both of the urbanization of this periurban area of Timisoara Municipality, but also of the development of the agricultural field. Also, in this study were analysed 3 remote sensing indices determined based on Landsat 8 images, data that can be the basis for a monitoring of urban expansion in western Romania.

Key words: *GIS , Land cover, index, Normalized Difference Vegetation Index (NDVI), Normalized Burn Ratio (NBR), Normalized Difference Build up Index (NDBI), remote sensing*

INTRODUCTION

A series of communes that border the Municipality of Timișoara have experienced, in recent times, a significant development, becoming the "suburbs" of the municipality due to the development of facilities, utilities and infrastructure.
The urban development of the Timisoara Metropolitan area from 1990 until now has led to substantial changes in the communes in the immediate vicinity of the Municipality of Timisoara, so that there have been significant changes in the use of land. In this context, the periurban area of Timisoara Municipality represents an area of major interest for a healthy sustainable development and to satisfy the needs of all those involved. Thus, a correct management is required to support the community in the periurban area [23].
Land use and land cover are 2 terms that are very often used [20]. Land cover refers to the physical characteristics of the earth's surface: the distribution of vegetation, water, soil and other physical features, including those determined by human activities [15]. Land use - refers to the way in which the land area has been used by people, for example the functional role of land for various economic activities [4].
In conclusion, Land cover and Land use is the result of natural, socio-economic factors and land use by people in time and space [16]. Land cover and Land use monitoring is a very complex process for a better understanding of the dynamics of the landscape over a long period of time. Such monitoring cannot be performed without using geospatial methods in the field of remote sensing and Geographic Information Systems (GIS). Recent studies

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have looked at how Land cover has undergone major changes in recent years, based on data from modern remote sensing systems. Landsat 8, Sentinel 2, Rapid Eye, World view, etc. systems were used in such studies. Information from remote sensing systems [6], [13] together with field data led to an objective classification of land cover.

Remote sensing techniques are the basis of the process of mapping large areas, and the information contained in the spectral bands of remote sensing images is of real use in monitoring and managing the earth's surface.

Integrating in a Geographic Information System [10], [11] data on the use and coverage of land, statistical data on the population of communes in the periurban area of Timisoara, respectively topo-cadastral data from field measurements, the decision-making process regarding the urban development of Timisoara Municipality and its adjacent communes can be improved [7], [14], [18]. Some studies also analyzed the agricultural areas in the Periurban perimeter of Timisoara in order to assess spatial and temporal variability [19].

MATERIALS AND METHODS

The peri-urban area of Timişoara Municipality consists of 12 territorial administrative units, Fig.1 and 26 localities, Fig. 2. According to the statistical yearbook [9], the data on the surface and the number of inhabitants are presented in Table 1.

Table 1. Demografic data – Periurban Area of Timisoara iIty

No.	Administrative Territorial Unit - ATU	Surface ha	Number of inhabitants
1.	Dumbravita	1,896	10,984
2.	Ghiroda	3,412	7,188
3.	Mosnita Noua	6,912	9,095
4.	Giroc	5,200	14,037
5.	Sanmihaiu Roman	7,530	7,865
6.	Sacalaz	11,951	9,314
7.	Sanandrei	9,253	7,147
8.	Giarmata	7,169	7,469
9.	Remetea Mare	7,286	2,639
10.	Sag	3.495	,631
11.	Dudestii Noi	5,394	3,509
12.	Bechicherecu Mic	4,668	3,207

Source: Data's from NIS.

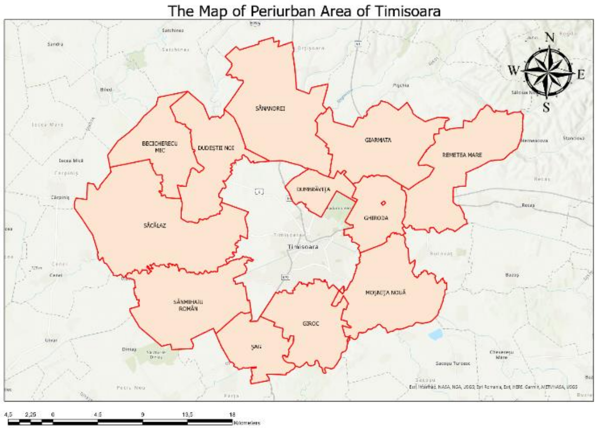

Fig. 1. The map of Periurban area of Timişoara
Source: original image, based on GIS data.

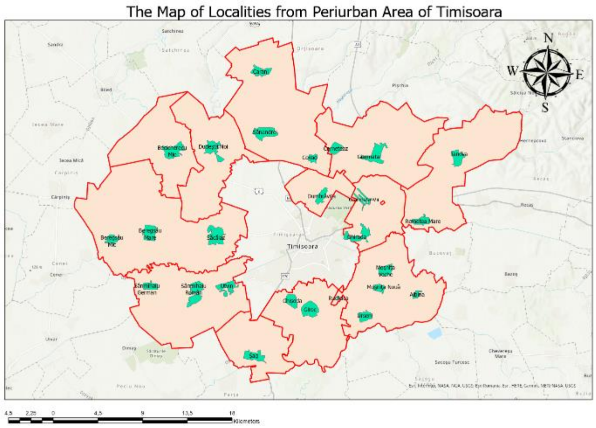

Fig. 2. The map of Localities from Periurban area of Timişoara
Source: original image, based on GIS data.

In this paper were used vector and raster data, available free of charge for the entire territory of Romania, Table 2.

Table 2. Data used and data source

Data	GIS data type	Source
Land Cover	Raster	[3]
Administrative Territorial Units - ATU	Vector	[1]
Localities	Vector	[1]
Digital Elevation Model	Raster	[22]
Remote sensing images (2014-2018)	Raster	[12]

Source: original data.

Data on how to use land cover (Land Cover) are part of the Corine Land Cover Project which is a European project that highlights the dynamics of land cover on a European scale [3].

Based on this project, Land Cover data are updated approximately every 6 years and are available free of charge on the website of the European platform Copernicus [21], which is a platform managed by the European Environment Agency.

The Corine Land Cover - CLC data are in GIS format of the vector type and the attributes of the polygons contain the information regarding the characteristics of the land cover type. The classification of the lands was made on 3 hierarchical levels, namely: Level 1: 5 classes Level 2: 15 classes Level 3: 44 classes

Fig. 3. Legend of Corine Land Cover Classes
Source: https://land.copernicus.eu

The classification of the land cover was made based on a process of visual photointerpretation and images obtained from remote sensing systems: Landsat TM and ETM, SPOT, IRS P6, RapidEye, Sentinel-2 and Landsat-8. These data were supplemented with auxiliary data (aerial photographs, thematic maps). All CLC (Corine Land Cover) data layers are available on the internet [3], Figure 3.

In order to better understand how to change the land cover, a series of remote sensing satellite scenes from the Landsat 8 system were also used in this study. For this purpose, satellite scenes were downloaded between 2017 - 2020, July-August, and analysed the evolution of remote sensing indices: Normalized Difference Vegetation Index (NDVI) [17], Normalized Burn Ratio (NBR), [2], [5], [8] and Normalized Difference Build up Index (NDBI) [24].

The NDVI value varies from -1 to 1. Higher the value of NDVI reflects high Near Infrared (NIR), means dense greenery. Generally, NDVI has the following values: from -1 to 0 and NDVI represents Water bodies, from -0.1 to 0.1 NDVI represents Barren rocks, sand, or snow, from 0.2 to 0.5 NDVI represents Shrubs and grasslands or senescing crops and from 0.6 to 1.0 NDVI represents Dense vegetation or tropical rainforest.

The NBR index is defined to highlight areas that have burned and to index the severity of a burn and the NDBI value lies between -1 to +1. Negative value of NDBI represent water bodies where as higher value represent build-up areas. NDBI value for vegetation is low.

The calculation formulas of these indices are described in equations (1), (2) and (3).

$$NDVI = (NIR - R)/(NIR + R) \tag{1}$$

where: NDVI – Normalized Difference Vegetation index, NIR – Near Infrared Band, R – Redd band

$$NBR = (NIR - MIR)/(NIR + MIR) \tag{2}$$

where: NBR – Normalized Burn Ratio, NIR – Near Infrared Band, MIR – Middle Infrared Band

$$NDBI = (SWIR - NIR)/(SWIR + NIR) \tag{3}$$

where: NDBI – Normalized Difference Build up Index, SWIR – Shortwave Infrared Band, NIR – Near Infrared Band

RESULTS AND DISCUSSIONS

Based on the GIS solutions used (Arc GIS software) 5 thematic maps of the studied area were accomplish, and the maps are represented in Figure 4.

The GIS Maps are representing the land cover in the Periurban area of Timisoara in the period 1990 - 2018. From a statistical point of view, CLC (Corine Land Cover) data in the period 1990 - 2018 are presented in Tables 3 and 4.

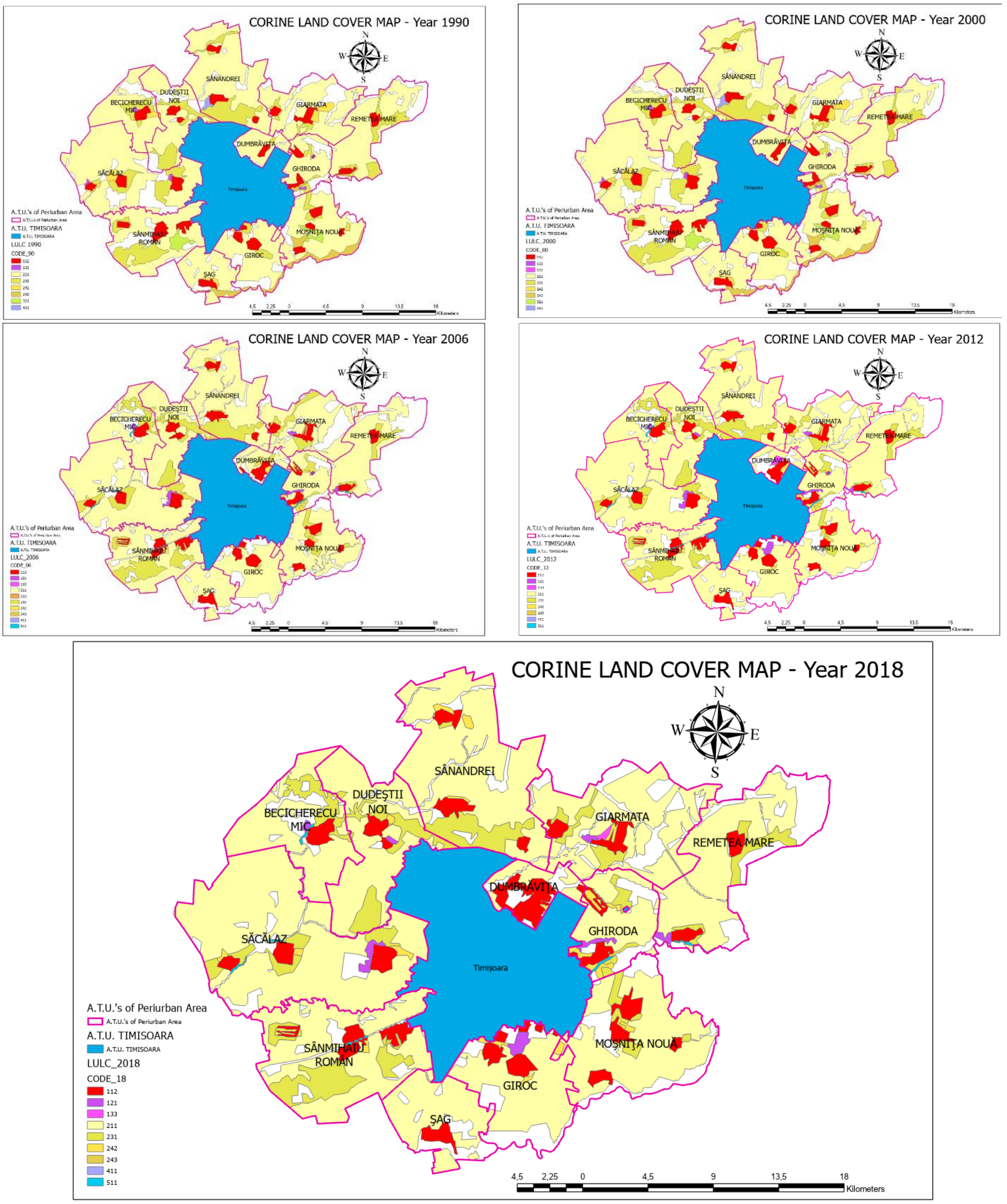

Fig. 4. The maps of Land Cover from 1990 - 2018
Source: original images based on Corine Land Cover.

The thematic maps are suggestive and express in a visual and concrete form the way in which the Periurban area of Timisoara City experienced a considerable development in the period 1990 - 2018 from an urban point of view.

In this context, GIS maps correlated with remote sensing images can support the precision agriculture for sustainable land management, regardless of their use category, by creating spatial databases containing their characteristic attributes.

From an economic point of view, the use of GIS and Remote sensing imagery is a major advantage over the use of classic cartographic material because it can provide a real-time situation regarding the use and exploitation of the parcels at the level of an Administrative Territorial Unit (ATU).

Based on the data presented, it can be stated that the highest increase in the period 1990 - 2018 was Discontinuous urban fabric 1.89% (1,129 ha) and Non-irrigated arable land of 2.05% (496 ha) and the decrease was felt. most at Pastures -1.91% (1,335 ha) and Land mainly occupied by agriculture, with significant areas of natural vegetation -2.02% (1,300 ha). The situation of the changes at the level of the study area, for the period 1990 - 2018 is presented in Table 5.

Table 3. Distribution in hectares of Land Cover for the period 1990 - 2018

CLASS	LAND COVER	ARIA(ha) 1990	ARIA(ha) 2000	ARIA(ha) 2006	ARIA(ha) 2012	ARIA(ha) 2018
112	Discontinuous urban fabric	4,020	7,216	8,321	8,285	5,148
121	Industrial or commercial units	117	117	273	484	498
133	Construction sites		33	1	109	43
211	Non-irrigated arable land	49,704	389,947	395,759	392,280	50,200
222	Fruit trees and berry plantations	0	0	48	0	0
231	Pastures	7,785	9,773	7,731	7,216	6,449
242	Complex cultivation patterns	689	748	628	753	777
243	Land principally occupied by agriculture, with significant areas of natural vegetation	1,339	5,170	38	38	38
321	Natural grasslands	588	594	0	0	0
411	Inland marshes	100	141	52	52	9
511	Water courses	0	0	177	177	136

Source: Data's from CLC 1990, 2000, 2006, 2012 and 2018.

Table 4. Percentage distribution of Land Cover for the period 1990 - 2018

CLASS	LAND COVER	ARIA(%) 1990	ARIA(%) 2000	ARIA(%) 2006	ARIA(%) 2012	ARIA(%) 2018
112	Discontinuous urban fabric	6.25	1.74	2.01	2.02	8.13
121	Industrial or commercial units	0.18	0.03	0.07	0.12	0.79
133	Construction sites	0.00	0.01	0.00	0.03	0.07
211	Non-irrigated arable land	77.25	94.25	95.82	95.82	79.31
222	Fruit trees and berry plantations	0.00	0.00	0.01	0.00	0.00
231	Pastures	12.10	2.36	1.87	1.76	10.19
242	Complex cultivation patterns	1.07	0.18	0.15	0.18	1.23
243	Land principally occupied by agriculture, with significant areas of natural vegetation	2.08	1.25	0.01	0.01	0.06
321	Natural grasslands	0.91	0.14	0.00	0.00	0.00
411	Inland marshes	0.16	0.03	0.01	0.01	0.01
511	Water courses	0.00	0.00	0.04	0.04	0.21

Source: Data's from CLC 1990, 2000, 2006, 2012 and 2018.

In order to better understand how to change the land cover, a series of remote sensing satellite scenes from the Landsat 8 system were also used in this study.

For this purpose, satellite scenes were downloaded between 2017 - 2020, July-August, and analysed the distribution of NDVI indices, Figure 5, NBR, Figure 6 and NDBI, Figure 7.

From the analysis of the data from 2018, a high correlation was identified between NBR, NDBI and NDVI indices.

Regarding the statistical accuracy of the experimental analysis of the data, it was performed by appropriate mathematical and statistical methods (p, R2, test F).

To assess the interdependencies between NBR, NDBI and NDVI remote sensing indices, regression analysis was used which resulted in polynomial functions with related precision parameters.

Table 5. Area change from 1990 -2018

	Change (1990 - 2018)	Area Change (ha)	Area Change (%)
1	Complex cultivation patterns - Discontinuous urban fabric	50,720	0.881
2	Complex cultivation patterns - Non-irrigated arable land	376,829	6.548
3	Complex cultivation patterns - Pastures	76,037	1.321
4	Complex cultivation patterns - Water courses	25,029	0.435
5	Discontinuous urban fabric - Complex cultivation patterns	132,446	2.301
6	Discontinuous urban fabric - Construction sites	0,669	0.012
7	Discontinuous urban fabric - Industrial or commercial units	33,817	0.588
8	Discontinuous urban fabric - Inland marshes	1,001	0.017
9	Discontinuous urban fabric - Land principally occupied by agriculture	2,293	0.040
10	Discontinuous urban fabric - Non-irrigated arable land	37,019	0.643
11	Discontinuous urban fabric - Pastures	28,116	0.489
12	Discontinuous urban fabric - Water courses	19,228	0.334
13	Industrial or commercial units - Complex cultivation patterns	50,258	0.873
14	Industrial or commercial units - Discontinuous urban fabric	3,647	0.063
15	Industrial or commercial units - Pastures	1,245	0.022
16	Industrial or commercial units - Water courses	4,324	0.075
17	Inland marshes - Discontinuous urban fabric	20,891	0.363
18	Inland marshes - Non-irrigated arable land	1,647	0.029
19	Inland marshes - Pastures	24,724	0.430
20	Land principally occupied by agriculture - Complex cultivation patterns	29,104	0.506
21	Land principally occupied by agriculture - Discontinuous urban fabric	20,691	0.360
22	Land principally occupied by agriculture - Industrial or commercial units	4,700	0.082
23	Land principally occupied by agriculture - Non-irrigated arable land	242,168	4.208
24	Land principally occupied by agriculture - Pastures	0,697	0.012
25	Land principally occupied by agriculture - Water courses	53,845	0.936
26	Natural grasslands - Discontinuous urban fabric	37,214	0.647
27	Natural grasslands - Land principally occupied by agriculture	1,001	0.017
28	Natural grasslands - Non-irrigated arable land	171,257	2.976
29	Natural grasslands - Pastures	340,681	5.920
30	Non-irrigated arable land - Complex cultivation patterns	361,933	6.289
31	Non-irrigated arable land - Construction sites	42,076	0.731
32	Non-irrigated arable land - Discontinuous urban fabric	1,087,295	18.893
33	Non-irrigated arable land - Industrial or commercial units	200,505	3.484
34	Non-irrigated arable land - Inland marshes	7,606	0.132
35	Non-irrigated arable land - Land principally occupied by agriculture	33,721	0.586
36	Non-irrigated arable land - Pastures	538,487	9.357
37	Non-irrigated arable land - Water courses	7,016	0.122
38	Pastures - Complex cultivation patterns	144,386	2.509
39	Pastures - Discontinuous urban fabric	159,790	2.777
40	Pastures - Industrial or commercial units	102,302	1.778
41	Pastures - Land principally occupied by agriculture	1,431	0.025
42	Pastures - Non-irrigated arable land	1,256,844	21.839
43	Pastures - Water courses	20,224	0.351

Source: original data obtained after GIS spatial analysis.

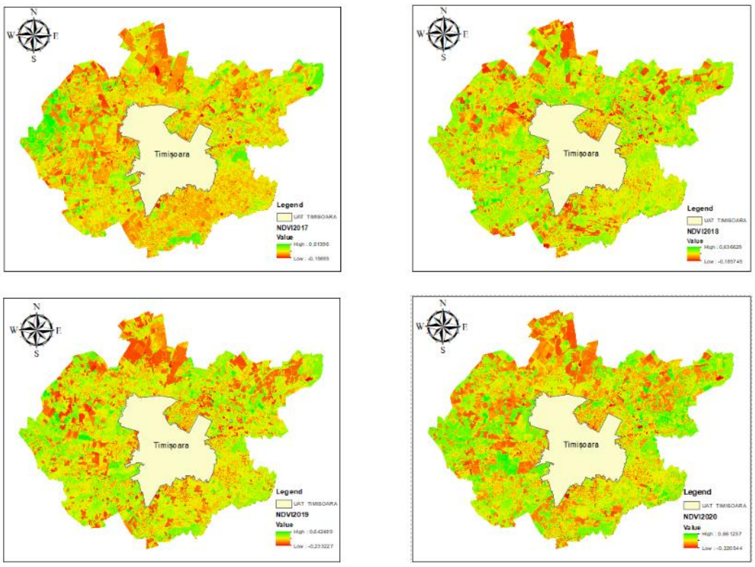

Fig. 5. The maps of NDVI 2017 -2020
Source: original images based on Landsat 8 Imagery.

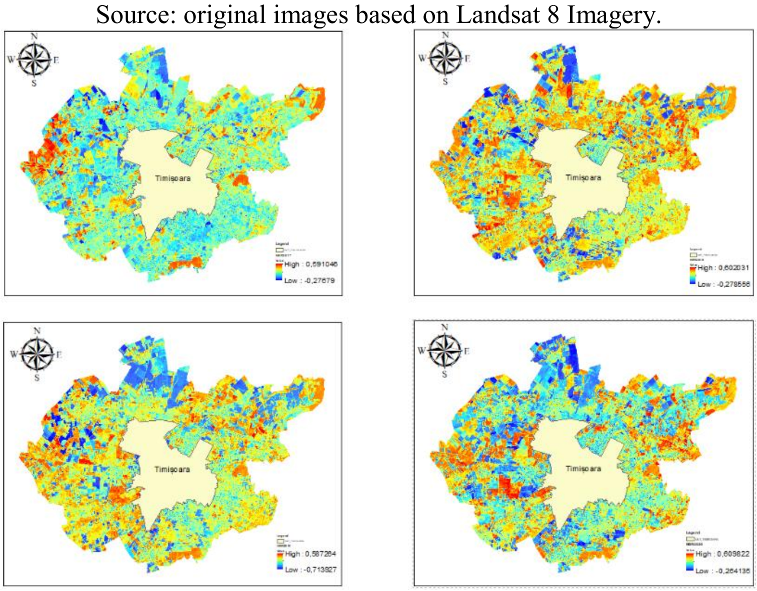

Fig. 6. The maps of NBR 2017 -2020
Source: original images based on Landsat 8 Imagery.

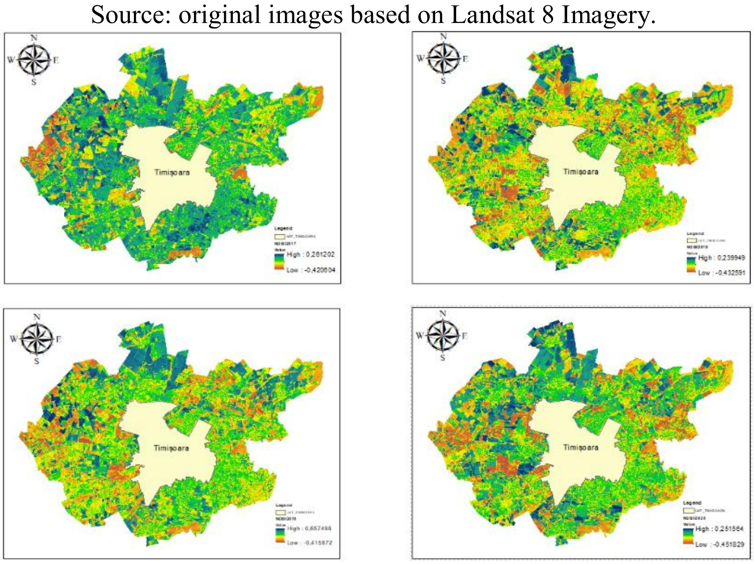

Fig. 7. The maps of NDBI 2017 -2020
Source: original images based on Landsat 8 Imagery.

Table 6. Remote sensing index values

CLASS	NBR 2018	NDBI 2018	NDVI 2018
112	0.259186	-0.12143	0.327436
121	0.234976	-0.10488	0.280786
133	0.284165	-0.11584	0.336997
211	0.286317	-0.12514	0.348214
231	0.370533	-0.17661	0.425699
242	0.303872	-0.1427	0.362165
243	0.336919	-0.1711	0.396058
411	0.446249	-0.27733	0.45946
511	0.405585	-0.232	0.429187

Source: original data obtained after calculated the remote sensing indexes.

The NDVI index, used to characterize the vegetation, had average values between 0.28078 - 0.45946. The NDVI index recorded minimum values for category 121 - Industrial or commercial units and reached maximum values for category 231 - Pastures and category 411 - Inland marshes.
The NBR index used to evaluate the combustion potential based on multispectral satellite data had values between 0.23497 - 0.44624. The minimum values recorded for the NBR index were recorded in the land cover category 121 - Industrial or commercial units to reach the maximum values in category 411 - Inland marshes and 231 - Pastures.
The NDBI index used to map the built-up urban areas had values between -0.2773 - -0.10488. The minimum values recorded for the NDBI index were recorded in the land cover category 411 - Inland marshes to reach the maximum values in category 121 - Industrial or commercial units.
The statistical correlation analysis revealed the high level of correlations between NBR, NDBI and NDVI indices for the periurban area of Timișoara Municipality. High correlations were identified between NBR, NDBI and NDVI indices, namely -0.97351 between NBR and NDBI, 0.977785 between NBR and NDVI and -0.92114 between NDBI and NDVI. Given the high level of correlations between the analysed index, the regression analysis was used to evaluate the predictive relationship of each index based on the spectral values of the other 2 indices.

Prediction for NDVI values based on spectral data recorded for NBR and NDBI was possible with high statistical accuracy: R2 = 0.985; p <= 0.001 for NBR, equation (4), respectively R2 = 0.942; p <= 0.001 for NDBI, equation (5).

$$NDVI_P = -2.363x^2 + 2.412x - 0.1503 \quad (4)$$
where: $NDVI_P$ – predicted NDVI; x - NBR.

$$NDVI_P = -6.36x^2 - 3.307x + 0.02324 \quad (5)$$
where: $NDVI_P$ – predicted NDVI; x - NDBI.

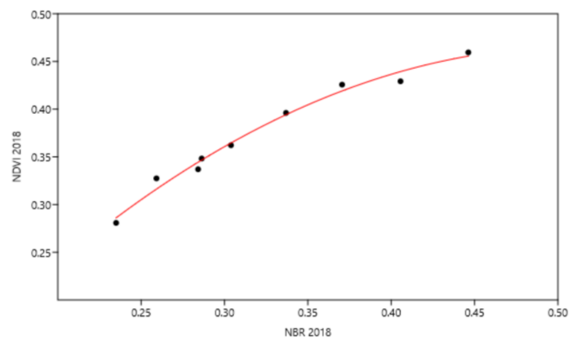

Fig. 8. Relation of dependence between NDVI - NBR for the study area
Source: original graph based on data from Table 6.

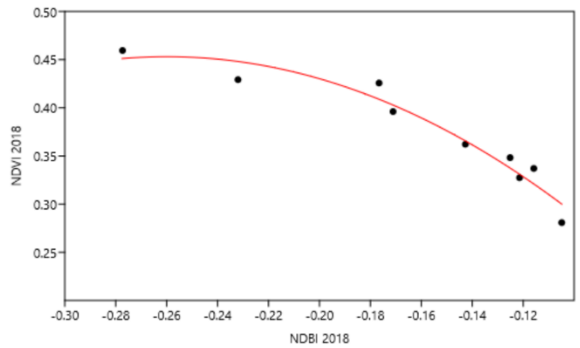

Fig. 9. Relation of dependence between NDVI – NDBI for the study area
Source: original graph based on data from Table 6.

The PCA analysis of the distribution of NDVI classes, for the studied area, according to NDBI and NBR, is shown in Figure 7. PC1 explained 97.507% of variance, PC2 explained 2.2792% and PC3 explained 0.21412% of variance. The multivariate analysis facilitated the grouping of the results according to the calculated remote sensing indices and the land cover categories in the peri-urban area, based on Euclidean distances, figure 8, with a high statistical precision, cophenetic index value being 0.7298.

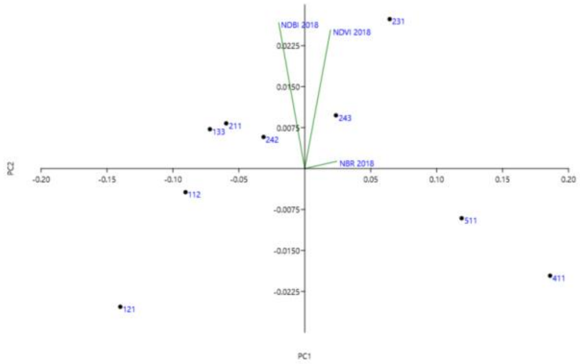

Fig. 10. PCA scatter diagram
Source: original image based on experimental data.

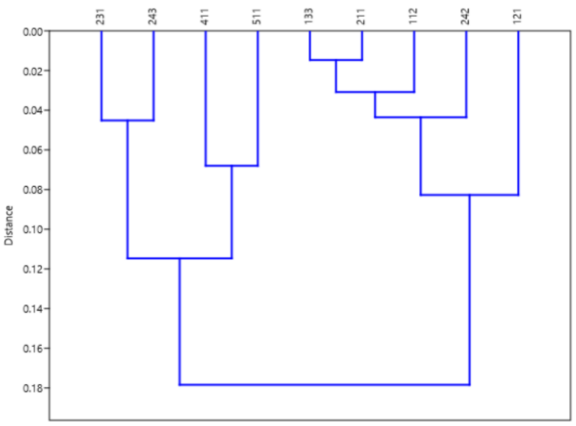

Fig. 11. Dendrogram of cases studied based on Euclidean distances
Source: original image based on experimental data.

CONCLUSIONS

From the analysis of the data from 1990 to 2018, based on the GIS spatial analyses, the following conclusions could be drawn: About 5,700 hectares have changed their destination. The most significant changes were the change from the category of Pesterers in Non irrigated arable land (21.8% - 1,256 ha) and the change from the category Non irrigated arable land to Discontinuous urban fabric (18.9% - 1,087 ha) this leading to the conclusion of urbanization to this periurban area of Timisoara Municipality, but also to the development of the agricultural field.

The science of the Geographic Information Systems together with the Remote sensing imagery can be used by the local administrations of the periurban localities of the major cities of Romania in order to monitor how the use of the land is changing and to predict the future directions of development of these areas.

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IMPROVING THE EFFICIENCY OF AGRICULTURAL ENTREPRENEURSHIP BY PROCESSING RAPESEED TO BIODIESEL

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Abstract

The expediency of rapeseed processing and biodiesel production is investigated in the article. Potential opportunities for biodiesel production at completed mini-plants have been identified and the costs for the creation of production facilities have been calculated. A comparative evaluation of the efficiency of biodiesel production from rapeseed and sale of its seeds has been carried out. Higher economic efficiency from rapeseed processing than mass export of this raw material is substantiated, which will increase the profitability of agricultural enterprises. The key guidelines for the location of production facilities for the processing of rapeseed for biodiesel on a cooperative basis at the regional level have been formed. The paper uses general and special research methods, in particular the calculation and design method to substantiate the estimated cost of production facilities for processing rapeseed into biodiesel. The results of interviews with key stakeholders, producers of rapeseed, prove the feasibility of practical application of these proposals in enterprises.

Key words: *agricultural enterprises, biodiesel, rapeseed processing.*

INTRODUCTION

Ukraine is an important producer of vegetable oils. The main oilseeds that agricultural enterprises specialize in growing are sunflower, soybean and rapeseed. At the same time, the capacities of the oil and fat industry are mainly used for soybean and sunflower processing. Rapeseed is still systematically excluded from this list, as the main vector of its export is seeds, and rapeseed oil is almost never used in the diet.
Declining opportunities for rapeseed exports due to the epidemiological situation and a very low share of its processing, lead to a decrease in the volume of cultivation and loss of rapeseed in some areas. Accordingly, in the medium term it is advisable to diversify the sectors of domestic consumption of rapeseed. In the future, it is advisable to focus on the processing of rapeseed into biodiesel. This issue is especially relevant in the context of current administrative and territorial transformations.
Today in Ukraine it is necessary to develop capacities for own production of biodiesel from renewable resources. The growth of environmental pollution, the scarcity of traditional energy sources encourage scientific organizations and business structures to search for new environmentally friendly fuels. One of these areas is the production of diesel fuel from rapeseed oil.
Analyzing scientific sources on the problem of processing rapeseed into biodiesel, it should be noted that research has been conducted in several areas. Scientists of the first direction focused on the efficiency of rapeseed processing, in particular: ensuring the efficiency of agricultural production by using production facilities for processing rapeseed into biodiesel [5, 7, 9, 11]; assessing the profitability of agricultural enterprises [1]; studying the impact of factors on the

profitability of the US biodiesel industry [6]; study of energy viability of rapeseed biofuel production [8]. Scientists of the second direction of the research studied the trends of rapeseed processing into biodiesel as one of the directions of development of renewable energy sources in Ukraine and the world [3, 2, 4, 19, 22]. Scientists of the third direction, for example, Yurchuk N.P. and Yurchuk S.S. [23], Matvieieva I. et al. [10], in their work focus on the environmental friendliness of biodiesel, ie less harmful impact on the environment compared to diesel fuel. Despite the significant amount of research on this topic, more in-depth study requires questions about the feasibility of processing rapeseed into biodiesel, justification of its economic efficiency for agricultural enterprises, the location of processing facilities in some regions of Ukraine.

The object of the study are agricultural enterprises of Ivano-Frankivsk region. The choice of the object of study is due to the fact that the level of profitability of rapeseed production in Ivano-Frankivsk region in 2019 was – 4%, and in 2020 – 0 %. At that time, the average level of profitability in Ukraine during this time was 9.4 % and 17.2 %, respectively, and in some areas reached 28 % and 37 % [15]. The subject of the study is the level of efficiency of agricultural enterprises, which is formed in the process of selling rapeseed and processing it into biodiesel.

The urgency of this issue has led to the direction of our study, which aims to assess the feasibility of processing rapeseed into biodiesel and identify prospects for regional location of production facilities for processing.

MATERIALS AND METHODS

The methodological basis of the study were general and special methods. In particular, the calculation and design method was used to substantiate the estimated cost of production capacity of the mini-plant for processing rapeseed into biodiesel and to calculate the total cost of processing 1 ton of rapeseed for biodiesel. Theoretical methods of analysis and synthesis were used to assess and justify the feasibility of further processing of rapeseed, abstract-logical - to form theoretical generalizations, assumptions and conclusions. The general scientific method of comparison was used to substantiate a better alternative to rapeseed processing compared to its implementation. General scientific empirical methods of observation and description made it possible to substantiate the territorial location in the Ivano-Frankivsk region of production facilities for processing rapeseed into biodiesel.

The study used data from the Main Department of Statistics of Ukraine in Ivano-Frankivsk region and the official websites of enterprises that sell equipment for processing and sell biodiesel.

RESULTS AND DISCUSSIONS

Ukraine is a country dependent on energy imports, so the development of rapeseed fuel production can become one of the priorities of state agricultural policy. The study of economic efficiency of biodiesel production today is gaining considerable relevance as an effective mechanism for stimulating the development of the agro-industrial complex.

In EU countries, rapeseed oil is mainly used for biofuel production. This type of oil ranks third in world production and is produced mainly by the United States, Malaysia and China [3]. Biodiesel is most often produced from rapeseed oil (84 %). Vegetable oil is a mixture of triglycerides, esters combined with a molecule of glycerin. The main task in obtaining biodiesel is to remove glycerin, replacing it with alcohol.

According to the Research Institute of Alternative Fuels, Ukraine has the capacity to produce at least 0,5 million tons of biodiesel and bioethanol per year. However, today even a small amount of biodiesel consumed in Ukraine is imported from EU countries. The paradox is that this biofuel is produced from products exported by Ukrainian companies [12].

Today in Ukraine there is no plant of European level for the production of biofuels. Foreign investors offer to build in Ukraine quite large plants for the production of biodiesel with a capacity of 50-100 thousand tons per year, this requires processing about 300 thousand tons of rapeseed, and the cost of such a plant is quite high. Insufficient raw material base and lack of guarantees for its stable supply, as well as undercapacity of similar plants abroad block the development of construction projects for such plants, with the participation of foreign investors [18].

Construction in Ukraine of mini-plants for the production of biodiesel with a capacity of 2.7 thousand tons per year or the creation of production facilities directly on the territory of agricultural enterprises that grow rapeseed, has good economic prospects. The yield of biodiesel from one ton of rapeseed is 40 %, ie under the above capacity we get 1.1 thousand tons of biodiesel per year. Taking into account the cost of the premises and other technical means to ensure the extraction of oil and its processing into biodiesel, the cost of production capacity was determined. According to our calculations, the cost of one mini-plant for processing 2.7 thousand tons of rapeseed per year is 2,856.8 thousand UAH (Table 1).

Table 1. Calculation of the plant cost for the production of biodiesel from rapeseed

General characteristics of the plant	
The territory of the plant, ha	0.5
Rapeseed processing: per day, tons	10.8
per year thousand tons	2.7
Biodiesel production: per day, tons	4.3
per year thousand tons	1.1
Number of working days	250
The total cost of the plant, thousand UAH, including:	2,856.8
Buildings and structures, thousand UAH	850.0
Equipment, thousand UAH, including:	2,006.8
equipment for oil production, thousand UAH, including:	784.9
oil press screw MMSh-450, productivity is 420-450 kg/h. (3 pieces at the price of 210 thousand UAH)*	630
filter line LF-4, capacity 200 l / h (3 pieces at the price of 38.4 thousand UAH)*	115.2
capacity for oil (2 pieces with a capacity of 3,000 l at the price of 9.8 thousand UAH)	19.6
capacity for meal (3 pieces with a capacity of 700 kg at a price of 6.7 thousand UAH)	20.1
equipment for the production of biodiesel (EXON-250 complex, capacity 6,000. l), thousand UAH *	1,221.9
Machine-tractor park, thousand UAH	350.0

Source: authors' own calculations.
* The cost of equipment according to official websites: GG “TT Group”[16], PP “LAVRIN”[17].

It should be noted that today the biggest problem of technical equipment of mini-plants in Ukraine is the purchase of biodiesel plants. Back in January 2007. Chernivtsi enamel factory “Karpaty” presented plants for the production of biodiesel with a capacity of 10 to 200 liters per hour, but serial production was not established. Accordingly, there is a need to purchase this equipment abroad. However, in our opinion, Ukrainian industry has the potential to produce the above facilities.

A significant advantage of rapeseed processing is that once in the air, biodiesel does not harm plants or animals and there is a complete biological decomposition of this substance. Biodiesel is mainly used to form a mixture with diesel fuel. The most commonly used mixture of biodiesel with a share of 20 % in diesel fuel (B20), are popular and mixtures with a lower share. Pure biodiesel (B100) is also in high demand in many countries, especially in Germany [12]. For example, Gbf german biofuels gmbh has an annual production capacity of over 130,000 tons of high quality biodiesel [15].

The production of 1,000 liters of biodiesel requires 1,000 liters of purified rapeseed oil, as well as 186 methyl alcohol, 5 kg of catalyst and other excipients. Taking into account all the conditions of the technological process of biodiesel production, it is determined that the cost of processing 1 ton of rapeseed for biodiesel is 618.2 UAH (Table 2).

The environmental component of rapeseed processing efficiency is important, but the most important is the economic component. The economic feasibility of processing rapeseed into biodiesel is justified by its higher efficiency compared to the sale of rapeseed seeds in domestic and foreign markets. Gross rapeseed harvest in Ivano-Frankivsk region has been increasing dynamically in recent years. The cost of 1 ton of rapeseed produced in 2020 was UAH 9,802, and the cost of 1 ton of rapeseed sold was UAH 10,620. The selling price of 1 ton was UAH 10,630.3, respectively, the level of profitability of sales – 0.0 % [21].

Thus, the cultivation of this type of product in 2020 in the region was neither unprofitable nor profitable. Although the situation regarding the level of profitability in 2020 has slightly improved (in 2019 there was a loss of 4.0%), but high competition in the rapeseed market for the sale of its seeds and the presence of traders, contribute to the shortfall of agricultural enterprises.

Table 2. Calculation of the total cost of processing 1 ton of rapeseed for biodiesel

№	Expense items	Calculation	Amount, thousand UAH
1.	Amortization		451.3
	including depreciation of buildings and structures (4%)	(850-40)/30	27
	depreciation of oil production equipment (12%)	(784.9-78.4)/5	141.3
	depreciation of biodiesel production equipment (12%)	(1,221.9-122)/5	220
	depreciation of machine and tractor park (12%)	(350-35)/5	63
2.	Expenses for repair of fixed assets (1%)	2,856.8*0.01	28.6
3.	Remuneration with accruals		597.6
	including administrative staff (2 people)	(6,900*2)*12	165.6
	service staff (6 people)	(6,000*6)*12	432
4.	Electricity (total capacity 146 kV / h)		490.6
	including biodiesel plant (80 kV / h)	160 thousand kV *1.68 UAH	268.8
	three oil presses (22 kV/ h)	132 thousand kV *1.68 UAH	221.8
5.	Heating and lighting costs	3,6 thousand kV *1.68 UAH 1 thousand cubic meters *7.99 UAH	14
6.	The cost of methanol, catalyst		87
Total costs			1,669.1
Costs per ton at a capacity of 2.7 thousand tons, UAH			618.2

Source: authors' own calculations.

At the same time, the sale of products obtained as a result of processing according to the technological process (biodiesel, rapeseed meal, crude glycerin) can provide higher profitability.

If we make economic calculations, taking into account the current conditions for the production and sale of rapeseed by agricultural enterprises of Ivano-Frankivsk region in 2020, their results will indicate the feasibility of processing rapeseed into biodiesel (Table 3).

The introduction, along with the cultivation of rapeseed, of the technology of its processing into biodiesel, will promote better use of the production potential of agricultural enterprises, which are more profitable to convert rapeseed into biodiesel fuel than to sell rapeseed seeds on the foreign market. When processing 1 ton of rapeseed for biodiesel, you can get 4,339.8 UAH of profit, while when selling rapeseed - only 10.3 UAH, with a level of profitability of 41.7% and 0.0 %, respectively. In total, when selling 2.7 thousand tons of rape, agricultural producers received 27.8 thousand UAH, and when processing into biodiesel could receive 11,716.9 thousand UAH.

Table 3. Efficiency of rapeseed processing into biodiesel on the example of Ivano-Frankivsk region

Indicator name		Indicator value
Rapeseed processing on biodiesel	Product yield as a result of processing 1 ton of rapeseed	400
	incl. biodiesel yield, l	550
	cake yield, kg	68
	yield of technical glycerin, kg	14,760
	The cost of the received production from 1 t of rape - all, UAH	11,200
	incl. cost of biodiesel, UAH (28 UAH per 1 liter *)	2,200
	the cost of cake, UAH (4 UAH per 1 kg *)	1,360
	cost of technical glycerin, UAH (20 UAH per 1 kg)	9,802.0
	The cost of 1 ton of grown rapeseed, UAH	618.2
	The cost of processing 1 ton of rapeseed, UAH	10,420.2
	Total costs for production and processing of 1 ton of rape, UAH	4,339.8
	Profit from 1 ton of rapeseed as a result of processing, UAH	41.7
	The level of profitability of processing 1 ton of rape,%	11,716.9
Implementation of rapeseed	The cost of 1 ton of rape sold, UAH	10,620
	Sales price of 1 ton of rape, UAH	10,630.3
	Profit from the sale of 1 ton of rapeseed, UAH	10.3
	The level of profitability of sales of 1 ton of rape,%	0.0
	Profit from the sale of 2.7 thousand tons of rapeseed, thousand UAH	27.8
Economic effect (increase in profit as a result of rapeseed processing compared to sales) thousand UAH		11,689.1

Source: authors' own calculations.
* The price is set according to the official sites: Ecoist [14], Agrovektor [13].

Therefore, according to Table 3, it can be concluded that in general from the construction of one plant we get an increase in profit by 11,689.1 thousand UAH. Comparing the additional profit with the cost of the required production capacity, we can conclude that investment in construction will pay off in the first year of operation. In addition, companies will be able to save working capital by providing their own needs with biodiesel. Also, during processing, they will receive cake (a valuable feed additive), which enterprises engaged in animal husbandry can use for their own needs. The obtained glycerin is also widely used in the pharmaceutical and perfume industries, so it is constantly in demand.

If agricultural enterprises are not integrated into a single organizational and technological chain, it is important to establish economic partnerships between rapeseed producers and enterprises that process rapeseed into biodiesel on mutually beneficial terms. In our opinion, agricultural enterprises need to create production facilities for rapeseed processing on a cooperative basis. Such a mini-plant is able to meet the needs of agricultural producers in one or three territorial communities of the region, depending on the volume of raw material production. 69 large and medium-sized enterprises are engaged in the production of this type of product in the Ivano-Frankivsk region, and the total sales volume is 92.6 thousand tons [20]. At the beginning of 2021, a new regional administration came into force due to administrative-territorial decentralization. Rapeseed was sold in 2020 by enterprises Horodenka (16.6 thousand tons), Kolomyia (5.1 thousand tons), Sniatyn (2.8 thousand tons) districts, which in 2021 as a result of administrative decentralization were merged into Kolomyia district. Rapeseed was also sold by enterprises of Halych (2.8 thousand tons), Rohatyn (22.1 thousand tons), Tysmenetsia (2.7 thousand tons), Tlumats (3.2 thousand tons) districts and t. Frankivsk (32.6 thousand tons), which are united in Ivano-Frankivsk district. In Kaluh district, with the same name of the newly created district in 2021, 4.5 thousand tons of rapeseed were sold. If we implement the above measures for processing rapeseed into biodiesel and offer to process at least half of the sold rapeseed, then the sale of 49.4 thousand tons of the remaining 43.2 thousand tons of rapeseed could provide capacity for 16 similar processing plants.

Hawing consideed the distribution of rapeseed sales in Ivano-Frankivsk region by district, taking into account the territorial proximity of communities and transport, which is focused on the administrative centers of reorganized districts, we can make the following proposals for the location of mini-rapeseed processing plants (Fig. 1):

(1). 1 plant can be located on the territory of Tlumach territorial community, the volume of rapeseed sales in the reorganized district of the same name, which also included Olesha and Obertyn territorial communities, amounted to 3.2 thousand tons. That is, a small part of the rapeseed 0.5 thousand tons may not be sent for processing, but be sold.

(2). 1 plant Tysmenytsia territorial community with a capacity of 2.7 thousand tons, as the volume of rapeseed sales by agricultural enterprises of the reorganized district of the same name, which also included the lands of the other five created territorial communities located around Ivano-Frankivsk, amounted to 2.7 thousand tons.

(3). 1 plant can be located in Halych territorial community with a capacity of 2.7 thousand tons, as the volume of sales in the reorganized district of the same name, which also included Bilshivtsi and Dubovets communities amounted to 2.8 thousand tons.

(4). 4 plants in the communities reorganized in 2021 by joining Rohatyn district to Ivano-Frankivsk. We also recommend to place one plant at a time in Burshtyn and Bukachivtsi communities, as well as two factories in Rohatyn community, which is larger in area of agricultural land. The new production capacity will process 10.8 thousand tons, the total sales of rapeseed by agricultural enterprises in 2020 amounted to 22.1 thousand tons.

(5). 1 plant in Ivano-Frankivsk territorial community of Ivano-Frankivsk district. It should be noted that the largest volume of rapeseed sales according to statistics is indicated by enterprises registered in the administrative center of the region, district and territorial community – t. Ivano-Frankivsk.

Fig. 1. Proposals for the territorial location of rapeseed processing plants in Ivano-Frankivsk region.
Source: authors' own research.
– production facilities for rapeseed processing into biodiesel.

In total, these agricultural enterprises sold 32.6 thousand tons of rapeseed. Accordingly, these enterprises, wishing to carry out processing, can transport rapeseed to neighboring local communities.

(6). 2 plants can be located in the newly created Kalush area, which remained the administrative center and was created by joining two more neighboring areas. New production facilities located in Kalush and Verkhnia territorial communities, will process 5.4 thousand tons per year, and the total sales of rapeseed in 2020 amounted to 4.5 thousand tons. Therefore, suppliers of raw materials for capacity reloading Verkhnia communities in the amount of 0.9 thousand tons may be enterprises from neighboring Burshtyn and Bukachivtsi communities of Ivano-Frankivsk district.

(7). 2 plants – in the newly created Kolomyia district, which remained the administrative center and was created by joining the neighboring Sniatyn and Horodenka districts. The volume of rapeseed sales in the reorganized area in 2020 amounted to 5.1 thousand tons. One of such plants should be located on the territory of FE "Prometei" of Matiivtsi territorial community, which in 2020 sold only 52.9 % of the produced rapeseed, and the total production amounted to 1,551 tons, which is enough to ensure the capacity of the plant for six months. The second plant located on the territory of Korshiv territorial Community in the amount of 0.3 thousand tons can be supplied with raw materials by the enterprises of the neighboring Obertyn community of Ivano-Frankivsk district where there is a surplus of rapeseed of 0.5 thousand tons.

(8). 1 plant of processing rapessed in Zabolotiv territorial community, which together with the Sniatyn territorial community were previously merged into, now attached to Kolomyia, Sniatyn district. Sales amounted to 2.8 thousand tons.

(9). 2 plants in the Horodenka territorial community and 1 plant in the Chernelytsia community, which were previously merged into the Kolomyia, Horodenka district, now attached to Kolomyia. The total sales of rapeseed in 2020 amounted to 16.6 thousand tons. These production facilities will process 8.1 thousand tons per year. One of these plants should be located on the territory of "SVC named after T.H. Shevchenka.

In addition, rapeseed production is higher than sales, ie the potential number of processing plants may be higher.

If in 2020 year 92.6 thousand tons of rapeseed were sold and 1 ton of UAH 2,831.3 profit was received from the sale (a total of UAH 262,178 thousand), then according to our proposals it would be expedient to sell 49.4 thousand tons and make a profit 139,866 thousand UAH. The remaining 43.2 thousand tons of rapeseed would be appropriate to process for biodiesel and other products with a profit of a ton of 4,855.1 UAH, and only 209,740 thousand UAH. As a result, from the sale of 49.4 thousand tons of rapeseed and processed products from 43.2 thousand tons it will be possible to get 349,606 thousand UAH of profit or 33.3 % more than in 2020 year.

We believe that the implementation of these measures can also increase the efficiency of small agricultural enterprises in the region. That is, it is advisable to operate small businesses that will specialize mainly in the cultivation of rapeseed, and ancillary production will be husbandry. Having obtained state support in the process of obtaining credit resources, such small agricultural enterprises can place on their territory equipment for processing rapeseed into biodiesel. As a result, we will increase the efficiency of small agricultural entrepreneurship and additional filling of rural and settlement budgets.

CONCLUSIONS

Quite often, agricultural enterprises are forced to sell rapeseed on their own, seeking to obtain better conditions for the sale of products than they are offered by intermediaries. At the same time, the construction of small processing plants by direct producers of rapeseed or mini-plants by representatives of the processing industry requires insignificant capital investments and pays off quickly. The possibility of processing will reduce the loss of raw materials by farmers during storage.

Conducted research confirms the economic and environmental feasibility of processing rapeseed into biodiesel. On the one hand, the selected approaches are the basis for the systematic development of crop production and processing industry, on the other hand, contribute to the optimization of rapeseed production by activating cooperative principles. Approbation of the obtained results showed a significant interest of producers and processors in the relevant analytical and forecasting products. It is advisable to create production facilities for processing rapeseed into biodiesel considered FE "Prometei", "APC named T.H. Shevchenko", Precarpathian State Agricultural Research Station ISH of the Carpathian region of NAAS, which are engaged in rapeseed cultivation.

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THE IMPORTANCE OF AGRICULTURAL PRODUCTION FOR THE DEVELOPMENT OF AGROTOURISM ACTIVITIES IN PRAHOVA COUNTY, ROMANIA

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Abstract

This paper aims to present the evolution of agriculture in Prahova County, in the period 2014-2018, analyzing in particular the production of cereals, fruits and vegetables without omitting animal husbandry and the production of milk and eggs. In order to highlight the main trends of agricultural production in Prahova County, the areas cultivated with cereals for grains, oil plants, potatoes, vegetables, as well as the areas occupied by orchards, vineyards and livestock were subjected to analysis. Grain cereals occupy an average of 95,502.4 hectares, being the largest area. This is followed by the average of oil plants with 27,156.6 hectares, followed by vegetables with an average of 4,230 hectares and potato cultivation with an average of 2,530.4 hectares. For the other crops analyzed, there were increases in maize, fodder, barley production and decreases in rye production. The analysis of fruit and vegetable production highlighted the fact that it belongs largely to private property, this being an asset for the development of slang tourism in Prahova County. Analyzing the milk production, a decreasing trend was found over the entire analyzed period.

Key words: *agricultural production, evolution, agrotourism, cultivation of plants, vegetables, Prahova County*

INTRODUCTION

Taking into account the current trends of the international market regarding the demand for agrotourism products and Romania's potential in tourism, the country has a competitive advantage that will bring some well-known tourist areas to the attention of agrotourism lovers [4].
If development in this direction will be achieved at high levels, the development of agrotourism can be a chance to capitalize the natural and anthropogenic tourist resources in a sustainable way in a long run [2].
Agrotourism can lead to the conservation of rural nature while providing the opportunity for the development of local communities. Development strategies in this regard can be developed with the basic idea of the local perspective of existing agrotourism destinations that have great potential for future development [5].
Due to the link established between agrotourism and agriculture, environmental protection and infrastructure, the major importance for the long-term development of the rural area can be a basic support for the development of new businesses in the private sector leading to a local development of the communities involved [8].
The results of these developments could be easily materialized in increasing the incomes of the rural population, in improving the structure of expenditures, involving specialized investments and developing transport infrastructure, along with the creation of new activities resulting from local trade due to local population and visitors [9].
The modernization of the rustic space, the arrangement of some agrotourism routes, the realization of repairs and the endowment with the household equipment are some of the benefits brought by this objective [7] [9].
The fact that agrotourism involves the social factor in the village environment it aims the use of civilizational nature, culture and education and the development of friendly links between the local community and tourists but also exchanges of experience and progress.

The study took into account the possibilities of agricultural development in Prahova County as well as the possibilities offered by private households for the supply of cereals, vegetables, fruits and livestock for milk collection [1] [3].

For agrotourism, agricultural products are a basic point in supporting the development of the activity. That is why it is necessary to analyze them at the zonal level to determine, along with the other important points necessary for the development of agrotourism, the basis of supporting tourists in holiday destinations whatever they are, a natural setting of agritourism farms [10].

Lately, it more and more discussed about the ecosystem services that a region offers for tourists from an agricultural, tourist and cultural point of view. That is why it is needed to determine the resources of an area meant to contribute in the future to its development from an agrotourism point of view [11].

In this context, the purpose of the paper is to identify the current stage of development of agricultural production in Prahova County using some specific indicators looking for resources which could bring to the development of agrotourism.

MATERIALS AND METHODS

For this purpose, the research was based on the data obtained in the economic context, using secondary information to further create a necessary basis for the implementation of a field research. The information obtained in this way allows the understanding of the studied phenomena.

The collection of secondary information involves a documented activity based on the collection of reliable, objective and valid data from reliable sources. That is why the original statistical sources were provided by the National Institute of Statistics [6].

The main methods used in this study are statistical processing, for the indicators of the mean, standard deviation and coefficient of variation related to each group of indicators for the analyzed period.

RESULTS AND DISCUSSIONS

Within the diversity of relief units Prahova County has a wide variety of soils, the mountainous area is characterized by the presence of prepodzols and podzols, in the area of hills there are luvosols, rendzine, eutricambsols, distrambosols that are specific to meadows, fodder crops and orchards and in the field could be found chernozems, phaeoziomes and preluvosols that favor the cultivation of cereals.The arable lands has a share of 3.87% for class I of very good quality from the total agricultural area of the county. Class II of good quality arable land is 21.14% of the total county agricultural area. Class III of arable land with a moderate limit for cultivation is 30.5% of the total county agricultural area.

Class IV of arable land with severe limitations occupies a percentage of 29.06% and class V of extremely limited arable land occupies 15.45% of the total agricultural area of Prahova County.

Table 1 shows the evolution of the agricultural area of Prahova County in the period 2014 - 2018.

Table 1. Agricultural area in Prahova County between 2014 – 2018

Year	Total area / hectares
2014	138,321
2015	140,109
2016	142,824
2017	142,118
2018	142,403
Mean	141,155
St. Deviation	1,897.11
Variation coefficient (%)	1.34

Source: author's own research.

Table 1 shows an increasing trend recorded by the annual agricultural area from 138,321 hectares in 2014 to 142,824 hectares in 2016, after which it decreases to 142,118 hectares in 2017 and then to increase to 142,403 hectares in 2018. One cause of this decrease noticed in 2016 is the decline of cereal crops for berries and potatoes. It can be observed that the average of the crops for the analyzed period is 141,155. It can be seen that the average total area of crops in Prahova County, expressed in Hectares is 141,155 and the standard deviation is 1,897.11. The coefficient of variation has the value of 1.34 which means a homogeneous series whose average is representative. Table 2 shows the main crops in Prahova County for the analyzed period.

Table 2. The main agricultural crops in Prahova County between 2014 – 2018

Year	Grain cereals	Potatoes	Oily plants	Vegetables
2014	98,862	2,696	21,426	4,488
2015	98,279	2,595	24,512	4,342
2016	100,673	2,547	24,159	4,119
2017	88,741	2,392	33,323	4,097
2018	90,957	2,422	32,363	4,104
Mean	95,502.4	2,530.4	27,156.6	4,230
St. Deviation	4,735.16	112.05	4,773.89	158.11
Variation coefficient (%)	4.95	4.78	17.57	3.73

Source: author's own research.

From the data presented in Table 1, the largest cultivated area of cereals is observed. This is followed by oil plants, vegetables and potatoes. During the analyzed period, grain cereals registered an evolution of decreasing cultivation in 2015 compared to 2014 with 583 hectares. For 2016, the cultivation of grain cereals registers an increase of 2,394 hectares compared to 2015. In 2017, the area of cereal crops decreases by 11,932 hectares compared to 2016 and then in 2018 to increase again by 2,216 hectares. Regarding the potato crop, there is a decrease of the cultivated area in 2015 compared to 2014 of 98 hectares. This trend continues to decrease in 2016 by 48 hectares compared to 2015. In 2017 there is the lowest area cultivated with potatoes in the entire analyzed period of 2,392 hectares being with 155 hectares smaller than the one cultivated in 2016. For 2018, it will increase by 30 hectares. The cultivation of oil plants annually registers significant increases starting from 21,426 hectares in 2014 to 33,323 hectares in 2017, after which in 2018 it is cultivated with 960 hectares less. Vegetables record an annual decrease in cultivated area. In 2014 they occupied 4,488 hectares, in 2015 the cultivated area decreased by 146 hectares, in 2015 the cultivation of vegetables continues to decrease by 223 hectares compared to 2015 and in 2017 by 22 hectares compared to 2016. In 2018 notes an increase in the area cultivated with vegetables by 7 hectares compared to 2016. The analysis of statistical indicators shows the highest specific average of the main agricultural crops in the category of grain cereals, this being followed by that of oil plants, vegetables and potatoes. The coefficient of variation is below 35% which indicates homogeneous series for the main agricultural crops in the analyzed period. The average is representative.Table 3. shows the main grain crops for grains by categories.

Table 3. Grain grain cultivation by categories between 2014-2018

Year	Wheat	Maize	Rye	Barley
2014	38,661	51,524	121	7,258
2015	36,806	54,392	43	5,845
2016	38,487	54,324	22	6,662
2017	33,205	49,444	0	5,071
2018	35,688	50,090	0	4,225
Mean	36,569.4	51,954.8	37.2	5,812.2
St. Deviation	2,247.44	2,319.50	50.13	1,212.66
Variation coefficient (%)	6.14	4.46	134.75	2.17

Source: author's own research.

From Table 3, it can be seen that the largest area cultivated with cereals belongs to corn crops with over 50,000 hectares, followed by wheat with over 30,000 hectares, barley and

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barley with over 4,000 hectares. Rye occupies the last place in the cultivation of grain cereals, being declining every year and in the last two years 2017 and 2018 not being cultivated. For the analyzed period it is observed the largest cultivated area with corn was registered in 2015 of 54,392 hectares and the smallest of 49,444 hectares was cultivated in 2017. For wheat the largest cultivated area was achieved in 2014 with 38,661 hectares. This remained constant for the entire analyzed period, the values increasing or decreasing not being significant year by year.

Regarding Barley and Barley, we can see the decreasing trend of cultivated areas starting from 7,258 hectares in 2014 to 4,225 hectares in 2018. The weakest crop is Rye, which in 2014 was cultivated on 121 hectares, in 2015 was cultivated on 43 hectares and in 2016 it was cultivated on 22 hectares after which its cultivation stopped. There is a higher average crop of cereal grains for maize, followed by wheat and barley. The coefficient of variation indicates values below 35% for them, which shows that there is a degree of homogeneity of the respective grain cultivation series, the average is representative, while for rye it is found that the series is inhomogeneous. Table 4. shows the agricultural vegetable production for the period 2014 - 2018.

Table 4. Vegetable agricultural (t) production of Prahova County between 2014 – 2018

Year	**Maize**	**Wheat**	**Barley**	**Rye**
2014	225,314	133,173	23,715	197
2015	185,874	136,743	20,192	286
2016	209,229	157,447	25,565	77
2017	287,216	152,335	19,938	0
2018	325,727	128,080	15,364	0
Mean	246,672	141,555.6	20,954.8	112
St. Deviation	57,982.86	12,686.14	3,928.91	126.3
Variation coefficient (%)	23.5	8.96	18.74	112.76

Source: author's own research.

Table 4. shows that the highest maize production in 2018 was 32,5727 tons, with 100,413 tons more compared to the base year 2014. For the analyzed period, the maize production trend is decreasing for 2015, after which it is increasing year by year, two years. Wheat production registers an increase until 2016 by 24,274 tons compared to 2014, after which it decreases by up to 29,367 tons in 2018. According to the statistical data processing, the highest average of the maize production recorded for the analyzed period is noticed, followed by the wheat and barley production, while the section production registers the lowest average for this time. The coefficient of variation indicates a homogeneous series for the production of corn, wheat and barley, the average is representative and inhomogeneous for the production of rye whose environment is not representative. Figure 1 shows the total fruit production and that collected from the private property of Prahova County for the period 2014 – 2018.

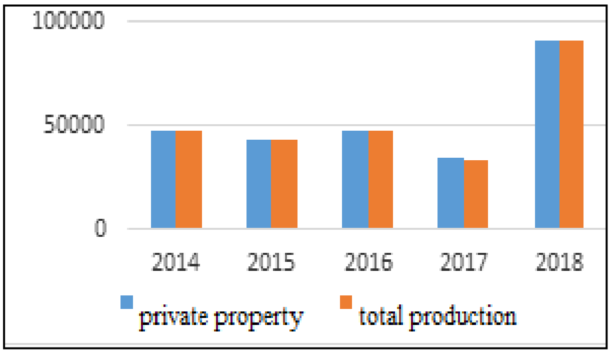

Fig. 1. Graph of the evolution of fruit production in Prahova County between
Source: author's own research.

As can be seen from Figure 1. fruit production in Prahova County is mostly private property. This is a main asset for the development of agrotourism at county level being one of the basic resources for this form of tourism. In Table 5 the situation of fruit production by categories for the period 2014-2018 is presented.

Table 5. Fruit production in Prahova County by categories (t) 2014 - 2018

Fruits (t)	2014	2015	2016	2017	2018
Plums	23,499	21,312	27,780	18,010	50,207
Apples	13,712	14,366	10,966	7,801	30,041
Pears	3,503	2,434	2751	2,256	2,766
Peaches	580	496	668	707	741
Cherries	2,686	2,320	2,308	1,901	3,086
Apricots and greens Nuts	1,506	1,186	1,306	1,373	1,462
Nuts	1,137	1,297	1,367	1,745	2,202
Strawberries	28	22	16	0	0
Other fruits	1,058	96	171	148	124
Mean	5,301	4,836.55	5,259.22	3,771.22	10,069.88
St. Deviation	7,998.58	7,621.54	9,082.89	5,824.21	17,802.05
Variation coefficient (%)	150.88	157.58	172.7	154.43	176.78

Source: author's own research.

It can be concluded that the most important fruit production in Prahova County is occupied by plums, in 2018 it reached 50,207 tons compared to 2017 when their lowest production of 18,010 tons was recorded. In second place is the production of apples with a value of 30,041 tons in 2018. The lowest production of apples stands out in 2017 with 7,801 tons compared to 2014 when it was 13,712 tons. On the third place of fruit production at county level is observed the place occupied by pears. The highest pear production is noted in 2014, of 3,503 tons. It decreases over the analyzed period year by year to 2,766 tons in 2018. The production of cherries and cherries is increasing in 2018 to 3,086 tons compared to the base year 2014 when it was 2,686 tons. The lowest production of cherries and sour cherries is recorded in 2019 with a value of 1,901 tons. Apricot and Vegetable production is declining over the analyzed period while Walnuts record increases in production from year to year from 2014 to 1,137 tons until 2018 when it reaches the value of 2,202 tons.

It is possible to observe a decreasing evolution of the strawberry production from 28 tons in 2014 to 16 tons in 2016 after which the values are no longer found in the productive statistics.

The same decreasing trend is noticeable for the category of other fruits if in 2014 there were 1,058 tons of production in 2018 reaching 12 tons. The highest average fruit production is obtained in 2018 and the lowest is obtained in 2017. The coefficient of variation has values above its maximum limit, which indicates inhomogeneous data series therefore the average is not representative. Table 6 presents data specific to the number of animals expressed in heads at the level of Prahova County for the analyzed period.

Table 6. The herd of animals private in Prahova County 2014 – 2018

(Heads)	2014	2015	2016	2017	2018
Cattle	37,742	38,819	37,654	38,848	37,099
Swine	96,844	98,106	96,594	84,272	79,507
Sheep	137,002	138,268	136,955	136,570	135,307
Goats	35,281	36,807	38,137	39,053	39,063
Mean	76,717.25	78,000	77,335	74,685.75	72,744
St. Deviation	49,245,54	49,222.27	48,430.42	46,459.99	46060.98
Variation coefficient (%)	64.19	63.1	62.62	62.2	63.31

Source: author's own research.

For the analyzed period the herd of animals from Prahova County shows us that sheep are in the first place in their breeding. Sheep have the highest number of 38,848 heads in 2017 compared to 2014 when they amounted to 37,742 heads. A good year in which the number of sheep's heads was over 37,742 is also 2015 with 38,819 heads. For 2016, their situation shows a decrease of up to 37,645 heads, a trend that is maintained for 2018 when their number reaches 37,099 heads. The second place for the number of animals in the county is occupied by pigs. Their evolution shows an increase in the number of heads for the year 2015 by 1,262 heads more than in 2014. After this year the number of pigs is decreasing by 1,512 heads for the year 2016 and 12,322 heads in the year 2017 compared to 2016. For the year 2018 the number of heads of pigs decreased by 4,765 heads. The analysis of the number of animals for cattle for the period 2014-2018 shows a constant trend of over 37,000 heads with slight annual fluctuations of annual increase or decrease while for goats there is an increase year by year from 35,281 heads for the year 2014 to 39,063 heads for the year 2018. You can see the highest average growth of herds for the period analyzed for 2015 and the lowest average value for 2018. The coefficient of variation is high which indicates a heterogeneous structure of the community, the average series is not significant. Tables 7 and 8. show private agricultural production of animal origin for milk, wool and honey.

Table 7. Private agricultural production of animal origin for milk 2014 – 2018

(thousand hectoliter)	**2014**	**2015**	**2016**	**2017**	**2018**
Milk	924	899	913	809	812
Cow's milk and buffalo	778	762	790	678	690
Mean	851	830.5	851.5	743.5	751
St. Deviation	103.23	96.87	86.97	92.63	86.26
Variation coefficient (%)	12.13	11.66	10.21	12.45	11.48

Source: author's own research.

Table 8. Private production of wool and honey in Prahova County 2014 – 2018

(t)	**2014**	**2015**	**2016**	**2017**	**2018**
Wool	478	462	491	501	497
Honey	439	620	467	974	1018
Mean	458.5	541	479	737.5	757.5
St. Deviation	27.57	111.72	16.97	334.46	368.4
Variation coefficient (%)	6.01	20.65	3.54	45.35	48.63

Source: author's own research.

The data exemplified in Table 7 show the production of milk collected from the private sector as slightly decreasing for the analysis period. In 2014 it amounted to 924 thousand hl and in 2015 it decreased by 25 thousand hl. For 2016 there is an increase of a 4 thousand hl compared to 2015 and in 2017 there is a decrease of 104 thousand hl compared to 2016. For 2018 milk production shows a decrease of 3 thousand hl compared to 2017. We notice the increasing trend of wool production for the period 2014-2017 starting from 478 tons to 501 tons, after which there is a slight decrease of 4 tons in 2018.

The average milk production in the private environment of Prahova County is the highest in 2016 and the lowest in 2017.

The coefficient of variation is below 35% which indicates homogeneous series for which the average is representative. In terms of honey production, the trend is fluctuating year from 439 tons for 2014 to 620 tons in 2015 after which it decreases to 467 tons in 2016 and then to record double increases for 2017 to 974 tons and 1,018 tons respectively in 2018. The average private production of wool and honey registers the highest value in 2018 and the lowest value in 2014.

The coefficient of variation indicates a high degree of homogeneity for 2015, 2017 and

2018. For the period 2014 - 2016 the average is representative while for the period 2017-2018 the mayoralty is not representative.

Table 9 shows the evolution private egg production expressed in millions of pieces.

Table 9. Private egg production at the level of Prahova County between 2014 – 2018

(million pieces)	2014	2015	2016	2017	2018
Eggs	173	159	157	147	146

Source: author's own research.

You can see the upward trend in egg production at the county level starting from 17 million pieces in 2014 to 146 million pieces in 2018. In 2015 production decreased by 14 million pieces compared to 2014 and in 2016 it decreased by 2 million pieces compared to 2015. The decrease registered in 2018 was 1 million pieces compared to 2017. The situation of the vine crop area as a private property existing in Prahova County is presented in Table 10.

Table 10. Area of fruit vineyards in Prahova County 2014 – 2018

(hectare)	2014	2015	2016	2017	2018
Vine on the fruit	8,409	8,139	7,324	7,293	7,121
Grafted vines	7,343	7,076	6,261	6,230	6,136
Hybrid	1,066	1,063	1,063	1,063	985
Mean	5,606	5,426	4,882.66	4,862	4,747.33
St. Deviation	3,967.71	3,815.66	3,350.35	3,332.68	3,295.28
Variation coefficient (%)	70.77	70.32	68.61	68.54	69.41

Source: author's own research.

From the analysis of the private area occupied by the vine on the territory of Prahova County it is noted according to the decreasing trend registered every year for the fruit vineyards pronouncing from 8,409 hectares in 2014 to 7,121 hectares in 2018. In 2015, the area cultivated with vines per fruit decreased by 270 hectares. In 2016 compared to 2015 the decrease was 815 hectares and in 2017 compared to 2016 this decrease was 31 hectares. In 2018, the decrease of the area occupied by the vine was 172 hectares compared to 2017. This decreasing trend is also reflected in the evolution of grafted and hybrid vineyards. The share of grafted fruit vines is higher compared to that of hybrid fruit vines. The area of fruit vineyards in Prahova County has the highest average in 2016 and the lowest value is for 2018. The coefficient of variation is high which indicates that the average is not significant, the serial structure being heterogeneous.

In the following, it is analyzed the situation of vegetable production as a whole and also by the main categories of vegetables in Prahova County and private farms (Table 11 and 12).

Table 11. Vegetable production in Prahova County 2014 -2018

(t)	2014	2015	2016	2017	2018
Private sector	57,158	55,417	48,193	49,957	47,319
Total vegetable	57,108	55,368	48,160	49,924	47,308
Mean	57,133	55,392.5	48,176.5	49,940.5	47,313.5
St. Deviation	35.35	34.64	23.33	23.33	7.77
Variation coefficient (%)	0.06	0.06	0.04	0.04	0.01

Source: author's own research.

As can be seen, as in the case of the other analyzes presented, the vegetable production is mostly private in Prahova County, the difference being insignificant in terms of quantity. The trend recorded for the analyzed period is decreasing starting from 57,158 tons in 2014 to 47,319 tons in 2018. The analysis of specific indicators for total vegetable production and that of the private sector expressed in tons, shows the highest average recorded in 2014 and its lowest value in 2018. The coefficient of variation tends to zero, the variation of the characteristic being small, the series it is homogeneous and the mean is representative.

Table 12 shows the evolution of vegetable production by product categories.

Table 12. Vegetable production in Prahova County by categories between 2014 – 2018

(t)	2014	2015	2016	2017	2018
Tomato	17,029	16,754	15,764	16,511	15,437
Dried Onions	5,697	5,106	4,267	4,292	4,039
White cabbage	18,524	17,640	14,224	14,589	14,421
Mean	13,750	13,166.66	11,418.33	11,797.33	11,299
St. Deviation	7,014.04	6,994.78	6,240.91	6,570.46	6,307.83
Variation coefficient (%)	51.01	53.12	54.65	55.69	55.82

Source: author's own research.

We can see that the main place in vegetable production is occupied by white cabbage which in 2014 recorded 18,524 tons, with 4,103 tons more compared to the reference year. The decrease in the production of white cabbage every year is reflected as a decreasing trend in the other categories of vegetables, namely dried onions and tomatoes. The production of dried onions in Prahova County in 2018 decreased by 1,658 tons compared to the base year 2014. Regarding the decrease in tomato production in 2018, there are 1,592 tons less than in the base year 2014. Vegetable production for the analyzed period indicates the highest average value expressed in tons for 2014 and the lowest value is recorded in 2016. The coefficient of variation is higher than 35% which indicates that the series is not representative.

CONCLUSIONS

In conclusion, on the territory of Prahova County which occupies a percentage of 2% of the total agricultural area in Romania, the arable area is 53%. A percentage of 26% is occupied by pastures and 13% is intended for hayfields. The orchards cover an area of 5% of the total agricultural area of Prahova County of 272,834 hectares and vines of 3%. [11].

The most important crops are cereals for grains, followed by oil plants, potatoes, vegetables and fruits and grapes. From a zootechnical point of view, Prahova County provides the necessary for a number of other counties in the country for the poultry sector and the number of animals it owns, therefore the most important products of the agricultural sector are cereals followed by fruits and grapes to which milk is added. meat, abundant resources to be able to develop the base of agrotourism at zonal level.

The existence of agricultural resources in Prahova County offers the possibility of implementing agro-tourism development plans. Therefore, a number of localities can benefit from local development planning, thus contributing to the increase of the well-being and income of the population as well as to an economic growth due to the activities resulting from agrotourism.

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DETERMINANTS OF CREDIT ACCESSIBILITY BY ARABLE CROP FARMERS IN ODO-OTIN LOCAL GOVERNMENT AREA OF OSUN STATE NIGERIA

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Abstract

The study assessed agricultural credit accessibility by arable crop farmers in Odo-Otin Local Government Area, Osun State, Nigeria. Multi stage sampling procedure was used in selecting 120 arable crop farmers. Primary data were collected with the aid of a well-structured interview schedule and subjected to frequency counts, percentage, mean, standard deviation, chi-square and Pearson Product Moment Correlation (PPMC) analyses. The results revealed that the mean age of the arable crop farmers was 53.04 years ± 13.48 years, majority (75.8%) were male and majority (85.8%) were married. Majority (83.3%) were at moderate level of farm credit accessibility. The major constraints to accessing credit in the study area were delay in approval/disbursement ($\bar{X}$ =4.85) and lack of collateral ($\bar{X}$ =4.58). Results of the hypothesis showed significant association between accessibility of farm credit and sex (χ^2=14.219, p=0.001) and level of education, the results also showed positive and significant relationship between accessibility of farm credit and age (r=0.527; p= 0.000) and household size (r=0.426, p= 0.000) of the arable crop farmers. It was concluded that there was moderate level of credit accessibility by the arable crop farmers. Also, sex, level of education, types of arable crops grown, land acquisition pattern, age, household size, farming experience and farm size were the determinants of credit accessibility by the arable crop farmers. It was recommended that the arable crop farmers should increase their scale of farming in order to have better access to farm credit and that government should provide enough farm credit at low interest rate for the arable crop farmers in the study

Key words: *accessibility, agricultural credit, arable crop farmers*

INTRODUCTION

Agricultural credit refers to one of the several credit vehicles used to finance agricultural transactions. These vehicles include loans, and advances [4]. According to [13], credit is an important tool to increase agricultural productivity. Essentially because credit is a support service that enables farmers to procure inputs, hire labor and equipment, it is also perceived as an aid to agricultural transformation and economic development. Agricultural credit is needed to hasten the transformation of traditional farm practice to modern commercial farming [1].

In the same vein, [7] cited that credit is a significant sustenance facility for improved agricultural productivity. It has been observed that credit expedites adoption of innovations, bringing about additional farm productivity and income, promotes capital formation and expands marketing efficiency. It also aids farmers to procure inputs, hire labor and acquire equipment and improved seed varieties for improved agricultural production. Presumptuously, the need for credit is more acute in the rural areas because access to financial resources is decreased by low productivity and wide spread poverty of the rural farm sector. This low productivity is solely owing to the fact that they produce for subsistence consumption and a little salable excess.

In industrialized economies, households generally obtain credit against individual guarantees from commercial sources that arrive at loan decisions based on readily available information on borrowers' credit risk. However, in most developing economies poor households often do not have access to the guarantee mechanisms, such as non-real estate-based collateral. This situation, combined with the overall lack of information about potential borrowers' credit worthiness, contributes to a virtual exclusion of this group of borrowers from formal credit markets [6].

According to [8], credit enables the entrepreneur to train the right calibre of manpower, attract skilled ones where possible and provides them with a conducive environment for optimum performance. Since trained manpower is necessary for healthy economy, illiterate and unskilled persons are highly limited in their ability to go beyond their defects, so credit provides one with the right calibre of management personnel with which the proprietor can confidently hope for a proper organization of his farm.

There are two main sources of agricultural credit, which are of the formal and informal sources [7]. In the formal credit, organizations give arbitration among investors and borrowers, and charge farmers for reasonably lesser rates of loans interest that usually are government subsidized. In informal credit, markets money is offered by private persons.

The Nigerian agriculture is characterized by mainly peasant farmers and majority of these rural farmers live in the rural area and operate at subsistence level with land holding average of less than five hectares [3]. This assertion is one of the many reasons why agriculture in Nigeria is still very much at its lowest ebb. This is further compounded by several other constraints. The deterioration in the Nigerian economy, particularly in the area of agricultural productivity, has often been attributed to lack of credit services, which inhibited many farmers from adopting improved practices, since some of them lack the collateral to obtain loan or credit from financial institutions [3]. Procurement and use of credit for agricultural intentions advance productivity and therefore enhance food security status of a community. In concordance, [5] underlined low access to agricultural credit among other problems limiting agricultural productivity in Nigeria. Farming is virtually subsistence in nature in rural Nigeria, perhaps, commercial agriculture was largely absent in the areas, this is partly because most people dwelling in rural areas are poor, characterized by low income, large family size, lack of adequate formal education, low savings and investment, lack of access to credit facilities and use of crude farm implements.

Arable crop farmers have limited access (ability and entitlement to borrow from a credit source) and/or participation (the actual borrowing) in credit/loan facilities [10] resulting to inadequate production resources. These farmers are excluded from formal lending institutions to finance their small farm holdings because of the stringent conditions placed on their ways to access credit from the conventional banks [11].

Agricultural credit financing has been identified as a means of transforming the agricultural sector and revamping the Nigeria economy.

However, the difficulty of smallholder farmers who produce more than 90 percent of domestic food supply to participate in agricultural credits/loans has remained a fundamental problem.

Sub-Saharan African agriculture generally suffers this fate and this explains the socioeconomic characteristics of farmers and the nature and state of agricultural production across the African sub region.

Based on the foregoing, this study assessed accessibility of farm credit by arable crop farmers in Odo-otin Local Government Area, Osun State, Nigeria.

Objective of the study

The major objective of the study was to assess the accessibility of farm credit by arable crop farmers in Odo-otin Local Government Area, Osun State.

The specific objectives were to:

(i) describe the socio economic characteristics of the arable crop farmers in the study area;

(ii) determine the level of accessibility of farm credit by the arable crop farmers in the study area; and

(iii) determine the constraints to accessing agricultural credit in the study area.

Hypothesis of the study

There is no significant relationship between the level of farm credit accessibility and socio-economic characteristics of the arable crop farmers.

MATERIALS AND METHODS

The study was carried out in Odo-Otin Local Government Area in Osun State. The Local Government Area has its headquarters in the town of Okuku. It has an area of 294 km² and a population of 134,110 [9]. Multi stage sampling procedure was used in the study. The first stage involved purposive selection of two wards out of the seven wards in the local government area, due to high proportion of arable farmers in the wards. The second stage involved random selection of three villages each from the two wards selected to make a total of six villages. The last stage involved random selection of twenty (20) arable crop farmers from each of the villages to make a total of 120 arable crop farmers. Primary data were used in this study. The data were collected through the use of a well-structured interview and were subjected to percentage, mean scores, and standard deviation, chi-square and PPMC analyses.

RESULTS AND DISCUSSIONS

Socio-economic characteristics of arable crop farmers

Results in Table 1 showed that the mean age of the arable crop farmers was 53.04 years ± 13.48 years. This implies that most of the arable crop farmers were middle-aged and were still in their productive age. This conforms to [2] that the arable crop farmers in the study area were strong and agile. The results further showed that majority (75.8%) of the arable crop farmers were male, while 24.2% of the arable crop farmers were female. This implies that farming is a male dominated enterprise in the study area. This conforms to [7] results, that male acquire agricultural credits than female. This result is also in consonance with the norm where males are expected to take control of arable crops production while the female are expected to take control of the home management. The results further showed that majority (85.8%) of the arable crop farmer were married, this implies that majority of the arable crop farmers in the study area had marital with relationships and as such have responsibilities to cater for.

Table 1. Distribution of the arable crop farmers according to their socio-economic characteristics (n = 120)

Characteristics	Percentage	Mean
Age (in years)		
≤30	7.5	**53.04 ±13.48 years**
31-60	55.0	
≥61	37.5	
Sex		
Male	75.8	
Female	24.2	
Marital status		
Single	4.20	
Married	85.8	
Separated	0.8	
Divorced	5.0	
Widowed	4.2	
Household size		
1-5	23.3	**8 persons per household**
6-10	54.2	
11-15	22.5	
Level of education		
No formal education	9.2	
Primary	23.3	
Secondary	47.5	
Tertiary	20.0	
Years of formal education (in years)		
0	9.20	**10.0 years**
1-6	23.3	
7-12	47.5	
13-18	20	
Farming experience (years)		
1-10	36.7	**19.9 years**
11-20	30.8	
21-30	9.2	
31-40	10.0	
Above 40	13.3	
Farm size (hectares)		
1-5	57.5	**5.5 hectares**
6-10	28.3	
11-15	14.2	
Membership in cooperative societies		
Yes	95.8	
No	4.2	

Source: Field Survey, 2020.

This might not be unconnected with reliance on the family as a source of labor, the result is consistent with [7] and [8]. The results further showed that the mean household was 8 persons, which indicates that each household had at least 8 persons as members. This implies that arable crop farmers in the study area had medium number of households which may serves as labor in their respective occupations. The results further showed that the mean year of formal education was 10. 0 years. These results imply that arable crop farmers in the study area had good access to formal education. The results further showed that the mean farm experience was 19.9 years, this implies that majority of the arable crop farmers had been into farming for a long time and as such may be able to make optimum decision in their respective occupations. The results further showed that the mean farm size was 5.5 hectares. The results further showed that majority, (95.8%) of the arable crop farmers were members of cooperative societies, while few (4.20%) were not members of cooperative societies. The high membership may be as a result of derivation of benefit from the association.

Frequency of access to farm credit in a year

Results in Table 2 revealed that some, (43.30%) of the arable crop farmers accessed credit twice, 40.0 percent accessed credit once while few (16.70%) accessed credit three times in a year. This implies that the arable crop farmers had access to credit at least twice out of their time(s) of request.

Table 2. Distribution of arable crop farmers according to frequency of access to farm credit in a year (n = 120)

Frequency	Percentage (%)
1	40.00
2	43.30
3	16.70

Source: Field Survey, 2020.

Level of access to farm credit

Results in Table 3 showed that only few (16.7%) of the arable crop farmers indicated high level of farm credit accessibility, majority (83.3%) indicated moderate level of farm credit accessibility and 0% indicated low level of farm credit accessibility.

Table 3. Distribution of arable crop farmers according to level of farm credit accessibility in a year (n=120)

Level of farm credit accessibility	Values	Percentage (%)
High	> 2.49	16.7
Moderate	Btw 2.49- and 1.05	83.3
Low	< 1.05	0.0

Source: Field Survey, 2020.

This shows that there was moderate level of credit accessibility by the arable crop farmers.

Constraints to accessing farm credit

Results in Table 4 revealed that delay in approval/disbursement with a mean score of 4.85 and lack of collateral with a mean score of 4.58 were the main constraint to accessing credit in the study area, falling approximately in the strongly agreed scale. This was followed by high interest rate and unavailability of farm credit with a mean score of 4.4 and 4.3 respectively, which falls approximately in the agreed scale. Inadequate capital and lack of guarantor also have considerable scale of 3 (Undecided) with mean score of 3.84 and 3.42 respectively.

However, the least severe constraint to accessing farm credit identified by the arable crop farmers was poor harvest and distance from source with mean scores of 3.17 and 3.08 of respectively. Conformably, [7] also reported that lack of collateral and delay in approval were the main constraints to access to credit.

Table 4. Constraints to accessing farm credit (n = 120)

Constraints	Mean score	Rank
Delay in approval/disbursement	4.85	1st
Lack of collateral	4.58	2nd
High interest rate	4.4	3rd
Unavailability of farm credit	4.3	4th
Inadequate information on farm credit	3.84	5th
Lack of guarantor	3.42	6th
Poor harvest	3.17	7th
Distance from source of credit	3.08	8th

Source: Field Survey, 2020.

Test of hypothesis

Results in Table 5 show the result of chi-square analysis of association between accessibility of farm credit and selected socio-economic characteristics of the respondents. The results show significant association between accessibility of farm credit and sex (χ^2=14.219, p=0.001), level of education (χ^2=11.530, p=0.073), types of arable crops grown (χ^2=14.488, p=0.025) and land acquisition pattern (χ^2=26.603, p=0.000).

Sex had a significant association with accessibility of farm credit. This implied that accessibility of farm credit varies between male and female arable crop farmers. This may be due to the fact that male farmers have the tendency to have more farmland, hence get engaged in farming more than their female. This result might also be due to the fact that majority, 75.8 per cent of the respondents as observed from the study were males who might be assumed to be physically active engaging in different economic livelihood activities. This implied that the higher the number of male arable crop farmers, the higher the accessibility of farm credit.

Level of education also had a significant association with accessibility of farm credit. This implied that level of education varies among respondents with various levels of education sampled for the study; 23.3 per cent had Primary six certificates, 47.5 per cent had Secondary school certificates, and 20.0 per cent had Tertiary school certificates. This result agrees with that of [12] which revealed that access to farm credit increased with education among farmers. The implication of this result is that the higher the level of education of farmers, the higher their likelihood of accessing credit for their farm operations.

Types of arable crops grown also had a significant association with accessibility of farm credit. This implied that accessibility of farm credit varied among farmers based the types of arable crops grown. This result might also be due to the fact that maize was the most grown arable crop in the study area (42.50%). This result means that the more the arable crop farmers engage in growing maize, the higher the likelihood of accessing farm credit.

Land acquisition pattern also had a significant association with accessibility of farm credit. This implied that accessibility of farm credit varied among farmers based on their farmland acquisition pattern. This result might also be due to the fact that lease was the most employed form of land acquisition pattern in the study area (41.7%). This result shows that acquisition of land used for farming activities through lease will favour the accessibility of farm credit, meaning that the more the arable crop farmers acquire land used for farming activities through lease, the higher the likelihood of accessing farm credit.

Table 5. Chi-square analysis showing the association between accessibility of farm credit and selected socio-economic characteristics of the arable crop farmers (n=120)

Variables	χ^2 - value	Df	P-value	Decision
Sex	14.219	2	0.001	Significant
Marital status	9.258	5	0.321	Not significant
Religion	1.358	4	0.851	Not significant
Level of education	11.530	6	0.073	Significant
Types of arable crops grown	14.488	6	0.025	Significant
Land acquisition pattern	26.603	6	0.000	Significant
Source of farming inputs	2.471	6	0.650	Not significant
Source of farm credit	13.607	8	0.110	Not significant

Source: Field Survey, 2020.

Results in Table 6 show the PPMC analysis of relationship between the accessibility of farm credit and selected socio-economic characteristics of the respondents. The results show a positive and significant relationship between accessibility of farm credit and age (r=0.527; p= 0.000), household size (r=0.426, p= 0.000), farming experience (r=0.436, p=0.000) and farm size (r=0.518, p=0.000).

Age had a significant and positive relationship with accessibility of farm credit implies that as the arable crop farmer gets older, his involvement in farming activities and his ability to access credit increases because some credit agencies will prefer to give loan to older farmers than younger ones.

Household size had a significant and positive relationship with accessibility of farm credit.

This implies that as the number of household size of the farmer increases and they get engaged in farming activities, the more the tendency of farmers to access farm credit.
Farming experience also had significant and positive relationship with accessibility of farm credit. This might also be due to the fact that most the respondents as observed from the study had relatively extensive farming experience. This implied that increase in years of farming experience will lead to increase in accessibility of farm credit.
Also, farm size had positive and significant relationship with accessibility of farm credit. This implies that the bigger the size of a particular farm, the easier for the farmer to access more credit from the credit institution. The increase in size of farm would lead to an increase in credit accessibility and in turn increase productivity.

Table 6. PPMC analysis showing the relationship between accessibility of farm credit and selected socio-economic characteristics of the arable crop farmers (n=120)

Variables	r - value	P-value	Decision
Age	0.527	0.000	Significant
Household size	0.426	0.000	Significant
Years spent in formal schooling	-0.259	0.004	Significant
Farming as primary occupation	-0.389	0.000	Significant
Farming experience	0.436	0.000	Significant
Farm size	0.518	0.000	Significant
Household headship	-0.390	0.000	Significant
Membership of cooperative society	-0.165	0.072	Not significant

Source: Field Survey, 2020.

The implication of these findings is that sex, level of education, types of arable crops grown, land acquisition pattern, age, household size, farming experience and farm size should be considered by farm credit lending institutions in granting farm credit to arable crop farmers in the study area.

CONCLUSIONS

From the findings it was concluded that there was moderate level of credit accessibility by the arable crop farmers, delay in approval/disbursement, lack of collateral, high interest rate and unavailability of farm credit delay were major constraints to accessing farm credit. Also, based on study findings, it was recommended that the arable crop farmers should increase their scale of farming in order to have better access to farm credit, government should provide enough farm credit at low interest rate for the arable crop farmers in the study area and the arable crop farmers should organize themselves into cooperative groups in order to have short term and quick access to farm credit.

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ANALYSIS OF THE IMPACT OF RURAL DEVELOPMENT PROJECTS ON LOCAL COMMUNITIES

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Abstract

Considering the huge economic and social disparities between urban and rural areas of Romania, it is important to investigate the local community perception on the perceived impact of the rural development strategies, provided that local strategies should be developed based on citizens' needs. The study represents a first step towards a more complex research to evaluate the degree of satisfaction and wellbeing of the rural communities from Cluj County, following the implementation of the rural development programs. The research was conducted on the basis of primary data obtained from citizens of Cuzdrioara, a commune from Cluj County which represents a particular case, as its position allows the direct connection to national roads. The data were analyzed using descriptive statistics and inferential statistics. The Chi-square test and Fisher's exact test were performed for comparisons of proportions, while Mann-Whitney test and Kruskal Wallis test were used for the comparisons of scale scores between respondents. Through the objectives of the Local Development Strategy, Cuzdrioara commune aims to improve the way of life of the inhabitants by achieving the objectives proposed in the strategy. Many projects have been completed, being positively assessed by the citizens. The public administration fulfilled the objectives established in the Local Development Strategy.

Key words**:** *sustainable development, standard of living, local development programs*

INTRODUCTION

In Romania there are still huge economic and social disparities between urban and rural areas [40]. It is worth considering that 87.1% of the total 238,391 km^2 surface is represented by rural areas and that 45.0% [24] of the population lives in rural area. Hence, the necessity of rural development projects is paramount [32]. The European Union included rural development into the European strategic policy and starting with 2005, it has officially created a special organism (European Agriculture Fund for Rural Development) to finance the rural area and support the investments following three major directions: increasing agriculture and forestry competitiveness, improving the environment throughout a more efficient land management and increasing the quality of life in rural areas by encouraging economic activities [36]. A direct and logical consequence of implementing the rural development concept within the European policy is creating the adequate means of measurement in order to create and implement future improved strategies [8]. Simms et al. [39] built an index of local (rural) economic development – the rural economic capacity- RECI - tested in rural communities in Newfoundland and Labrador (Canada), trying to provide these communities with a useful tool for identifying strengths and weaknesses, as once identified, the community can base its strategic planning process, namely the necessary measures for development. The International Development Association (IDA) created the Rural Access Index (RAI) in order to measure community development starting from the premise that isolation and lack of transport connections are the main reasons for poverty. Since the isolation of communities is considered a major factor leading to poverty and marginalization. [37]. A similar rural index was developed in China, but from a spatial-temporal perspective [18, 19] and a more complex one in Poland [23]. The Romanian Academy of Economic Studies developed an index for evaluating rural potential based on five dimensions and classified rural communes according to these dimensions [1].

At a global level, “Agenda 21” represented the programmatic document which drew the lines of sustainable development so that each generation could benefit from world resources. The process of implementing Local Agenda 21 encouraged the participation of the whole community (business environment, governmental and non-governmental organizations and individual citizens), on the premises that sustainable development refers to long-term planning and recognizes the interdependence between social, economic and environmental factors in affecting health and quality of life. The Local Agenda 21 tools are: ”the Local Sustainable Development Strategy”, the “Local Action Plan” and the “Priority Projects Portfolio”[44].The National Development Plan is a specific concept of the European Cohesion Policy that pursues the balanced development of the Union's members by reducing development disparities between Member States/ regions of the Community. The European Commission's proposals on the management of the Structural Funds during the 2014-2020 programming period reflect an increased reorientation in support of efforts to achieve the Lisbon and Gothenburg key objectives, namely, increasing competitiveness, full and sustainable employment and environmental protection.

The Romanian development strategy comprised in the National Development Plan (NDP) 2014-2020 [30] focuses on the same objectives, particularly increasing economic competitiveness; the development and modernization of transport infrastructure; protecting and improving the quality of the environment; developing human resources, increasing employment and combating social exclusion; developing rural economy and increasing productivity in the agricultural sector; and support the balanced participation of all regions of Romania in the process of socio-economic development. The regional development strategy is linked to Community policies and regulations, as well as to national development strategies. Its priority objectives are mainly focused on the areas of intervention of the Structural Instruments and the European funds that finance rural development and fisheries. It was estimated that by year 2020, disparities between the North-West region and the other regions of the country will be reduced in order to increase the standard of living of citizens [13].

Alongside these official objectives, it is required to investigate community perception on the perceived impact of the rural development strategies, provided that local strategies are built or should be built according to the citizens’ needs [20]. Practice proved that participation was recognized to be an essential phase in building strategies for reducing wastages and a proper allocation of resources depending on sensitive domains [6, 18, 32] even if social obstacles often exist [45]. To our knowledge (as far as one can tell from the literature), a similar research involving the analysis of the community perception on the impact of the Local Development Strategies based on primary data collection has not been conducted in the North-West region to this date, even if the rural area drew the attention of other scholars [33, 40, 41].

Therefore, the objectives of the research were: (1) the analysis of residents’ perception regarding the current state of fact in the Cuzdrioara Commune and (2) to identify the impact of the rural development strategies on the wellbeing of the community and on its sustainable development.

Public perception on sustainable rural development projects is crucial [6, 10, 15, 18, 32, 46], and must undergo thorough analysis, mostly because it has been observed that it is generally at the beginning that projects benefit from local support, but when restrictions arise and the consequences for their wellbeing are not very obvious, the support decreases [27] and sometimes conflicts appear. This aspect is neglected most of the time. Public participation, as a consequence of favorable perception on development project is a key-factor for building sustainable programs [25]. Community perceptions are also indicators which could be of a great help for policy-makers, facilitating the tracking of rural development progress and adjust it in time [6]. In order to achieve sustainability, it is believed that communities must be allowed to evolve in local organizations that could satisfy their local needs [9]. The need of public consensus was acknowledged by authorities in different countries. In the United Kingdom, The National Infrastructure Commission was in chargeof building the national strategy for infrastructure in order to maintain the national competitiveness, understanding that community perception and consensus are vital, alongside the support of the authorities [11]. It is believed that a better civic engagement from the locals could lead to better and equitable results [21]. Locals' perceptions are sometimes surprising: a study analyzing the community perception from Canada highlighted a huge ignorance regarding community development [29].

The huge importance of a perception survey was recognized in both stages of an intervention action: before implementing a project in order to match it with actual and real needs of the community, and after the intervention to assess its impact [6]. For example, analyzing public perceptions on forestry projects in Panama was the key to improve the project design and management [17, 31]. Willingness to participate in community development projects was seldom visible in different communities, and not only for future projects, but also for the ongoing ones, as people understand that general projects are the precondition of their personal wellbeing [15]. There are cases when development projects are perceived as Government responsibility and the community does not interfere [14].

The quality of life among the Romanian communes has often been studied [33, 40, 41, 43]. Scholars focused on the economic development of the rural communities in the North-West region of Romania, observing the pace of evolution for communities which had access to different financial resources. A study conducted among the peripheral communes of Cluj County [40] revealed that the major problems for the community are represented by the lack of infrastructure, shops and water. Similar results were obtained by other scholars [6, 31], which underlined that rural roads generate the largest impact in rural development index and income growth [6]. Another study was conducted in Vultureni Commune from Cluj County in order to analyze the community perception on implementing the concept of ecovillage, which revealed some generalized issues in the Romanian rural areas, particularly the lack of community trust in authorities, the lack of civic education [41].

With regards to the influence of socio-demographic variables on the perception regarding rural development programs it has been observed that these variables can have a significant influence on the perception regarding rural development programs. A social issue may sometimes arise from the women's role in the rural society, which sometimes represents a serious barrier for participation [2, 7, 35, 48]. With regards to gender, differences between the social situation and involvement in the public life were observed among the rural population of the member states of the European Union. While in the North-West countries women are more involved in the public life and have an active role within the public decision-making structures, the situation is quite different for women from the South-East countries including Romania [2]. In these areas, women perceive the quality of life as unsatisfactory because of lower incomes and lack of social services [7]. For example, in a rural area of Turkey, there is a problem regarding women's lack of knowledge about rural development programs or tourism, even if there is a positive approach to visitors because of the perceived link between tourism incomes and development [2]. Related to tourism support, Mensah concluded that income and gender are the only variables which directly influence community participation, men being more participative than women [22], while Wang and Pfister [49] highlight that the female population is more supportive of the cultural aspects of tourism (art and crafts). Education is another issue in rural communities, as it was observed by Vixathep [48], it is often the privilege of men and therefore the limitation of women to public life becomes obvious.

MATERIALS AND METHODS

The present study represents a first step towards a more complex research to evaluate the degree of satisfaction and wellbeing of the rural communities from Cluj County, following the implementation of the rural development programs. The research was conducted on the basis of primary data obtained from citizens of Cuzdrioara, a commune from Cluj County which represents a particular case, as its position allows the direct connection to national roads. This aspect is considered essential for a reasonable increase of wellbeing given that connectivity represents a key factor for economic development [37].

Among the 2,861 communes in Romania, the Cuzdrioara Commune occupies the 724th place according to its socio-economic development potential which was determined using five major factors, such as the endogenous potential, physical-geographical characteristics, human capital, economy and technical-utilitarian equipment [1].

The commune is situated on the Somesan Plateau in the middle of the Somes River, in the north-eastern part of Cluj County, bordering Bistrita-Nasaud County to the east, the commune of Mica to the south, the municipality of Dej to the west and Caseiu commune to the north. The administrative territory of the commune consists of three localities: Cuzdrioara (residence), Manasturel and Valea Girboului, villages 3 km and 6 km respectively from the administrative center. The commune stretches over an area of 23.96 square kilometers [1].

The Local Sustainable Development Strategy 2014-2020 [15] of the Cuzdrioara commune is a complex document that provisions the vision and the way the local community aims to increase the quality of life of the commune's inhabitants. It is a flexible and dynamic working document, developed through a participatory process of the local community in accordance with the national development priorities contained in the National Development Plan. The strategy was developed based on the experience gained in the Local Agenda 21 project, applying a methodology to the local public administration of Cuzdrioara, and it is a programmatic document that responds to citizens' needs and makes them responsible both of the design phase and in its implementation. The local sustainable strategy is the document that indicates the path to achieve sustainable development [20].

A survey based on a questionnaire was conducted in order to achieve the objectives of the paper. The study aimed at measuring the perceptions of the rural residents regarding the benefits/impact of the development project through a questionnaire applied to 121 respondents, from Cuzdrionara, during a period of three months from February to April 2019. The questionnaire used consisted of three parts: (1): respondents' evaluation of the main problems of their commune; (2): evaluation of the impact of the implemented projects; (3): socio-demographic characteristics of the respondents. The convenience sampling method was used, due to its cost-effectiveness advantage i.e. the respondents were relatively easy to reach.

The data were analyzed using descriptive statistics and inferential statistics to investigate possible differences among respondents regarding demographic variables. The Chi-square test and Fisher's exact test (where appropriate) were performed for comparisons of proportions, while Mann-Whitney test and Kruskal Wallis test were used for the comparisons of scale scores between respondents. Intercooled STATA 10 was used for all statistical analyses (STATA

Corp., College Station, TX). A p-value of ≤ 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

Socio-demographic profile of respondents show that the sample is gender balanced. The young segment of respondents (18–33 years) is represented by almost half of respondents (43.8%), followed by the group aged 34-49 years, which represents 39.7% of the total sample. Respondents aged between 50 to 65 years old held only 14% of the respondents, while elders (aged 65+) held the smallest percentage of 2.5%. The sample is educated, since 65.3% of the respondents graduated from high school and 27.3% held a university degree (Table 1).

Table 1. Socio-demographic characteristics of the respondents

Variables	**%**
Gender	
Female	52.1
Male	48.9
Age	
18-33 years	43.8
34-49 years	39.7
50-65 years	14.0
>65 yeas	2.5
Education	
Less than high school	7.4
High school	65.3
Post-high school/University degree	27.3

Source: Own calculation on the basis of data from questionnaire.

From the point of view of rural development, the three main problems at community level mentioned by the respondents are: "street and pavement rehabilitation", "sewerage network" and the "renovation of the healthcare center". Regarding the main issue, "the streets and pavement rehabilitation", there are no significant differences between gendersand education levels ($p>0.05$), but it represents a major problem for respondents younger than 49 years ($p<0.05$). However, the importance for the other two issues is perceived differently, male residents are more concerned about the sewer network, while women care more about the renovation of the healthcare center, no significant differences were found with regard to the age categories and education level. Age has a direct influence on considering aspects of street and pavement rehabilitation and the sewer network ($p<0.05$). For people under the age of 50, these are priority directions, compared to the more invisible ones. Statistically significant differences were found among gender, age categories and education levels ($p<0.05$), males, young and more educated respondents being the most concerned regarding the sewage network. Females are concern about the renovation of healthcare center ($p<0.05$). No significant differences were found with regard to the age categories and education level and the renovation of the healthcare center ($p>0.05$) (Table 2).

Residents' perceptions regarding the main problems of the commune in terms of sustainable development were analyzed with the help of 10 items (Tables 3 and 4). The analyzed items were divided into three sections: (1) environment, which comprised two items (Sewage network and Sanitation); (2) economic with 2 items (Tourist promotion and Agricultural equipment); (3) social comprising 7 items (Drinking water supply, Public illumination, Roads and pavements, Agricultural roads rehabilitation, Medical supplies from the healthcare center, Playground and sports base). The selection of each item included into the analysis was based on the main problems identified in the commune development strategy for 2014-2020. At the same time, it was noticed that for most of the problems mentioned, a project was submitted in order to improve the situation registered in 2014. The results indicated that the respondents were mainly satisfied with the following aspects: public illumination (90%), agricultural roads rehabilitation (85.1%), playground and sports base (94.2%) and tourism promotion (41.3%).

Table 2. Residents' ranking of the main problems existing in the community

Characteristics	Street and pavement rehabilitation **N=114**			Sewerage network **N=102**			Renovation of the healthcare center **N=98**		
Level of importance	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Gender									
Female	27(47.4%)	26(55.3%)	6(60.0%)	16(43.2%)	17(43.6%)	19(73.1%)	14(93.3%)	13(59.1%)	26(42.6%)
Male	30(52.6%)	21(44.7%)	4(40.0%)	21(56.8%)	22(56.4%)	7(26.9%)	1(6.7%)	9(40.9%)	35(57.4%)
	χ^2=0.9506, df=2, p=0.622 Fisher' exact = 0.615			χ^2=6.8186*, df=2, p=0.033			χ^2=12.7537***, df=2, p=0.001		
Age									
18-33 years	18(31.6%)	24(51.1%)	7(70.0%)	20(54.1%)	16(41.0%)	9(34.6%)	8(53.3%)	7(31.8%)	25(41.0%)
34-49 years	23(40.4%)	21(44.7%)	1(10.0%)	16(43.2%)	15(38.5%)	10(38.5%)	5(33.3%)	8(36.4%)	30(49.2%)
50-65 years	14(24.6%)	1(2.1%)	2(20.0%)	1(2.7%)	8(20.5%)	5(19.2%)	1(6.7%)	5(22.7%)	6(9.8%)
>65 yeas	2(3.5%)	1(2.1%)	0(0.0%)	0(0.0%)	0(0.0%)	2(7.7%)	1(6.7 %)	2(9.1%)	0(0.0%)
	χ^2=16.0306**, df=6, p=0.014 Fisher' exact = 0.003			χ^2=12.5834*, df=6, p=0.050 Fisher' exact = 0.050			χ^2=9.8283, df=6, p=0.132 Fisher' exact = 0.097		
Education level									
Less than high school	6(10.5%)	2(4.3%)	1(10.0%)	0(0.0%)	3(7.7%)	3(11.5%)	2(13.3%)	3(13.6%)	2(3.3%)
High school	43(75.4%)	29(61.7%)	6(60.0%)	24(64.9%)	32(82.1%)	16(61.5%)	8(53.3%)	13(59.1%)	47(77.1%)
Post-high school/ University degree	8(14.0%)	16(34.0%)	3(30.0%)	13(35.1%)	4(10.1%)	7(26.9%)	5(33.3%)	6(27.3%)	12(19.7%)
	χ^2=6.7071, df=4, p=0.152 Fisher' exact = 0.103			χ^2=10.1724*, df=4, p=0.038 Fisher' exact = 0.019			χ^2=5.9202, df=4, p=0.205 Fisher' exact = 0.124		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own calculation on the basis of data from questionnaire.

Sanitation is also perceived as very good by 86.8% of the respondents, which is encouraging since it is stated to be a fundamental aspect for health and wellbeing [4]. This situation can be explained by the fact that all the projects regarding these aspects of rural development were implemented when the research work was conducted. On the other hand, the respondents were less satisfied with those aspects where the implementation of the projects had not been completed or started at the moment of the interview. The most concerning is the perception on the sewage network, because 87.6% of the respondents expressed an unfavorable opinion about it, but also regarding the medical supplies from the healthcare center (57% of the respondents were disappointed about it). These aspects were also noticed to be among the first three problems of the commune, having a direct impact on the social aspects of its sustainable development and living standard of the community [3, 4, 5, 12, 38].

Previous studies on life quality in Cluj County mention the same lack of satisfaction regarding health facilities [40]. Subsequently, a test was conducted to determine if there are any differences regarding residents' perception towards sustainable rural development and their socio-demographic profile. The results indicated that women were more concerned about the situation of the medical services than the men ($p<0.01$), this can be explained by the fact that women are generally more preoccupied about health [42, 47].

Another issue which was analyzed refers to the residents' perception on the relation between the perceived improvement in the quality of life and the implemented rural development programs. When asked if their standard of living increased during the last years due to the implementation of different development programs such as "rehabilitation of the agricultural road" and the "tourist information center", 94.2% of the respondents agreed that their living standard and wellbeing of the community is better, compared with the beginning of 2014 (the first year of the development strategy). The quality of life was previously analyzed based solely on statistical indicators and not on the residents' direct responses and perceptions [33, 40, 41, 43]. Furthermore the importance of the two main programs implemented and their possible effects were analyzed (Table 5). It was observed that the respondents consider that the rehabilitation of the agricultural road is very important (means=5.77, SD=1.56), especially for the male respondents (mean=6.29, SD=1.12) and those older than 50 years (mean=6.58, SD=1.00). This is not surprising at all, since men are generally more involved in agricultural activities than women [26] At the same time, agriculture represents the main activity for elderly people in the research area [34].

Table 3. Residents' perception on the sustainable rural development aspects from Cuzdrioara

	Dissapointing		Pretty good		Very good		I can not appreciate	
Environment component								
Sewage network	106	87.6%	4	3.3%	4	3.3%	7	5.8%
Sanitation	0	0.0%	15	12.4%	105	86.8%	1	0.8%
Economic component								
Tourist promotion	11	9.1%	26	21.5%	50	41.3%	34	28.1%
Agricultural equipment	47	38.8%	33	27.3%	9	7.4%	32	26.5%
Social component								
Drinking water supply	0	0.0%	9	7.4%	112	92.6%	0	0.0%
Public illumination	0	0.0%	12	9.9%	109	90.1%	0	0.0%
Roads and pavements	82	67.8%	28	23.1%	8	6.6%	3	2.5%
Agricultural roads rehabilitation	2	1.7%	13	10.7%	103	85.1%	3	2.5%
Medical supplies from the healthcare center	69	57.0%	39	32.2%	8	6.6%	5	4.1%
Playground and sports base	0	0.0%	5	4.1%	114	94.2%	2	1.7%

Source: Own calculation on the basis of data from questionnaire.

Table 4. Tests on differences between socio-demographic characteristics of the residents regarding the perception on sustainable rural development aspects

Components	Independent variables		
	Gender	Age	Education
Environment component			
Sewage network	n/a	n/a	n/a
Sanitation	n/a	n/a	n/a
Economic component			
Tourist promotion	n/a	n/a	n/a
Agricultural equipment	n/a	n/a	n/a
Social component			
Drinking water supply	n/a	n/a	n/a
Public illumination	n/a	n/a	n/a
Roads and pavements	n/a	χ^2=18.962*, df=9, p=0.026	n/a
Agricultural roads rehabilitation	n/a	n/a	n/a
Medical supplies from the healthcare center	χ^2=1.465**, df=3, p=0.002	n/a	n/a
Playground and sports base	n/a	χ^2=13.698*, df=6, p=0.033	n/a

* $p < 0.05$, ** $p < 0.01$

Source: Own calculation on the basis of data from questionnaire.

Table 5. Locals' perception on the importance of the implemented programs

Program	Min	Max	Mean	SD
Rehabilitation of the agricultural road	1	7	5.77	1.56
More investors because of agricultural roads rehabilitation	1	7	5.81	1.32
Tourist information center	1	7	5.62	1.64

Source: Own calculation on the basis of data from questionnaire.

Table 6. Residents' perception on the implemented programs

Variables	N=121	Rehabilitation of the agricultural roads	More investors because of agricultural roads rehabilitation	Tourist information center promotes commune values sufficiently well
Gender	Female	5.30 (1.75)	5.79(1.49)	5.98(1.44)
	Male	6.29 (1.12)	5.84(1.12)	5.22(1.77)
		Z=3.270***,p=0.001	Z=0.451, p=0.652	Z=2.779**, p=0.005
Age	18-33 years	5.28(1.75)	5.49(1.55)	5.21(1.77)
	34-49 years	5.97(1.36)	5.92(1.12)	5.73(1.50)
	50-65 years	6.58(1.00)	6.41(0.79)	6.35(1.41)
	>65 yeas	6.67(0.58)	6.67(0.58)	7.00(0.00)
		χ^2=11.866**, df=3, p=0.008	χ^2=7.222, df=3, p=0.065	χ^2=13.425**, df=3, p=0.004
Education level	Less than high school	6.55(1.01)	6.33(0.71)	6.22(1.71)
	High school	5.89(1.41)	5.81(1.08)	5.52(1.65)
	Post-high school/ University degree	5.27(1.89)	5.69(1.86)	5.70(1.63)
		χ^2=4.64, df=2, p=0.096	χ^2=1.974, df=2, p=0.373	χ^2=3.675, df=2, p=0.159

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own calculation on the basis of data from questionnaire.

For male respondents, it is more important that the streets have been paved, but it still represents a problem (Table 6). The older ones think it's good that they are asphalted, but young people still see it as a problem (see previous tables). There were other scholars who also mentioned the importance of roads for sustainable development [6, 33]. The existence of a tourist information center promoting the area is more important for women than for men. This can be explained by the fact that tourism represents an employment alternative for women in the rural area [16, 22]. Previous researches observed also that the female population tends to be more supportive of tourism activities [28, 49]. With respect to the age, it was observed that respondents over 50 years old perceived the importance of the tourism information center better, as well as road habilitation, due mainly to the increasing standard of living, and lack of other options (employment, migration) outside of the community [16] (Table 6).

CONCLUSIONS

Through the objectives of the Local Development Strategy, Cuzdrioara commune aims to improve the way of life of the inhabitants by achieving the objectives proposed in the strategy. After the analysis on the implementation of the Rural Development Strategy was found, the opinion of the locals was assessed about the projects conducted at the level of the commune. Out of the 38 projects proposed in the Development Strategy, up to 2018, 13 projects have been completed and by 2020 the total number of completed projects will reach 19. The three major problems (asphalting of streets and pavement rehabilitation, sewage network and rehabilitation of the healthcare center) perceived by the respondents are also identified in the Rural Development Strategy 2014-2020. For each problem, there is one project under execution. Rehabilitation of the agricultural roads has had a positive impact on the population through easy access to agricultural property, increasing land value and attracting local investors. Public street illumination, a project completed in 2015, brought a high degree of satisfaction to respondents, lower electricity bills, and the Cuzdrioara commune complied with European standards. The playground and sports base rehabilitation contributed to improve health, community relations, easy access and sporting performance, easier access to a relaxation area. The actions undertaken in the Cuzdrioara commune have not been left unobserved by the citizens; the local public administration has been evaluated with a high degree of satisfaction. Many projects were finished, being positively assessed by the citizens. The public administration fulfilled the objectives established in the Local Development Strategy. The impact of the rural development projects was favorably assessed.

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P2P-ACCOMMODATION IMPACT ON THE DEVELOPMENT OF THE RURAL REGIONS IN CHINA, BY THE EXAMPLE OF AIRBNB

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Abstract

Shared accommodation has changed the shape and patterns of tourism industry. China, which has opened its bounds during the last decade, is no exception. It is no doubt that the Chinese government is also steering huge efforts in rural regions through the last years to reduce poverty and to achieve economic and social development. Perceiving the great opportunities that sharing economy provides to governments worldwide, China has adopted, successfully integrated and even supported the sharing economy. P2P-accommodation, as part of the sharing economy, is seen as a chance to generate a positive influence in rural regions. Airbnb is the official partner of the Chinese government in this process and is actively participating in a wide range of activities. The main purpose of this article is to investigate the impact of P2P-accommodation on the Chinese rural regions development taking into consideration Airbnb presence on the market. A 5-step analysis methodology developed by the author is used, which examines the impact of Airbnb on the rural tourism market and how it helps the rural regions development in China. The revealed results show a positive economic impact of the integration of P2P-accommodation in rural regions, a variety of programs and measures to support the development of rural tourism in China and an improved well-being of the rural residents where Airbnb has concentrated its activity. As main conclusion we can underline that the integration of P2P-accommodation in Chinese rural regions has a positive influence helping poverty alleviation, revitalizing rural areas and improving life satisfaction of rural residents in China.

Key words: *development, P2P-accommodation, economic impact, rural tourism, China*

INTRODUCTION

Over the last decade, China has developed dynamically, unprecedented in its speed and scale. At national level, China seeks to abandon its outdated economic and social model and embark on a more balanced path of development. China is currently an influential economic and financial player on the international stage and the EU's second largest trading partner. Unfortunately, the problem of poverty and underdeveloped rural areas in the country remains on the agenda. In recent years, China has made efforts and invested a lot in revitalizing rural areas. Along with agriculture, the Chinese government finds excellent potential in the integration of shared accommodation in rural regions, which could help poverty alleviation, diversify the economic effects of the tourism industry toward rural China and provoke rural tourism to further develop and to provide international standards to tourists. Since Airbnb entered the Chinese market and introduced the P2P-accommodation along with Chinese local platforms, the geographical patterns of the listings have expanded to rural regions and stimulated the domestic tourism giving the tourists an option to have authentic experience, to get to know their culture and roots and to find peaceful surrounding as an escape from the overdeveloped urban areas. In this regard, the main research goal of the present study is to investigate the current and potential impact of Airbnb P2P-accommodation on rural region's development in China in terms of domestic tourism industry.

MATERIALS AND METHODS

The purpose of this research is to investigate the impact of shared accommodation on the development of the Chinese rural regions. Taking into consideration that the worldwide leader in P2P-accommodation is Airbnb,

which presence on the Chinese market is essential in terms and conditions of integration and development of the shared accommodation concept in close partnership with the Chinese government, the basic data refers to Airbnb. The methodology of the current study performs the following steps:
-Investigation of the current state and development prospects of the Chinese tourism with focus on domestic tourism due to the fact that domestic tourists are the major rural tourism practitioners in China.
-Study on history, state and development of rural tourism in China. The positive role that is playing in Chinese economy is to be revealed and the government efforts are to be summarized.
-The impact of the occurrence of Corona virus on the tourism industry in China is to be presented with a further study on the Covid-19 impact on domestic tourism.
-The integration of shared accommodation with a focus on Airbnb is to be investigated as also the current state and development in China and the different kind of activities, programs and partnerships in terms of rural tourism. The impact of Covid-19 on P2P-accommodation in China is to be measured in order to assess whether its recovery is faster than in the tourism field generally.
-Measurement of Airbnb's P2P-accommodation impact on rural regions development – taking in consideration poverty alleviation (Disposable Income of Rural Households by Selected Region of steady Airbnb presence); the tendencies in Poverty Conditions in rural areas in China, the trends in domestic tourism development and the intensity of Covid-19 recovery in a post pandemic situation.
The information used for the analysis is collected from official statements, publications and information bulletins of UNWTO, WTTC, National Bureau of Statistics in China and Airbnb China. The indicators are additionally synthesized till gaining indicators of significant information such as rate of increase/decrease, proportion rates and average value (mean and median). The information is further analysed with descriptive statistics such as summary and univariate analysis.

RESULTS AND DISCUSSIONS

Development of Chinese Tourism

Tourism in China has become one of the important industries in the structure of the national economy. Over the last few decades the tourist flows from and to the country and the domestic trips have significantly increased. Among the drivers, which led to this positive impact, as most important we can indicate the following:
-The appearance of a newly rich middle class.
-The easing of restrictions on movement by the Chinese authorities, especially for outbound tourism.
-The important role of China's government in building the necessary foundation for tourism development – transport (roads and railways), accommodation and catering establishments etc., complying with the international standards in tourism
As a result since 2012 Chinese ***outbound tourists*** are perceived as the greatest financial supporter for global tourism industry, forming 21% of the world's international tourism spending (USD 277 billion) for 2018. Considering ***inbound tourism***, in 2018 China is pointed out to be the fourth most visited country in the world after France, Spain and the United States. In 2018 China counted 62.9 million international tourist arrivals and performed steady increase of 3.6% compared to the previous 2017. For the same year the international tourism receipts are measured to be USD 40.4 million, which also indicated significant increase of 4.7% for the last 12 months[15]. At national level, tourism in China contributed USD 1.35 trillion to the national economy or 11% of China's GDP for 2018, which has almost doubled value as it was 6% in 2008. Moreover, tourism in China generated directly and indirectly employments of 28.25 million people, who were engaged in tourist services and the connected activities for the near 139.5 million inbound trips and five billion domestic trips in 2017 [3]. As we can conclude, the dynamics of production in tourism determine the dynamics of

employment and wages of employees in this sector [18].

Table 1. Performance of Chinese tourism, 2018

Indicator	Value
Inbound Tourism	141.2 million arrivals
Inbound tourism revenue	USD 127.3 billion
Outbound tourism	162 million trips
Domestic tourism	5.5 billion trips
Domestic tourism revenue	CNY 5.1 trillion
Total revenue	CNY 5.98 trillion

Source: [3].

The main preconditions for this dynamic process in Chinese tourism can be found in the opening of the Chinese economy and especially with the adoption of the Approved Destination Status (ADS) program in 1995. This initially allowed Chinese tourists to travel to a small number of state-approved destinations, but subsequently expanded the list of potential receptive destination significantly [6]. In our opinion, this opening process can be conditionally divided into three main phases:

-*First phase (mid-80s to early 90s of the 20th century)* – characterized by allowing travel of Chinese citizens abroad. Several Asian countries neighboring China have been approved, but travel purposes are limited to family visits. Business or private sector trips are also allowed, as well as cultural exchanges, including travel by scientists and participants in seminars and exhibitions.

-*Second phase (mid-1990s to 2010)* – adoption of the program for approved destinations, which expands the range of potential receptive tourist destinations. Licensing of a number of travel agencies that are allowed to organize group visits, usually to several foreign destinations. It is noteworthy that the visits are relatively short and the sights at place are viewed "quickly", thus limiting the contact with the locals and local lifestyle. The period is characterized by low incomes of tourists, strict tourist regulations, high language barrier and lack of experience in traveling abroad.

-*Third phase (from 2010 until now)* – characterized by increased incomes of Chinese citizens, who are beginning to spend more time on leisure and travel. The Chinese already have more travel experience, with a significantly larger number of destinations available (153 destinations/regions). Visa requirements have been eased for both Chinese outbound tourists and China's inbound tourists. Remarkably increased marketing activities of China's receptive destinations are to be reported as China is already a significant outbound tourist market. Thus, considerable qualitative changes in Chinese international tourism can be noticed. According to official data, individual travelers have already displaced organized group visits, with the former accounting for 60% of Chinese travelers abroad. Unpopular destinations are already being visited, the emphasis is on getting to know the local way of life, customs and culture, new things are being tried – not only cuisine, but also experiences. This applies in full force to both international and domestic tourism, where *rural forms are preferred*. Some of the most important features in the current profile of Chinese tourists are:

-They are more solvent;
-They are traditionalists;
-They are interested in world landmarks and world events;
-They like local specialties and hot drinks, even in summer;
-70% of them use air transport [13].

Covid-19 and Tourism

The emergence and rapid spread of Covid-19, which has grown into a global pandemic, has caused an unprecedented crisis in tourism industry around the world. Few months after the announcement of the first positive case, the governments were forced to introduce restrictive measures in almost all aspects of human life – personal, social, public, professional. Economically and socially, the world economy has suffered and continues to suffer enormous damage. The appearance of Covid-19 turned out to be one of the most dramatic in the history of tourism.

According to data from the latest report of UNWTO, till the end of October 2020 international tourist arrivals fell by 72% over the same period previous year. The connected loss of export revenues from these 900 million fewer international tourist arrivals is USD 935 billion, which is more than 10 times the loss in 2009 under the impact of the global economic crisis. Specifically, in Asia and the Pacific there were 82% less arrivals during the period considered – the greatest decrease worldwide, which is understandable with China announced to be the primary source of virus spread. Interesting observation at international level is that although international travel shows timid growth, domestic tourism continues to grow in several large markets including China, where domestic flights has returned to pre-pandemic levels. The expected economic loss because of the global crisis in tourism is estimated to be over USD 2 trillion in global GDP, which is more than 2% of the world's GDP in 2019 [16].

Table 2. Decline in international tourist arrivals by month, January – May, 2019/2020 (tourist arrivals in thousands)

Year	JAN	FEB	MAR	APR	MAY
2019	96,563	94,375	107,308	117,957	120,543
2020	98,453	83,408	48,313	3,653	2,837
Change	+2%	-11.6%	-54.9%	-96.9%	-97.7%

Source: [16].

Covid-19 and domestic tourism in China

Due to Covid-19 spread in China, the predicted decline in number of domestic tourists is 43% (3.4 billion people) and the loss in domestic tourism revenue is 52% or for the whole 2020 it will account less than USD 394 billion than in 2019. It is predicted that the effects of the pandemic on the Chinese tourism industry could be severe, which can be easily explained with the reduced paying capacity of the Chinese population because of the affected Chinese economy. On the other hand, reasonable effect on the reduced domestic tourism has also the drop in domestic flights. Chinese airline revenues in the first half of 2020 decreased by 77% compared to 2019 which is directly connected with the reduced domestic demand for air transport – for the first half of 2020 it fell by 62% [7]. Though, the second half of 2020 was more successful for Chinese domestic tourism, which led to partial recovery. Explanation could be found in the well-structured marketing campaigns in China about domestic tourism as a possible way to escape from home after the long lock-down in a number of cities. On the other side, China's domestic tourism has also one big advantage – 1.4 billion Chinese people, who have no other option than travelling within China [4].

Rural Tourism in China

Through the last two decades steady urbanization process is to be observed in China. From 2009 to 2019 the ratio between urban and rural population in China seems to be clearly rebalanced – from 52% rural population and 48% urban population in 2009 to 39% rural population and 61% urban population in 2019 (Fig. 1).

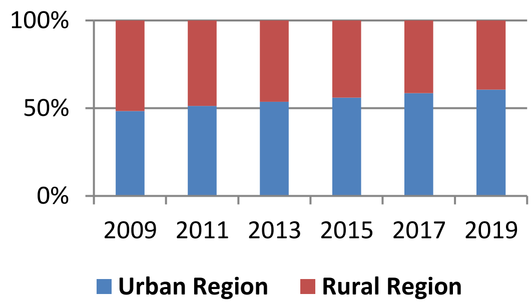

Fig. 1. Urban and rural population of China from 2009 to 2019 (selected years)
Source: [14].

Although big cities offer Chinese residents a lot of professional possibilities and personal comfort, especially for young people and young families, this doesn't mean that their life satisfaction is higher. A study reported that the Chinese people's life satisfaction score decreased from 7.29 in 2004 to 6.96 in 2014 [5]. Conjunctionally, the demand for rural tourism started gradually increasing as rural tourism is seen as a chance to alleviate problems caused by mass tourism in big overdeveloped cities and resorts. Most people living in big Chinese megalopolis are seeking for traditional and calm atmosphere, original and authentic experience and want to go back to the roots. That's the reason why rural tourism in China is one of the most preferable forms of tourism among domestic tourists. It's also important to notice that the evaluation of rural tourism experience is quite different between urban and rural tourists, but both of them are participating in rural tourism development. Moreover, approximately half of China's 55 UNESCO World Heritage Sites are in rural areas, giving rural tourism sector in China great development opportunities. If we could summarize it, rural tourism is generally seen as:

-Alternative to help alleviate problems caused by mass tourism in urban spaces;

-Catalyst for upgrading rural areas;

-Solid foundation for agricultural development;

-Specific way for poverty alleviation in rural areas in China;

-Conductor of cultural multiplication.

The development of rural tourism in China can be described as more dynamic through the last three decades, but with greater intensity since 1988, when China Urban and Rural Tourism Year was firstly introduced by the China National Tourism Administration (CNTA), followed by: China Eco-tourism Year in 1999, Chinese Life Tourism Year in 2004 and China Rural Tourism Year in 2006. After these several marketing campaigns of the Chinese government for promoting rural tourism as a sustainable tourism form [2], from our point of view, the results are excellent. As in 2018 the number of domestic travelers reached 5.54 billion, it is reported that more than a half – approximately 3 billion, were engaged in some form of rural tourism and generated tourism income exceeding CNY 800 billion. Gradually, through the whole period of development a variety of rural tourism-promoted activities, created by CNTA offering both financial incentives and government policy support, have effectively promoted the development of rural tourism in China (Baoren 2011). Moreover, at governmental level a National Rural Tourism Development Program (2009-2015) was introduced to all stakeholders. Based on this national program it was predicted that by the end of 2015 the National Tourism Bureau will have created 1,000 tourist towns and 10,000 characteristic tourism villages across China to promote rural tourism development at national level. The number of rural tourists was predicted to reach 771 million people and Chines rural tourism was challenged to form CNY 114.5 billion giving employment for 989 million people directly and additional 36.8 million indirectly. It was also expected that the average growth of per capita annual net income of farmers who engage in rural tourism will reach 5%. According to official data from CNTA in 2011, the revenue from rural tourism in China accounted for more than CNY 120 billion revenue and offered employment for over 15 million farmers. The last available data, officially announced by the Ministry of Agriculture and Rural Affairs, is for 2019, when rural tourism generated CNY 850 billion and 3.3 billion trips were made to rural areas. In our opinion, for this 10-years period this tremendous growth in rural tourism revenue – over seven times, is partially due to the successful integration of P2P-accommodation in the rural regions [19].

Additionally, another interesting trend is also being observed – more people want to return living in rural villages, attracted by the great opportunities for starting own business in the agricultural or tourism industry. In 2019 the people returned to the countryside were more than 8.5 million and the number of agricultural e-commerce firms exceeded 30,000.

Introducing Airbnb on the Chinese Rural Tourism Market

AirBnB was introduced to the Chinese market in 2009 through the Douban Forum – a social network of young people who exchange ideas and experiences. The posts there discuss mainly the flexibility of the platform in terms of check-in and check-out times. In fact, the earliest Chinese users of the platform are Chinese international tourists in terms of accommodation abroad. Subsequently, the Chinese government sees a valuable opportunity to stimulate GDP, increase tax revenues in the state treasury and create real work and income for more people, which is why it stimulates shared accommodation with a number of policies and regulatory frameworks. Currently, the main share of users are still international Chinese tourists in terms of their accommodation abroad, but with the help of the government, the stimulation of users in the field of domestic and rural tourism is also underway.

The main concurrence of Airbnb in China is the local P2P-platforms, which are very well developed and positioned on the Chinese tourism market. The bigger representatives of the local Chinese P2P-platforms are Tujia, Mayi, Xiaozhu, Muniao, Belvedor, Onehome, Fishtrip, Youtianxia, Ziroomstay, Zizalike. From these, the strongest native competitors for Airbnb in China are presented by Tuija and Xiaozhu [8].

Tujia is one of the most successful Chinese accommodation sharing projects, which according to the latest official figures for 2017 has more than 4,000 employees in nearly 1,350 Chinese and foreign destinations, and the list of shared accommodation units exceeds 400,000.

In terms of Airbnb development in China, highly valuable is the fact that Airbnb is the main partner of the Chinese government in promotion and introduction of the concept for P2P-accommodation among stakeholders at a national level. The platform has signed agreements with Shanghai, Shenzhen and Guangzhou to use the benefits of shared accommodation, further develop tourism and achieve poverty alleviation. Since 2016 Airbnb has signed memorandum of understanding with cities across China, the most important from them are with Shenzhen, Guangzhou, Shanghai, Chengdu, Chongqing and Guilin.

According to experts, shared accommodation will continue to grow strongly connected with rural tourism, which the Chinese government sees as one of the main ways to tackle poverty and increase the well-being of the ***rural population***. According to data, reservations for short stays in cities of the so-called third and fourth category and rural villages increased the most in the first half of 2018. Rural housing sharing has great potential as more Chinese tourists travel there to gain experiences they have only heard of and watched for. Large local platforms in this field are making more and more attempts to develop rural tourism, and this enables the local population to pursue new economic opportunities. In this regard, Airbnb also announced a partnership with the Yenqi Tourism Committee (Beijing), as part of its efforts to promote the housing sharing service and promote tourism in the Yenqing area. In 2018, AirBnB launched also a specialized rural tourism program in Guilin and, in partnership with the Guilin Tourism Development Committee, trained local families in Jingjiang Village on the benefits of sharing homes, the standards of welcoming tourists and the digital opportunities to do so. The main aim of the Guilin Rural Community Tourism program in partnership with Airbnb is to identify and promote new *economic opportunities* for locals through home-sharing.

According to AirBnB statistics, China is the company's fastest growing market and the second fastest growing outbound tourism market worldwide. It was planned to expand operations in several key cities and regions before the end of 2018, as China is expected to be Airbnb's largest source of tourists by 2020. According to the company, since its inception, there have been more than 10 million arrivals of Chinese tourists worldwide, more than half of which were in 2017. The number of Chinese tourists via Airbnb increased by 100% on an annual basis in 2017, and the number of advertised on the platform opportunities for accommodation in China – by over 125% [9].

In 2018 Airbnb also announced findings from its joint report with the World Tourism Alliance, titled “Home Sharing Empowers Rural Revitalization in China”. Based on data as of October 2018, Airbnb has seen an annual increase of 257% in rural listings in China. Close to 1,400 rural counties, county-level cities, and remote counties in China now have Airbnb listings, where Airbnb hosts have welcomed millions of guests and earned CNY 260 million in total *host income* [1].

Considerable growth can be recognized not only in home-sharing through the Airbnb platform, but also in terms of the so called “Experiences” – activities, hosted by locals and introducing the local culture, habits and lifestyle to the tourists. From only 10 Experiences in 2017, localized in Shanghai only, now there are more than 1,000 Experiences across China.

Covid-19 and P2P-accommodation in Rural China

Due to the pandemic situation in 2020 for the first five months of the year the official data shows that the transaction volume of P2P-accommodation in China fell by more than 72% and the number of bookings dropped by 65% compared with the same period in 2019. [17] In the second half of 2020 due to the better control of the Covid-19 spread, the short-term vacation rentals industry in China showed gradual recovery. It is important to emphasize that rural homestays and short-distance travel are mostly preferred among Chinese tourists. According to a report from the Sharing Economy Research Center from March to May there is proof for a start of the recovery process of P2P-accommodation industry on a month-on-month basis [10].

Table 3. Recovery process of Chinese P2P-accommodation, March - May

Period of 2020	Change in revenue	Change in bookings
March	+78%	+141%
April	+199%	+152%
May	+35%	+50%

Source: [10].

It is widely accepted that rural homestays are the top generator of positive Covid-19 recovery impact in China, especially in terms of shared accommodation development and domestic tourism. The newly reported from Airbnb tendencies in tourist`s behavior and demand are showing pronounced preference for trips close to home (81% of respondents) with maximal distance 200 km from traveler`s home and interest in the newly introduced by Airbnb Online Experiences (84% of respondents) as to reduce physical contact and guarantee secured experience for both sides – tourists and hosts.

The latest available official data for 2020 are confirming the hypothesis above. During the May Day holiday in China (May 1 to May 5) the Ministry of Culture and Tourism announced that the most popular choice for domestic tourism was *rural homestay*. For the holiday period rural areas in Beijing accepted more than 666,000 trips and benefited with CNY 79 million. Additionally, countryside homestays saw also a rapid growth – a survey among 100 hosts reported over 80% occupancy rate during the five holiday days. Data from the P2P-platform Tujia showed an increase by 6% in the rural homestay reservations for the same period [11].

P2P-accommodation impact on rural regions development

Since the real entering on Chinese tourism market of Airbnb and the widespread of shared accommodation among Chinese domestic tourists as whole are to be reported in 2013, the dataset will cover the period 2013-2019, which is the last available data at Chinese national level.

As it became clear from the previous sections, the integration of P2P-accommodation in China has an important role in domestic and rural tourism development. As presented in Table 4., in the period 2013-2019 the domestic tourists flow increased by more than 84%. Moreover, significant is the fact that till 2016, when Airbnb signed memorandums of understanding with different cities across China, the growth rate in domestic tourist flow was around 4.6% but after 2016 it began to grow on a year-on-year basis – **+6.8%** for 2016/2017; **+7.3%** for 2017/2018; **8.4%** for 2018/2019. Additionally, as seen from the information below, the number of rural residents in China practicing domestic tourism increased in the period 2013-2019 by 43%, which can be seen as a definite sign of improved well-being. More importantly, the tourism expenditure per capita of rural residents not only increased through the survey period, but also represented a larger share from the Tourism Expenditure per capita at a national level – from 64.4% in 2013 to 66.6% in 2019. Specifically, in the period 2013-2015 the share was around 64.4 to 64.7%, but after 2016 it shows more dynamical growth: 66% in 2017 to 66.6% in 2019. In our opinion, one of the favorable factors for this positive development of the domestic and rural tourism in China is the integration of Airbnb P2P-accommodation platform and the accompanying activities in partnership with the Chinese government, organizations and stakeholders.

Table 4. Domestic tourism in China, 2013-2019

Year	Domestic tourists (million)	*Rural Residents*	Tourism Expenditure/Per Capita (Yuan)	*Urban*	*Rural*
2013	3,262	*1,076*	805.5	*946.6*	*518.9*
2014	3,611	*1,128*	839.7	*975.4*	*540.2*
2015	4,000	*1,188*	857.0	*985.5*	*554.2*
2016	4,440	*1,240*	888.2	*1009.1*	*576.4*
2017	5,001	*1,324*	913.0	*1024.6*	*603.3*
2018	5,539	*1,420*	925.8	*1034.0*	*611.9*
2019	6,006	*1,535*	953.3	*1062.6*	*634.7*

Source: [12].

Generally, at a national level the poverty conditions in Chinese rural regions have improved tremendously since 2013 as seen in Table 5.

Table 5. Poverty Conditions in rural areas in China, 2013-2018 (2010 Standard – CNY 2300 per person per year)

Year	Poverty Population (10 000 persons)	*Change on year-on-year basis (%)*	Poverty Headcount Ratio (%)	*Change on year-on-year basis (%)*
2013	8,249	---	8.5	---
2014	7,017	*-14.9%*	7.2	*-15.3%*
2015	5,575	*-20.6%*	5.7	*-20.8%*
2016	4,335	*-22.2%*	4.5	*-21.1%*
2017	3,046	*-29.7%*	3.1	*-31.1%*
2018	1,660	*-45.5%*	1.7	*-45.2%*
2019	551	*-66.8%*	0.6	*-64.7%*

Source: [12].

The poverty headcount ratio has never been at such low level as in 2019 it is above 1% from the Chinese population. Again, apparently the more dynamic decrease of the poverty population in China is after 2016 to be reported.

Having a more careful look at the poverty conditions in the specific regions, where Airbnb has signed memorandums for P2P-accommodation development partnerships it makes impression that in two of the five Chinese regions the per capita disposable income of rural households is higher than the average at national level – Guangdong, where Shenzhen and Guangzhou are located, and Shanghai. Though, in the survey period significant is the fact that in the other three Chinese regions the per capita disposable income of households is showing positive development. If in 2013 the indicator under consideration in Sichuan, Chongqing and Guangxi is respectively 88.8%, 90.1% and 82.6% of the per capita disposable income of rural households at national level, in 2019 the share increased to respectively 91.6%, 94.5% and 85.5% from the average at national level. (Table 6.) It is clear that the signed memorandums in these three rural regions in 2016 influenced the local economy and population positively. Important is also the fact that in two of the researched regions – Chongqing and Guangxi, the indicator is increasing more dynamically (respectively +9.5% and +9.4%) than at national level (+8.6%) on average in the period 2013-2019.

Table 6. Per Capita Disposable Income of Rural Households by Selected Region, 2013-2019

Area	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
National	**9,429.6**	**10,488.9**	**11,421.7**	**12,363.4**	**13,432.4**	**14,617.0**	**16,020.7**
Guangdong/ Shenzhen; Guangzhou	11,067.8	12,245.6	13,360.4	14,512.2	15,779.7	17,167.7	18,818.4
Shanghai	19,208.3	21,191.6	23,205.2	25,520.4	27,825.0	30,374.7	33,195.2
Sichuan/ Chengdu	8,380.7	9,347.7	10,247.4	11,203.1	12,226.9	13,331.4	14,670.1
Chongqing	8,492.5	9,489.8	10,504.7	11,548.8	12,637.9	13,781.2	15,133.3
Guangxi/ Guilin	7,793.1	8,683.2	9,466.6	10,359.5	11,325.5	12,434.8	13,675.7

Source: [12].

CONCLUSIONS

As a conclusion we can assert that Airbnb P2P-accommodation has a positive impact on the development of rural regions in China, which can be proved with the following data supported statements:

-Tourism in China has big a contribution to national economy as it forms 11% of China`s GDP (2018) and employment, directly and indirectly of 28.25 million people. Domestic tourism performs bigger share from Chinese tourism with around 40 times more trips than the inbound tourism;

-Covid-19 spread caused unprecedented loss in international tourism worldwide (900 million fewer arrivals) and the greatest decrease is specifically in Asia and the Pacific (82% less arrivals). In China for 2020 the predicted decline in number of domestic tourists is 43% or 3.4 billion people. Though, second half of 2020 was more successful for the Chinese domestic tourism and a partial recovery is to be reported.

-Rural tourism is one of the most preferable forms of tourism among domestic tourists. The demand for rural tourism started to gradually increase since the new century has begun. Chinese rural tourism is generally seen as a catalyst for upgrading rural areas, specific way for poverty alleviation in China`s rural areas, conductor of cultural multiplication and soon it was pointed to help for faster recovery from the Covid-19 negative consequences.

-The development of rural tourism in China can be described as more dynamic through the last three decades. In this aspect three important government activities can be pointed as decisive:

-China Urban and Rural Tourism Year (1988); China Rural Tourism Year (2006) and the National Rural Tourism Development Program (2009-2015). The result is more than 3.3 billion domestic trips to rural regions and rural tourism income exceeding CNY 850 billion in 2018.

-The Chinese government evaluates the positive economic impact of the integration of P2P-accommodation in rural regions and sees great opportunity to stimulate GDP, increase tax revenues and improve the well-being of rural population. The most significant partnership in this aspect is with Airbnb - a number of policies and regulatory frameworks are being elaborated and introduced since 2013.

Airbnb has seen an annual increase of 257% in rural listings in China (2018) and now there are listing in more than 1,400 remote and cities villages. The reported host income in 2018 for rural regions is CNY 260 million.

-Due to the pandemic situation during the first five months of 2020 the transaction volume of P2P-accommodation in China fell tremendously (-72%) as also the number of bookings (-65%) compared with 2019, but in the second half of 2020 there is a positive Covid-19 recovery, where rural homestays are seen as the top generator of positive impact.

-During the researched period, 2013-2019, after the P2P-accommodation integrated in China through the Airbnb entrance, the domestic tourists flow increased by more than 84%. Additionally, after Airbnb has signed memorandums of understanding with different cities across China (2016) the growth rate in domestic tourist flow began to rise more dynamically.

-During the period 2013-2019 rural residents began to participate more in tourism and there is a curtain sign of their improved well-being – expenditure per capita of rural residents is higher, improved poverty conditions in Chinese rural regions (under 1% from the Chinese population). Additionally, the poverty conditions in the specific regions, where Airbnb has signed memorandums the per capita disposable income of rural households is higher on yearly basis, is closer to or above the average at national level and after 2016 it began to rise more sharply.

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RAW MILK PRICE TRANSMISSION IN THE SELECTED EU COUNTRIES

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Abstract

The EU dairy sector has faced new challenges since the main EU enlargement in 2004. This paper investigates spatial raw milk price transmission between Germany, France, the Netherlands, Poland, Lithuania, and Latvia. The study applies the Granger Causality test to analyse the short-term raw milk price movements between the selected markets. Results suggest that the raw milk markets of six countries have survived important price shocks over the investigated period. Furthermore, the raw milk price development patterns of countries that joined the EU in 2004 move towards the more integrated EU raw milk market. Results of the Granger Causality tests suggest that countries could be grouped in accordance to raw milk price setting. The price development patterns in countries that joined the EU in 2004 and before differ.

Key words: *horizontal price transmission, market, milk*

INTRODUCTION

Over the recent decades, the dairy sector has faced significant challenges of the raw milk market introduced by the enlargement of the European Union (EU) and removal of trade barriers, the changes in the EU standards and regulation (for example, removal of milk quotas) as well as the impact of another important factors that have contributed to the development of prices in member states. This study focuses on spatial price transmission of raw milk prices and EU market integration, because market malfunctions are closely related to the welfare issues.

Although the growing interest in price transmission topic is observed after the food crisis and the recent price spikes, the academic research on spatial price transmission in the EU dairy sector is not excessive. The largest share of studies deals with vertical price transmission and examines how price changes are passed along domestic supply chains. The examples of such studies in the EU countries include [1, 4, 8, 14, 16]. This academic research niche contributes to the understanding of domestic supply chains and empowers the revision and improvement of policy measures that assist in solving specific raw milk market problems.

The spatial price transmission research niche became more attractive in light of the EU enlargement that had changed business environment in member states. In dairy sector, such studies vary in terms of the geographical coverage and include the research on horizontal price transmission between different locations of the same country [13], analyse price changes between the groups of member states or deal with the EU-wide coverage [2, 11, 15], and investigate price transmission between the EU market and other countries [9]. Studies on price transmission in the EU dairy sector vary greatly in terms of applied methodological frameworks, selected data frequency and periods of investigation, the coverage of member states, and etc. Furthermore, most of these academic contributions bring important fragments of knowledge and support a better-targeted policy on both national and the EU levels. Indeed, the most recent progress in methodological developments of spatial price transmission research and related academic challenges are discussed in [12].

This study contributes to the better understanding of raw milk market integration processes after the EU enlargement in 2004. The research investigates spatial raw milk price transmissions between Germany (DE), France (FR), the Netherlands (NL), Poland (PL), Lithuania (LT), and Latvia (LV). A question to be answered is whether there is a difference between price behaviour in countries that joined the EU in 2004 and before this date. The understanding of price development patterns between the EU markets is critical for policy makers and academic society. This knowledge contributes to the discourse on the progress towards greater integration of the EU market and the relevant challenges.

The paper is organized as follows. Materials and Methods section informs about the origin of the used data and introduces applied econometric techniques. Results and Discussion section reports on the main results of the spatial price transmission between the selected six markets and link the relevance of main findings with other academic contributions. Conclusions section gives essential remarks on the main findings.

MATERIALS AND METHODS

Data. This study investigates spatial raw milk price transmissions between the selected EU countries. According to Eurostat [7], in 2019, the main producing countries were Germany (20.9% of the EU-27 raw milk, total available on farm), France (16.4%), and the Netherlands (9.5%). These countries represent the EU-15 group that has benefited from the more stable business environment and support policy. The second group includes the major raw milk producer in EU-12, namely Poland, and the neighbouring Lithuania and Latvia with the corresponding raw milk shares accounting for 9.2%, 1.0%, and 0.6%.

The study uses the monthly raw milk price data collected by the European Commission from the EU member states and covers the period from January 2005 to June 2020. The selected period demonstrates the changes in raw milk prices of the investigated member states after the EU enlargement in 2004. The study uses natural logarithms of prices and the methodological development is set as follows.

Methods. In this study, spatial price transmission focuses on the investigation of raw milk price links between markets of six member states in different locations. The study employs the Granger Causality test for the investigation of the short-term relationships between raw milk prices in the selected member states.

First, the study introduces the results of the Augmented Dickey-Fuller (ADF) test [3] for the price series of individual member states. This test classifies data into stationary and non-stationary.

The next step is the selection of the lag length for the Granger Causality test. In order to select a lag order, the unrestricted vector autoregressions are estimated for the each pair of countries. The decision on the lag order selection is made applying Schwarz information criterion (including 12 lags into lag specification).

Third, the Granger Causality test [10] investigates the nature of the short-term relationships between raw milk prices for the each pair of countries. This test allows understanding if the changes in raw milk prices of one member state could be explained by the previous price changes of this country and the lagged raw milk prices of another country. In fact, this test is often applied to identify a country that leads in price setting. However, the desired situation is the bidirectional price movement between two markets.

RESULTS AND DISCUSSIONS

The ADF test is applied to investigate the presence of the unit root in the selected price series of Germany, France, the Netherlands, Poland, Lithuania, and Latvia.

Table 1. Results of the ADF test for the logarithms of raw milk prices

Country	ADF test statistic	Test critical values 1.0%	Test critical values 5.0%	Prob.
Germany	-3.4596	-3.4666	-2.8774	0.0102
France	-4.4409	-3.4683	-2.8781	0.0004
Netherlands	-4.7196	-3.4717	-2.8796	0.0001
Poland	-3.1999	-3.4660	-2.8771	0.0216
Lithuania	-3.4965	-3.4662	-2.8772	0.0091
Latvia	-3.4462	-3.4670	-2.8775	0.0106

Source: Own calculation.

Results of the corresponding ADF tests are summarised in Table 1 and allow classifying data and considering the importance of significance level.

According to Table 1, tests for Latvia, Germany, and Poland cannot reject the hypothesis at 1.0% significance level. Thus, the conclusions on the stationary nature of price series depend on the selected significance level. However, the hypothesis of the unit root for the price series of all investigated countries can be rejected at 5.0% significance level. Thus, time series of six member states are stationary.

The next step is the selection of the lag lengths for the Granger Causality tests. It should be noted that this step is important, because the length of time delay can have an impact on the results of the Granger Causality tests. Table 2 shows the selected number of lags for unrestricted vector autoreressions.

Table 2. The selected lag length for unrestricted vector autoregressions by Schwarz information criterion

Countries selected for vector autoregressions	Selected lag order
Germany – France	2
Germany – Netherlands	2
Germany – Poland	2
Germany – Lithuania	3
Germany – Latvia	2
France – Netherlands	2
France – Poland	2
France – Lithuania	2
France – Latvia	2
Netherlands – Poland	2
Netherlands – Lithuania	2
Netherlands – Latvia	2
Poland – Lithuania	2
Poland – Latvia	2
Lithuania – Latvia	2

Source: Own calculation.

According to results demonstrated in Table 2, the Granger Causality tests should include two lags for the each pair of the investigated countries. However, in case of Germany and Lithuania, Schwarz information criterion suggests including three lags.

In the short run, the interactions between raw milk prices in alternative bilateral combinations of markets are analyzed employing the Granger Causality test. In Table 3, the hypothesis on the absence of the Granger Causality is rejected at the significance level lower than 5.0%.

Table 3. Results of the Granger Causality tests for the logarithms of raw milk prices

Hypothesis	F-stat	Prob.	Direction at 5.0% significance level
DE does not GC LV	15.0280	1.E-06	one-way
LV does not GC DE	2.1512	0.1194	
FR does not GC LV	4.0513	0.0190	two-way
LV does not GC FR	10.8300	4.E-05	
LT does not GC LV	14.0259	2.E-06	two-way
LV does not GC LT	4.1663	0.0171	
PL does not GC LV	19.4987	2.E-08	one-way
LV does not GC PL	1.5588	0.2133	
NL does not GC LV	6.2981	0.0023	two-way
LV does not GC NL	7.0809	0.0011	
FR does not GC DE	2.6531	0.0732	one-way
DE does not GC FR	16.3932	3.E-07	
DE does not GC LT	11.6418	6.E-07	two-way
LT does not GC DE	15.2291	8.E-09	
PL does not GC DE	3.9280	0.0214	two-way
DE does not GC PL	16.2921	3.E-07	
NL does not GC DE	1.3194	0.2700	one-way
DE does not GC NL	27.1789	5.E-11	
LT does not GC FR	5.5009	0.0048	two-way
FR does not GC LT	16.0350	4.E-07	
PL does not GC FR	13.3373	4.E-06	two-way
FR does not GC PL	5.0942	0.0071	
NL does not GC FR	32.0334	1.E-12	two-way
FR does not GC NL	6.4980	0.0019	
PL does not GC LT	14.5416	1.E-06	two-way
LT does not GC PL	6.7907	0.0014	
NL does not GC LT	14.5727	1.E-06	two-way
LT does not GC NL	5.4005	0.0053	
NL does not GC PL	3.5879	0.0297	two-way
PL does not GC NL	13.3640	4.E-06	

Note: GC – Granger Cause
Source: Own calculation.

According to Table 3, results suggest that the bidirectional price movement is violated between Germany and Latvia, Poland and Latvia, France and Germany, the Netherlands and Germany. It should be noted that results for Latvia are unexpected, because this country is not among the leading producers. However, according to the Granger Causality test, a price setting moves from Latvia to

Germany and Poland, while the latter countries represent a significant share of the EU dairy market.

The analysis of raw milk price series introduced in Fig. 1 sheds some light on this situation. According to Fig. 1, Latvia was the only country with the most remarkable raw milk price development differences after the accession to the EU. Indeed, the membership in the EU has changed the behaviour of the Latvian raw milk prices. Since 2007, the Latvian market has demonstrated a higher interaction of raw milk prices with other member states. In fact, the elimination of price series for the period 2005–2007 changes the results of the Granger Causality test fundamentally. Results for the shorter period also confirm one-way price movement, but the direction of the price setting goes in line with expectations, because the Latvian raw milk prices follow the development patterns of the leading producers.

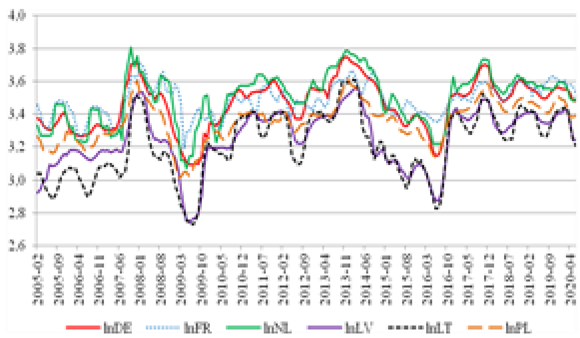

Fig. 1. Logarithms of raw milk prices for the selected countries
Source: Own elaboration.

Roman [13] argues that the decreasing gap between prices show the progress of the integration between markets. From this point of view, Fig. 1 demonstrates a higher level of market integration in countries that joined the EU in 2004 over the last couple years, compared to the early post-accession period.

Another interesting aspect is the status of the Lithuanian raw milk market. The Granger Causality test shows that the price series of the investigated countries have a weaker power explaining changes in raw milk prices in the Lithuanian market in the short run. It could be explained by peculiarities of the Lithuanian raw milk market and the challenges of the domestic supply chains.

Results of the Granger Causality tests also imply that raw milk price changes in Germany contribute to the price development in the Netherlands and France in the short run. This finding falls in line with the role of Germany in the EU raw milk market. Results also contribute to the study by [2] that finds a support for the higher integration of the EU raw milk market in countries that joined the EU before 2004.

Nevertheless, the slower process of raw milk market integration and differences in price setting between EU member states are often explained by a highly perishable nature of this commodity. In fact, some researchers argue that raw milk prices depend on the milk collecting hubs [2], because processors select reasonable raw milk transportation distances and need special facilities to operate a business.

For these reasons, the lower price level in Lithuania and Latvia, as well as similar price development patterns, could be explained by distances allowing to collect raw milk. The modest shares of the aforementioned markets in the EU dairy sector to some extent could be linked with production efficiency and competitiveness issues.

Although Poland and Lithuania are neighboring countries, the gap between raw milk prices during the post-accession period was high. Indeed, Fig. 1 shows that the Lithuanian raw milk prices are approaching the higher level over the recent years.

Main producing countries, namely Germany, France, the Netherlands, and Poland, demonstrate similar price development patterns and could be classified as a group of countries with higher price level. Granger Causality tests show that the EU raw milk market faces the similar challenges as other agricultural markets with the dominant share of production in several member states. For example, the EU pigmeat market study by [6] concludes that markets of member states with high power often drive price changes on smaller markets. However, the aforementioned study finds differences in price interactions between markets and suggests meaningful grouping considering this criteria. Furthermore, researchers [6] link market non-efficiency with the fragmentation of the EU market into such groups.

Indeed, the changes in price development patterns and the improved EU market integration can be explained by dramatic structural changes in dairy sectors of member states over the investigated period. According to EU Agricultural Outlook [5], the EU average dairy farm size rose by more than 50.0% over the period from 2005 to 2016. These structural changes allowed decreasing productivity gaps between EU countries. However, the process is not over and EU Agricultural Outlook [5] projects higher EU average yields.

For example, in Poland, the process of the successful integration was lead by high level of concentration in milk production [13]. The disappearance of small farms and the movement towards the higher level of the average milk productivity became a challenge in many countries that joined the EU after 2004. In some countries, the situation in dairy sector was exacerbated by the failure of efforts to overcome problems of domestic supply chains.

CONCLUSIONS

Findings support the previous academic research in favour of the EU progress towards a more integrated raw milk market. According to results, even Latvia that has demonstrated dramatic price development differences, compared to other investigated countries, moves towards a higher level of market integration over the time.

Another important aspect is the difference between price interactions of different markets. The Granger Causality test shows that countries could be grouped in accordance with raw milk price setting directions. In the short run, German raw milk prices could be used to explain price developments in France and the Netherlands, while the situation with Lithuanian, Polish, and Latvian markets differs. As a result, there are differences between price interactions in countries that joined the EU in 2004 and before the main enlargement. The countries of the earlier accession have a clear short-term price setting direction from the leading market, while in the case of those that joined in 2004, the links are not so obvious and price development patterns demonstrate importance of the post-accession period.

Although the higher integration level of the EU market is treated as a desired objective, policy makers should not forget about the pressure of similar price development patterns when the countries with lower productivity, higher production costs, and inefficient domestic supply chains are forced to follow unfavorable price development trends in highly productive countries. The Common Agricultural Policy should be a useful tool that allows us to overcome the aforementioned challenges and strengthen national dairy sectors.

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ECONOMIC ANALYSIS OF TRITICALE PRODUCTION: A CASE STUDY OF CORUM PROVINCE, TURKEY

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Abstract

This study aims to determine the production costs and profitability of the farmers' triticale production in Corum province. Because it is an important region in Turkey, Corum province was selected as the research area in triticale production. The study's data were determined by the stratified random sampling method obtained by the questionnaire method from 53 farms producing triticale in the Sungurlu district of Corum province. The production data set includes data for the 2019 year. According to the research findings, the average production cost per decare was calculated to be 290.85 TRY. The share of variable costs was 58.55% within the production costs, and the share of fixed costs was 41.45%. It was determined that the unit sale price of triticale was 0.87 TRY. The gross production value (GPV) of triticale in the region was calculated as 356.44 TRY/da, gross profit 185.73 TRY/da, and net profit 65.16 TRY/da. The unit cost of triticale in the region was 0.84 TRY. The relative profit was determined as 1.22 unit. As a result of the research, as the triticale production areas increase, the fixed costs per decare increase, and the variable costs decrease. The profitability indicators per decare and kilogram sales price increased with the triticale groups' with.

Key words: *triticale, economic analysis, production cost, profitability, Turkey*

INTRODUCTION

Triticale is a type of grain that combines the high yield of wheat with the durability of rye. It can adapt to very different climatic and soil conditions. It is more productive than other grain types in arid conditions. This feature is an important product for regions where annual rainfall and irrigation are limited [2]. Triticale grain is mostly used as a feed for ruminants and poultry as it is a source of protein, amino acids, and B vitamins [8] [19]. It is also used as grain, roughage, silage and straw [13].
The aim of agricultural enterprises is to increase productivity in production. This is possible by maximising the production volume in agriculture or minimising the costs of producing a certain product [4].
There are many studies on triticale cultivation in the literature [14] [9] [11] [7] [3] [15], but the study on the economic analysis of triticale production is limited.
This research aimed to carry out costs and profitability analysis for triticale production located in Corum province. Besides, technical information such as foliar fertiliser, nitrogen and phosphorus applications, and soil and leaf analysis applications were interpreted for triticale producers according to farms groups.

MATERIALS AND METHODS

The research's primary material consisted of original data obtained by a face-to-face questionnaire applied to farmers involved in triticale production farms at Sungurlu district of Corum province. In the 2019 production year, Corum province has 26.47% triticale production area and 26.78% triticale production of Turkey [17].
Besides, the data obtained from similar research studies conducted by the relevant persons and institutions were also used. Survey data included the 2019 production period. The research area was given in Figure 1.

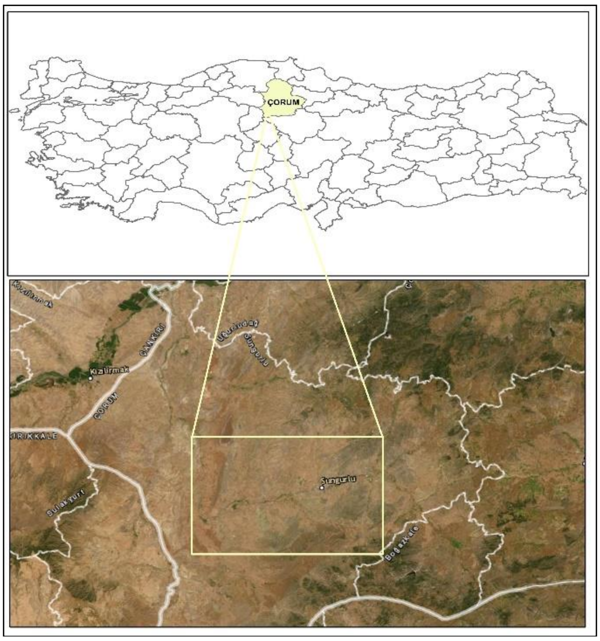

Fig. 1. Location map of the study areas
Source: Own calculation.

The sample size in the research was determined using the Neyman Method. The number of farms to be interviewed was calculated with the formula given below [18].

$$n = \frac{(\sum N_h S_h)^2}{N^2 D^2 + \sum N_h S_h^2}$$

where:
n- Sample size,
N- Total number of units in the population,
Nh- Number of units in group h,
Sh- Standard deviation of group h,
Sh^2- Variance of group h,
D^2- d^2/z^2,
d^2- Allowed error from population average,
z^2- Value of the allowed safety limit in the distribution table.
The farms' triticale land size was different, divided into different groups to ensure homogeneity. According, the farms were classified three groups as group 1 (15 decares and less; 18 farms), group 2 (15.01-25.00 decares; 16 farms) and group 3 (>25.01 decares; 19 farms). The average triticale area of the farms in the groups was determined as 13.06 decares for I group farms, 21.25 decares for II group farms, 45.79 decares for III group farms and 27.26 decares for all farms.

Profitability indicators were calculated to determine the success level of farms producing triticale. The triticale production quantity was multiplied by the sales price, and the production value was calculated. The gross profit was calculated by subtracting the total variable cost from the triticale production value in the studied farms. Net profit was calculated by subtracting total production costs from the triticale production value. Relative profit was calculated by dividing triticale production value by production costs [1] [6].
Fertilisation cost, machine rental cost, seed cost, labour cost, pesticide cost, other variable costs and working capital interest within the content of variable costs. The working capital interest was calculated by taking half of the interest rate applied by Ziraat Bank (4%) for crop production. Fixed costs were calculated as general administrative expenses (3% of variable costs) and land rent [1] [6]. The exchange rate for 2019 was 1 ($) dollar = 5.67 (TRY) Turkish Lira. One decare of land is equal to 0.1 hectares of area.

RESULTS AND DISCUSSIONS

Table 1 presents some technical information about triticale production. The average of farms applying soil analysis farmers was 72.22% in the I farm group, 68.75% in the II farm group, 68.42% in the III farm group and 69.81% in all farms. The lowest soil analysis application was at the III farm group, and the highest soil analysis application was at the I farm group. The average of farms applying leaf analysis farmers was determined as 22.22% in the I farm group, 25.00% in the II farm group, 26.32% in the III farm group and 24.53% in all farms. The lowest leaf analysis application was at the I farm group, and the highest leaf analysis application was at the III farm group. The average of farms using foliar fertilisers farmers was 55.56% in the I farm group, 68.75% in the II farm group, 47.37% in the III farm group and 56.60% in all farms. The lowest foliar fertilisers use was at the III farm group, and the highest foliar fertilisers use was at the II farm group. The average of farms with non-operating agricultural income was 77.78% in the I farm group, 75.00% in the II farm group, 57.89% in the III farm group and 69.81% in all farms. The lowest non-operating agricultural income was at the III farm group, and the highest non-operating agricultural income was at the I farm group. The average of farms with non-agricultural income was 72.22% in the I farm group, 62.50% in the II farm group, 63.16% in the III farm group and 66.04% in all farms. The lowest non-agricultural income was at the II farm group, and the highest non-agricultural income was at the I farm group.

The amount of seed use of the farmers was calculated. It was determined that 19.04 kg of seed were used per unit area in the farms. It was determined that as the triticale production areas increased, the amount of using seed increased. Fertiliser usage amounts of the farmers were calculated as 8.92 kg N (nitrogen) and 17.53 kg P (phosphorus) per decare pure substance in triticale production.

Table 1. Technical information about triticale production

Indicators	**Farm groups (da)**			**Farms average**
	I	II	III	
Soil analysis (%)	72.22	68.75	68.42	69.81
Leaf analysis (%)	22.22	25.00	26.32	24.53
Foliar fertiliser (%)	55.56	68.75	47.37	56.60
Non-operating agricultural income (%)	77.78	75.00	57.89	69.81
Non-agricultural income (%)	72.22	62.50	63.16	66.04
The seed used amount per decare (kg)	18.88	19.07	19.17	19.04
The N used amount per decare (kg)	8.19	9.60	9.05	8.92
The P used amount per decare (kg)	7.07	7.71	7.82	7.53

Source: Own calculation.

The production costs of farms producing triticale were examined under two separate items as fixed and variable costs. Fixed costs are the costs that exist in the enterprises, whether production is made or not. In other words, this cost item does not depend on the production volume. Variable costs occur when production is made and may vary depending on the volume of production. In other words, this cost item may increase or decrease according to the production volume [12]. Fixed costs of triticale producing farms include land rent and general administrative expenses. The average fixed costs of triticale producing farms were calculated as 3,286.93 TRY. This value varied between 1,607.25 TRY and 5,489.03 TRY in the groups. Land rents cost (3,147.64 TRY) has the highest share among the fixed costs. This was followed by general administration expenses (139.29 TRY).

Table 2. Production costs in farms (TRY/farms)

Production Costs	**Farm groups (da)**			**Farms average**
	I	II	III	
Fertilisation cost	658.06	1,034.38	2,190.53	1,321.04
Machine rental cost	601.11	924.38	1,888.16	1,160.09
Seed cost	307.98	505.5	1,095.5	649.93
Labour costs	323.33	481.88	1,061.58	635.85
Pesticide cost	290.28	437.50	905.26	555.19
Other variable costs	98.64	160.54	412.33	229.78
Working capital interest	45.59	70.92	151.21	91.10
Total variable cost (A)	2,324.99	3,615.08	7,704.57	4,642.98
Land rent	1,537.50	2,453.13	5,257.89	3,147.64
General administration expenses	69.75	108.45	231.14	139.29
Total fixed cost (B)	1,607.25	2,561.58	5,489.03	3,286.93
Total production costs (A+B)	3,932.24	6,176.66	13,193.60	7,929.91

Source: Own calculation.

Fertilisers, machinery rents, seedlings, labour costs, pesticides, other variable costs and working capital interest constituted the variable costs elements. The average variable costs of triticale producing farms were calculated as 4,642.98 TRY. This value varied between 2,324.99 TRY and 7,704.57 TRY in the groups. Fertilisation cost (1,321.04 TRY) has the highest share among the variable costs. This was followed by machine rental cost (1,160.09 TRY), seedling cost (649.93 TRY), labour costs (635.85 TRY), pesticide cost (555.19 TRY), other costs (229.78 TRY) and the interest of working capital (91.10 TRY).

According to the farms' size groups, total production costs were calculated as an average of 7,929.91 TRY. This value was calculated as an average of 3932.24 in the I group, 6,176.66 TRY in the II group, and 13,193.60 TRY in the III group (Table 2).

According to the per decare, total production costs were calculated as an average of 290.85 TRY for all group. This value varied between 288.14 TRY and 301.19 TRY in the groups. The share of fixed costs was 41.45% in total production. This value was calculated as 40.87% in the I group, 41.47% in the II group and 41.60% in the III group. The most important cost elements among fixed costs were the land rent cost (39.69%) and general administration expenses cost (1.76%). The variable production cost was amounted to be 170.30 TRY per decare for all group. This value varied between 168.26 TRY and 178.08 TRY in the groups. The share of variable costs was 58.55% in total production. This value was calculated as 59.13% in the I group, 58.53% in the II group and 58.40 % in the III group. It was determined that as the triticale production area increased, the share of variable costs in total costs decreased. The most important cost elements among variable costs were the cost of the fertilisation (16.66%), machine rental cost (14.63%) and seedling cost (8.20%) (Table 3).

Table 3. Production costs per unit area in farms

Production Costs	**Farm groups (da)**			**Farms average**
	I	II	III	
Cost (TRY per decare)				
Fertilisation cost	50.40	48.68	47.84	48.45
Machine rental cost	46.04	43.50	41.24	42.55
Seed cost	23.59	23.79	23.92	23.84
Labour costs	24.77	22.68	23.18	23.32
Pesticide cost	22.23	20.59	19.77	20.36
Other variable costs	7.56	7.55	9.00	8.43
Working capital interest	3.49	3.34	3.30	3.34
Total variable cost (A)	*178.08*	*170.12*	*168.26*	*170.30*
Land rent	117.77	115.44	114.83	115.45
General administration expenses	5.34	5.10	5.05	5.11
Total fixed cost (B)	*123.11*	*120.54*	*119.88*	*120.56*
Total production costs (A+B)	301.19	290.67	288.14	290.85
The share in the production costs (%)				
Fertilisation cost	16.73	16.75	16.60	16.66
Machine rental cost	15.29	14.97	14.31	14.63
Seed cost	7.83	8.18	8.30	8.20
Labour costs	8.22	7.80	8.05	8.02
Pesticide cost	7.38	7.08	6.86	7.00
Other variable costs	2.51	2.60	3.13	2.90
Working capital interest	1.16	1.15	1.15	1.15
Total variable cost (A)	*59.13*	*58.53*	*58.40*	*58.55*
Land rent	39.10	39.72	39.85	39.69
General administration expenses	1.77	1.76	1.75	1.76
Total fixed cost (B)	*40.87*	*41.47*	*41.60*	*41.45*
Total production costs (A+B)	100.00	100.00	100.00	100.00

Source: Own calculation.

In another study [16] conducted in 2016 in Bursa province, the total variable cost per decare in triticale production was found to be 193.77 TRY (64.08%) and total fixed cost 108.63 TRY (35.92%). They calculated the total production cost of triticale as 302.40 TRY per decare. According to the study of [12], the total production cost was amounted to be high in our study. This is because of the different working periods.

Some success criteria indicate the success of farms and allow them to make their plans accordingly. The farms' success criteria, such as production costs of farms, gross product value, gross profit, net profit, and relative profit, were compared according to farm groups. The profitability status of triticale production is shown in Table 4.

The triticale's gross production value was calculated by multiplying the triticale yield by per kilogram selling price. This value was calculated as 301.92 TRY in the I group, 300.59 TRY in the II group, 302.17 TRY in the III group and 299.69 TRY per decare average of farms. Triticale farms have income from by-products and agricultural supports. This by-product was sold in bales after the triticale was harvested. The by-product value was calculated as 30.58 TRY on average of farms. This value was 30.49 TRY in the I group, 31.16 TRY in the II group, and 30.37 TRY in the III group.

Table 4. Cost and profitability in triticale production

Production Costs	Farm groups (da)			Farms average
	I	II	III	
1. Triticale GPV (TRY/da) *(9x11)*	301.92	300.59	302.17	299.69
2. By-products value (TRY/da)	30.49	31.16	30.37	30.58
3. Agricultural support (TRY/da)	29.02	27.35	24.94	26.17
4. Total GPV (TRY/da) *(1+2+3)*	361.44	359.10	357.48	356.44
5. Variable cost (TRY/da)	178.52	170.54	168.67	170.71
6. Gross profit (TRY/da) *(4-5)*	182.91	188.56	188.81	185.73
7. Total production costs (TRY/da)	301.64	291.09	288.56	291.28
8. Net profit (TRY/da) *(4-7)*	59.79	68.00	68.92	65.16
9. Yield (kg/da)	348.89	347.81	340.53	345.57
10. Per kilogram cost (TRY) *(7/9)*	0.86	0.84	0.85	0.84
11. Per kilogram selling price (TRY)	0.86	0.87	0.89	0.87
12. Per kilogram net profit (TRY) *(11-10)*	0.00	0.03	0.04	0.03
13. Relative profit *(4/7)*	1.20	1.23	1.24	1.22

Source: Own calculation.

Agricultural products should be supported for the sustainability of agricultural production and to increase the production per unit area [5]. In this context, triticale farms benefited from diesel-fertiliser support of 27 TL per decare, which were determined by the state [10].

Agricultural supports value was calculated as 26.17 TRY per decare average of farms. This value was 29.02 TRY in the I group, 27.35 TRY in the II group, and 24.94 TRY in the III group. It was determined that as the triticale production areas increased, the rate of benefiting from agricultural supports increased. The total triticale gross production value was calculated by adding the by-product value and agricultural support value to the gross production value and amounted to be 356.44 TRY per decare average of farms. This value was calculated as 361.44 TRY in the I group, 359.10 TRY in the II group, and 357.48 TRY in the III group. It was determined as the triticale production area was increased, the total production value per decare decreased. The gross production value, by-product value, agricultural support value, gross profit, net profit, relative profit, kilogram cost and profit margin per kilogram were calculated to reveal the farms' cost and profitability. The gross profit calculated by subtracting the variable costs from the triticale production value was calculated as 185.73 TRY per decare average of farms. This value was calculated as 182.91 TRY in the I group, 188.56 TRY in the II group, and 188.81 TRY in the III group. Net profit was calculated by subtracting the total costs from the triticale production value. The farms' average net profit per decare was amount to be 65.16 TRY. This value was calculated as 59.79 TRY in the I group, 68.00 TRY in the II group, and 68.92 TRY in the III group. It was determined that as the triticale production areas increase, the net profit also increases. The average net profit per decare of the group I of farms was low. Because the sales price of triticale per decare of farms in the first group was low, and the total costs per decare were high.

The kilogram cost of triticale was calculated by dividing the production costs by the yield. Accordingly, the average kilogram cost of the farms was calculated as 0.84 TRY. This value was 0.86 TRY per kilogram in the I group, 0.84 TRY per kilogram in the II group, and 0.85 TRY per kilogram in the III group. Kilogram sales prices were calculated as 0.87 TRY on average of farms. This value was 0.86 TRY per kilogram in the I group, 0.87 TRY per kilogram in the II group, and 0.89 TRY per kilogram in the III group. It was determined that as the triticale production areas increase, the kilogram sales prices also increase. The relative profit was calculated by dividing triticale production value by production costs, and calculated as 1.22 per decare average of farms. This value was calculated as 1.20 in the I group, 1.23 in the II group, and 1.24 in the III group. Relative profit value refers to the production value of 1.22 unit in return for 1.00 unit expenditure for triticale production. It was determined that as the triticale production areas increase, the relative profit value also increase. Besides, relative profit calculated, excluding agricultural support value, was calculated as 1.13 per decare average of farms. This value was calculated as 1.10 in the I group, 1.14 in the II group, and 1.15 in the III group. It was determined that the relative profit calculated without the agricultural support decreased by 7.06%, and therefore agricultural support was significant for triticale producers.

Figure 2 presents relative profit values according to farms sizes. It was determined that the relative profit values vary according to the size of the triticale production areas. Relative profit values vary between 1.10 units and 1.35 units according to the size of the farms. Although the relative profit values followed a fluctuating course, it was determined that they showed an increasing trend. The triticale production areas of the farms vary between 8 decares and 200 decares. It was determined that the production costs were high, and the sales price to triticale was low in farms with low relative profit value.

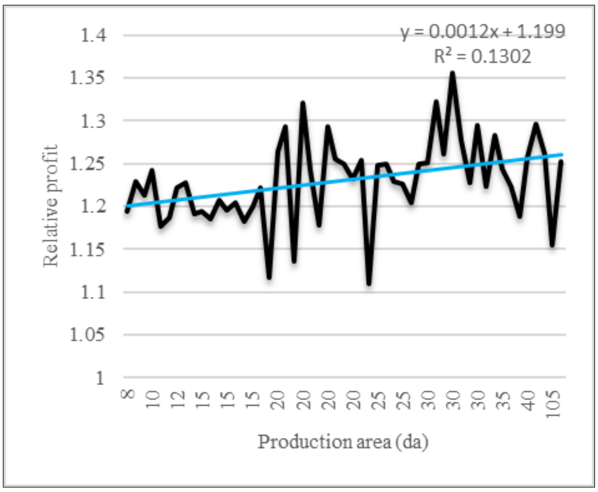

Fig. 2. Relative profit values according to triticale production areas
Source: Own calculation.

CONCLUSIONS

This study was conducted in Corum, which was important in Turkey triticale production. Production costs of triticale, which was economically significant in the research area, was calculated. The data were obtained through face-to-face interviews with farmers through a questionnaire. It was determined that the farms' total production costs, 58.55% were variable, and 41.45% were fixed costs. Of the variable costs, 16.66% was fertiliser costs, 14.63% was machinery rental costs, 8.20% was seed costs, 8.02% was labour costs, 7.00% was pesticide costs, 2.90% other variable costs, and 1.15% was working capital interest expense. Of the fixed costs, 39.69% was land rent costs, and 1.79% was general administration expenses. It was determined that as the farms' size increases in the farms' groups, the variable costs per decare decrease, and the fixed costs increase. Besides, it was determined that as the farms' size increased, gross profit, net profit and relative profit increased. It was calculated that the farms earned of the total triticale gross production value 8.58% from by-product income and 7.34% from agricultural support income.

By-product income and agricultural support income are important for triticale producers. It is thought that if agricultural supports are increased, triticale production will improve, and farmers will gain more income.

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REACTION OF SUDAN GRASS AND SORGHUM-SUDAN HYBRIDS TO SALINITY

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Abstract

According to the data obtained in 2019-2020, a noticeable decrease in seed germination to 84-94% in sterile female parent lines of Sorghum was found when the concentration of NaCl in the solution was 1.0%, and at 1.5% it decreased to 23-80%. The lowest performance (23%) was obtained in A-63 line. Paternal varieties of Sudan grass reduce germination to 68-87% with 1.0 NaCl and to 45-74% with 1.5% of salinity. The most significant seed germination of Sudan grass with 1.0% of salinity (82-87%) was found in Zemlyachka, Sputnitsa and Zlata varieties with a solution concentration of 1.5% in Zemlyachka (74%). Among the other varieties of Sudan grass, the most salt-tolerant were Alexandrina and Violeta varieties. In the Bulgarian variety SVE, when NaCl concentration in the soil solution was 1.0%, the seed germination rate was 82%, and when its concentration increased to 1.5%, it was 32%. In the obtained Sorghum-Sudan hybrids with 0.6% salt concentration, seed germination decreased to 67-96%, but most of all (96%) it was obtained in the combinations of Zersta 90C x Sputnitsa and A-63 x Nika. The highest seed germination with 1.0% – 1.5% saturation of NaCl solution was obtained in the recognized hybrids Zersta 90C x Zemlyachka, Zersta 90C x Sputnitsa, and the combination of Knyazhna x Sputnitsa. The increase in concentration of the soil solution significantly reduces the length of the shoots and roots of the seedlings to 1.6 – 3.4 cm with 1.0% NaCl con-centration and 0.7 – 2.4 cm in the variant with 1.5% of salt presence. In the Navi-gator and Gvardeets hybrids, the length of seedlings with high salt concentration (0.6-1.5%) was the highest.

Key words**:** *sterile lines, varieties of Sudan grass, Sorghum-Sudan hybrids, germination, length of seedlings*

INTRODUCTION

The area of solonetz in the Stavropol Territory is 1.5 million hectares. The main features of these soils are high density and cloddy structure [12]. pH of chernozem and chestnut soils in the region on an area of 38-43% is 6.9-8.0. The soil salinity is one of the main negative factors that reduces the productivity of agricultural production [7]. The amount of exchangeable sodium in solonetzic soils reaches 15-20%, and in solonetz soils more than 20% of the base exchange capacity. At the same time, solonetz soils are relatively rich in nutrient elements. The cultiva-tion of salt-tolerant crops is effective on such soils [5].
Russian and foreign varieties, hybrids and sterile lines of Sweet sorghum, Sudan grass, and Sorghum-Sudan hybrids have a relatively high drought resistance (transpiration coefficient 230-300), but their cultivation in the North Caucasus is often combined with a high concentration of NaCl in the soil [4, 13]. To create salt-tolerant hybrids and varieties, special breeding programs for sorghum crops are carried out [8, 12]. The species composition, variety assortment and salinity tolerance largely determine the time of sowing and the density of Sudan grass and Sorghum-Sudan hybrids [6].
Literature sources show that the use of NH_4^+ increases the salt tolerance of plants by limiting the accumulation of Na^+ [15]. In Sweet sorghum, the concentration of Na^+ in the roots decreases, which ensures their low concentration in the shoots by protecting the photosynthesis structures [18, 19]. Under

conditions of salinity stress, Arabidopsis improves the ability of photosynthesis [9]. Wheat increases salt tolerance when its seeds are treated with sorghum extracts [3]. Jasmonic and humic acids improve the salt tolerance of plants due to an increase in antioxidant enzymes [2, 14]. The increased activity of such enzymes points to better compartmentalization of Na^+ under salinity stress condition [1]. Transgenic hybrids in conditions of significant salinity of the soil show higher concentration of chlorophyll and provide better yields [11]. The locuses of quantitative traits of salinity stress adaptibility serve as target sites for selection using marker assisted selection (MAS) to improve salt tolerance [17].

The aim of the research is to clarify the methods of laboratory evaluation of salt tolerance and to determine its level under exogenous exposure to sodium chloride (NaCl) in new varieties of Sudan grass, sterile female parent lines of Sorghum, and the degree of inheritance of this trait in Sorghum-Sudan hybrids obtained on their basis.

MATERIALS AND METHODS

In the arid conditions of the North Caucasus, information about the degree of salt tolerance of sorghum plants during the first growing season contributes to their profitable cultivation on saline soils. Clarification of the conditions of seed cultivation, NaCl concentrations, and the study of the results of their growth under saline conditions was the aim of the research. Seeds of the same size without visible infection and damage were selected for trial establishment. They were sprouted in sterile Petri dishes. The sample size was 100 seeds in four-fold replication for each variant. The seeds were germinated on filter paper moistened with distilled water (control) or salt solutions (experimental versions). The concentration of NaCl in the solution was 0.15%, 0.3, 0.6, 1.0, and 1.5%. All variants were kept for 8 days in an aeration bath with the temperature of 24-25°C. We took into account the energy and laboratory germination, the length of the shoot and root. The basis for the evaluation of salt tolerance was the methods of Ivanov Yu.M., Udovenko G.V. [10], Semushkina L.A. [16] and our own research [12].

In the experiment, we studied the seeds of 4 sterile female parent lines of Sorghum (Zersta 90C, Zersta 38A, A-63, Knyazhna), 5 varieties of Sudan grass (Zemlyachka, Sputnitsa, Nika, Zlata, Sofia) – fertility restorers (Table 1) and 11 new Sorghum-Sudan hybrids obtained on their basis (Table 2). The Navigator (Zersta 90S x Zemlyachka) and Gvardeets (Zersta 90S x Sputnitsa) hybrids have been in the register of selective breeding results of the Russian Federation from 2007 to 2020, respectively. Salt tolerance of 11 varieties of Sudan grass selected by other Russian and foreign breeding centers was determined (Table 3).

RESULTS AND DISCUSSIONS

Minimal growth inhibition and accumulation of biological mass of seedlings of the studied plants in a solution of NaCl in comparison with the control version indicates the stability of the sample. In the results of salt tolerance studies presented in tables 1 – 3, a high seed germination rate was established on the control variant without NaCl, the minimum experiment rate of which was 92%.

0.15% solution concentration in some cases increases the seed germination in comparison with the control. A noticeable decrease in germination to 84-94% in sterile female parent lines was found at 1.0% NaCl, and at 1.5% it decreased to 23-80%. The lowest rate (23%) was obtained at the A-63 line.

Paternal varieties of Sudan grass reduced germination to 68-87% at 1.0% NaCl concentration and to 45-74% at 1.5% salinity. The most significant seed germination at 1.0% salinity (82-87%) was obtained in the varieties Zemlyachka, Sputnitsa and Zlata, at 1.5% solution concentration – in Zemlyachka (74%) and Nika (62%).

Table 1. Seed germination and the length of seedlings of the seed parents, depending on the degree of salinity of the aqueous solution

Name of the variety, line	Control, without NaCl			NaCl concentration											
				0.3%			0.6%			1.0%			1.5%		
	seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm	
		shoot	root		shoot	root		shoot	root		shoot	root		shoot	root
Sterile female parent lines of Sorghum															
Zersta 90C	98	6.6	6.8	94	7.6	5.5	92	7.0	5.9	90	5.1	2.2	44	2.4	0.7
Zersta 38A	99	7.1	7.5	96	6.2	6.1	97	4.0	6.2	94	3.0	5.5	76	1.3	2.2
A-63	99	7.0	6.7	91	6.7	4.5	89	3.8	5.9	84	3.0	3.4	23	1.4	1.2
Knyazhna	99	7.7	8.9	98	6.2	6.7	90	6.4	5.3	90	5.8	5.3	80	2.7	2.1
Paternal varieties of Sudan grass – fertility restorers															
Zemlyachka	98	9.2	9.6	90	7.1	4.7	89	6.5	4.6	87	2.3	2.3	74	1.4	0.9
Sputnitsa	98	9.8	9.6	94	9.1	7.8	93	6.2	7.6	82	2.0	1.6	45	0.9	1.0
Nika	98	8.9	10.5	98	8.5	9.7	97	5.9	3.8	68	5.3	2.1	62	1.4	1.1
Zlata	99	9.0	12.5	9.8	9.1	6.3	97	5.7	5.8	82	5.0	5.9	52	0.3	0.5
Sofia	97	7.8	11.7	93	6.7	9.0	89	5.5	6.0	76	4.3	5.0	49	2.6	2.0

Source: developed by the authors based on [10].

Table 2. Influence of soil salinity of NaCl on germination rates and seedling length of the new obtained Sorghum-Sudan hybrids

Name of the hybrid	Control, without NaCl			NaCl concentration											
				0.3%			0.6%			1.0%			1.5%		
	seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm	
		shoot	root		shoot	root		shoot	root		shoot	root		shoot	root
Zersta 90C x Zemlyachka	99	8.9	10.3	95	7.3	8.9	91	6.8	6.9	68	2.3	3.4	22	0.9	1.8
Zersta 90C x Sputnitsa	99	7.6	11.3	97	7.3	10.2	96	5.7	7.4	63	2.3	3.3	19	1.0	1.7
A-63 x Sputnitsa	96	6.8	9.6	89	6.7	6.9	73	4.6	6.5	42	1.8	2.0	8	0.5	1.1
Zersta 90C x Nika	94	9.0	9.5	94	7.0	7.9	89	4.4	6.3	34	1.1	2.9	17	0.9	1.2
A-63 x Nika	99	7.9	10.5	97	5.3	8.0	96	5.2	7.2	73	2.3	3.8	9	0.8	1.2
Zersta 38A x Nika	97	7.3	8.8	95	7.0	7.7	78	3.4	6.1	51	2.8	4.2	4	0.9	1.7
Knyazhna x Nika	97	7.4	8.7	81	5.0	5.2	67	4.1	3.5	44	3.3	2.5	10	1.0	0.8
Zersta 38A x Sputnitsa	99	7.1	11.9	96	5.2	9.7	82	4.1	5.9	39	2.7	4.1	8	0.6	1.6
Knyazhna x Sputnitsa	99	6.3	6.0	96	6.7	5.2	88	4.2	5.0	62	1.8	0.6	39	0.5	0.5
Zersta 90C x Sofia	98	8.4	9.9	95	5.1	6.8	78	3.8	6.5	59	3.2	3.1	10	1.0	2.2
Zersta 90C x Zlata	99	7.3	9.0	94	5.8	7.6	89	2.8	5.4	50	2.0	2.5	12	0.8	1.4

Source: developed by the authors based on [10].

Table 3. Seed germination rates depending on the degree of soil salinity in varieties of Sudan grass

Name of the variety	Control, without NaCl			NaCl concentration											
				0.3%			0.6%			1.0%			1.5%		
	seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm		seed germination, %	length, cm	
		shoot	root		shoot	root		shoot	root		shoot	root		shoot	root
Alexandrina	97	7.0	7.5	92	5.9	6.9	92	6.1	5.1	82	3.1	3.1	57	1.8	1.9
Anastasia	97	7.3	6.8	94	6.7	6.0	91	6.2	5.9	81	4.5	5.0	43	1.3	1.2
Fioleta	92	10.2	11.7	86	8.5	6.6	80	6.2	7.0	72	6.9	4.6	51	1.6	0.7
Zernogradskaya 576	93	9.4	6.4	78	8.2	5.7	75	7.2	4.2	69	4.0	2.9	14	2.0	0.5
SVE Bulgaria	99	6.8	10.7	95	4.6	6.7	93	4.0	6.3	82	2.7	3.7	32	0.3	2.0
Udacha	96	5.1	8.3	98	5.0	6.4	90	4.4	8.7	78	3.1	5.1	17	0.6	0.7
Mechta Povolzhya	98	10.3	14.3	98	8.3	12.1	94	6.1	6.7	65	1.5	1.9	54	0.4	1.0
Spartanka	98	7.1	8.6	93	6.2	6.9	88	3.5	4.7	63	2.8	3.5	23	2.3	1.8
Evgenia	94	8.5	11.6	90	8.0	12.9	80	6.9	12.7	74	4.7	7.1	53	1.3	0.5
Yubilejnaya 20	92	10.2	9.6	89	8.7	9.2	77	7.0	6.3	65	1.7	2.5	28	1.3	1.0
Zonalnaya 6	97	8.9	8.1	95	6.5	6.9	87	2.3	3.6	81	3.2	1.9	27	0.6	0.5

Source: developed by the authors based on [10].

In the obtained Sorghum-Sudan hybrids, the seed germination in the control variant and at 0.15% solution concentration had the same rate and varied within 93-99%. Increasing the degree of salinity to 0.3% reduced seed germination by 2-8%. At a solution concentration of 0.6%, the germination rate decreased to 67-96%. The lowest (67%) rate was in the new hybrid Knyazhna x Nika, and the highest (96%) in the combinations of Zersta 90C x Sputnitsa (Gvardeets) and A-63 x Nika. Increasing the NaCl content to 1.0% and 1.5% reduced the germination rate to 34-73% and 4-39%, respectively. The highest seed germination at 1.0% and 1.5% NaCl concentration was obtained in recognized Navigator hybrids, Gvardeets and Knyazhna x Sputnitsa combinations.

In A-63 x Nika, 1.0% concentration of the solution provided seed germination of 73%, and 1.5% – 9%. Thus, taking into account high doses of NaCl (1.0%), the maximum germination rates were obtained in Sorghum-Sudan hybrids Navigator, Gvardeets, A-63 x Nika, Knyazhna x Sputnitsa. In the presence of salt in the solution of 0.6% or less in the above combinations, the seed germination had standard rates. The solution concentration of

1.5% reduces the germination rate in these variants to 9-39%. At the same time, at this concentration, the germination rate of the female parent of Zersta 38A was 76%, the male parent of Zemlyachka – 74%, Nika – 62%.

Seed germination rates are important but in most cases they are approximate and do not always correlate with the true salt tolerance of varieties and hybrids of sorghum crops. A more significant correlation with productivity in the field was established when evaluating salt tolerance according to the length of the shoots and roots of the sprouts [10, 12].

When a minimum dose of NaCl (0.15%) was added to the solution, in addition to a slight change in germination, the sizes of the root and shoot also fluctuated. In comparison with the control, the concentration of 0.15% in sterile lines increased the length of the shoot by an average of 0.3-0.4 cm, and the root by 1.5 cm. The paternal varieties of Sudan grass showed a decrease in the length of the shoot by 1.9 cm, and the root by 2.9 cm.

In Sorghum-Sudan hybrids, the averaged data also show a decrease in the size of the shoot to 3.3 cm and the root by 0.9 cm when sowing in a solution with a minimum salt concentration.

The increase in NaCl concentration to 0.3% also did not cause a significant reduction in the length of the shoot and root of seedlings in comparison with the control data. In most variants, the rates were similar to the data, as at 0.15% salt concentration. The increase in NaCl to 0.6% provided a slight decrease in the length of the shoot in comparison with the control by 1.8-2.9 cm and 2.0-5.4 cm of the root, but in general these rates had high values – 4.8-6.0 cm.

A significant reduction in the length of seedlings was found with an increase in NaCl concentration to 1.0% -2.2-4.4 cm in the shoots and 2.4-3.9 cm in the roots. 1.5% salt concentration reduced these values to 0.8-2.0 cm and 1.3-1.5 cm, respectively. At a salt solution concentration of 1.0-1.5 %, there is a decrease in the length of Sorghum-Sudan hybrid seedlings in comparison with their seed parents by 1.2-1.5 cm. At a salinity of 0.15-0.6%, such variations were not established.

In the sterile line of Zersta 90C, fertility restorers of the varieties of Sudan grass Zemlyachka, Sputnitsa, as well as obtained on their base recognized Sorghum-Sudan hybrids Navigator (Zersta 90C x Zemlyachka) and the new combination of Gvardeets (Zersta 90C x Sputnitsa), the length of the shoot and root of the seedlings with NaCl concentration of 0.15 and 0.3% were identical to the values of the standard variants. The solution concentration of 0.6% tended to slightly reduce the length of the shoot of the seedlings by 0.6-2.9 cm and the root by 0.1-2.8 cm. At the same time, the length of the shoot and the Navigator hybrid had a value of 6.8 cm, and the root of 6.9 cm. The average data of their parents were 5.3 cm and 6.7 cm, respectively.

The new hybrid Gvardeets had similar measurements in the shoot – 5.7 cm, the root – 7.4 cm, and their seed parents had 6.6 cm and 6.8 cm. This indicates a better toleration of the roots of the seedlings of both hybrids and the shoot of the seedlings of the Navigator hybrid to salinization with 0.6% solution.

The further increase in the concentration of the soil solution significantly reduced the length of the seedlings to 1.6-3.4 cm with 1.0% NaCl concentration and 0.7-2.4 cm in the 1.5% variant. As with 0.6% salt concentration in Sorghum-Sudan hybrids in comparison with the shoot, longer measurements were obtained in the roots – 0.95 cm and 1.75 cm, respectively, with 1.5% NaCl concentration and 2.3 cm and 3.4 cm in 1.0% solution. As for their seed parents, a certain pattern in the size of the roots and shoots was not established. In the Navigator and Gvardeets hybrids, the size measures of the shoots and roots at a salt concentration of 0.6-1.5% were among the highest. The significant measurements of the shoot length were obtained in the combinations of Zersta 90C x Sofia and Knyazhna x Nika, the root length – Zersta 90C x Sofia, Zersta 38A x Sputnitsa and Zersta 38A x Nika. Among the other varieties of Sudan grass, the most salt-tolerant were the varieties of Alexandrina and Fioleta. In the Bulgarian variety SVE, with 1.0% NaCl concentration in the solution, the seed germination rate was 82%, but with its increase to 1.5% – 32%.

The increase in the level of salt tolerance among the obtained Sorghum-Sudan hybrids in comparison with their seed parents was not established.

CONCLUSIONS

The most significant seed germination of the Sudan grass at 1.0% salinity (82-87%) was obtained from the Zemlyachka, Sputnitsa and Zlata. At 1.5% solution concentration – in Zemlyachka (74%) and Nika (62%).

In Sorghum-Sudan hybrids with 1.0% NaCl salinity, the maximum germination rate was obtained in Navigator (68%), Gvardeets (63%), A-63 x Nika (73%) and Knyazhna x Sputnitsa (62%). With 0.6% salt concentration or less, the germination rate was standard.

At 0.6-1.5% salt solution concentration, the most significant size measurements of the shoots and roots were found in the Navigator and Gvardeets hybrids.

The increase in the level of salt tolerance among the obtained Sorghum-Sudan hybrids in comparison with their seed parents was not established.

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THE DEVELOPMENT OF TRITICALE PRODUCTION IN TURKEY: THE CASE OF CORUM PROVINCE

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Abstract

In this study, socio-economic structure and producing problems of triticale cultivation farms in Corum province were analysed. The study was carried out in Sungurlu district of Corum Province where the triticale cultivation is intensive in 2019 production period. According to the Neyman method, the sample farms were determined, and the data were obtained by face-to-face interviews with 53 triticale cultivate farmers. The farms were classified according to their size as Group I (≤ 15.00 decares; 18 farms), Group II (15.01-25.00 decares; 16 farms), and Group III (>25.01 decares; 19 farms). Average triticale land presence in farms was 27.26 da, and the share of triticale lands in total land presence was calculated as 9.58 %. It was determined that the average farmers' age of 46.36 years, duration of education received 8.19 years, an average of 5.02 people per house, and 2.11 years of experience in the farmers' triticale cultivation. It was determined that the most important problems of the farms having problems in triticale production; were high input costs, proper credit and fertiliser supply, low triticale sales price, cooperation and organisation between farmers, quality seed supply, water and irrigation problems. Triticale has become an important product for human and animal nutrition due to its ability to grow in marginal environments and its nutritional properties. It is thought that triticale production will increase in the coming years in the region if the triticale farmers' problems are solved.

Key words: *triticale, production, farming problems, socio-economic structure, Turkey*

INTRODUCTION

Cereals are the most significant cultivated crops and reason for the primary energy and protein source for both humans and animals' nutrition [8, 9]. Cereals are a group of plants in the Graminae (*Poaceae*) family. Cereals are divided into two critical groups according to climate demands. These are cool-climate cereals and warm climate cereals. Among the cool-climate cereals are wheat (*Triticum*), barley (*Hordeum*), oat (*Avena*), rye (*Secale*) and triticale (*xTriticosecale*) plants [1].

Among cool-climate cereals, the most grown crop in the world is wheat. Barley, oats, rye and triticale are the most planted areas after wheat. Triticale is the 5th most grown among cool climate cereals plant [3].

Triticale (*xTriticosecale*), the product of wheat and rye hybridisation, was proved high yield potential even under adverse growing (resistant to cold and drought) conditions [7]. Also, the nutritional value it contains is higher than wheat and rye [6].

As a global product, triticale production in the world was slow until 1985. Since then, triticale production and cultivation area have increased rapidly. In 2019 years, the total area cultivated to triticale worldwide is roughly 3.8 million ha. In the same year, production was 14 million tons (Fig. 1).

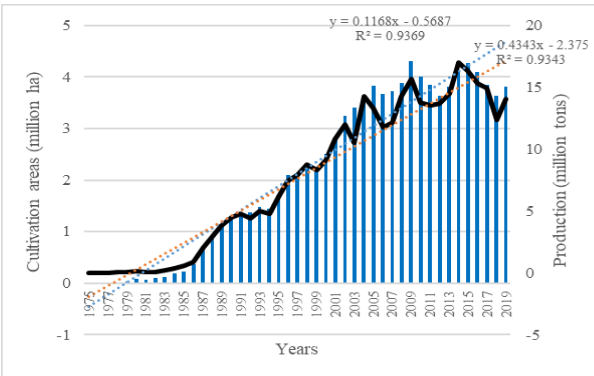

Fig. 1. Triticale cultivation areas (million hectares) and production (million tons) in the world
Source: [3].

Turkey is ranked number eleventh in the world by triticale cultivation area share of 1.53% after Poland (34.53%), Belarus (11.92%), Germany (9.41%), France (8.02%), Spain (6.59%), China (5.54%), Russian (3.56%), Lithuania (2.77%), Hungary (2.20%) and Romania (2.07%) (Fig. 2).

Turkey is ranked number twelfth in the world with a triticale production share of 1.53% after Poland (31.99%), Germany (15.61%), France (11.67%), Belarus (9.32%), Spain (4.27%), China (3.20%), Russian (2.53%), Lithuania (2.47%), Hungary (2.41%), Austria (2.32%) and Romania (2.23%) (Fig. 3). Accordingly, a third of triticale agriculture is carried out in Poland regarding both production and cultivation area.

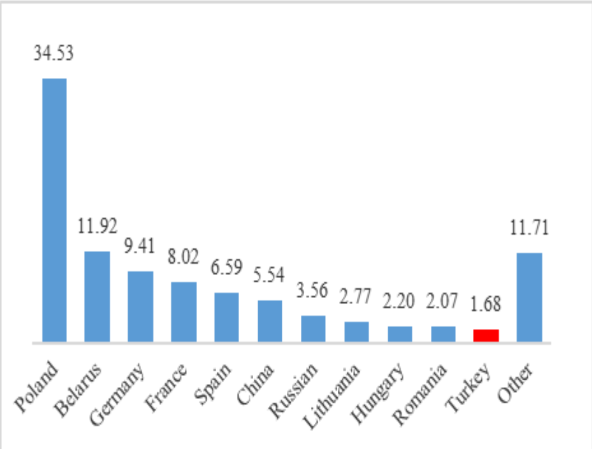

Fig. 2. The shares of countries in the world triticale cultivation area (%)
Source: [3].

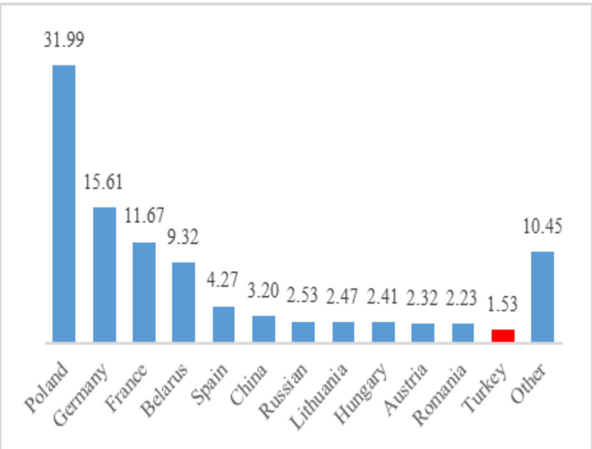

Fig. 3. The shares of countries in the world triticale production
Source: [3].

According to 2019 data, Turkey's triticale planting area has 641 thousand decares. The production amounted to 215 thousand tons. Triticale yield is 336 kg per decare. Triticale cultivation areas increased by 123%, and production amounts increased by 128% compared to the average of 2004-2006. The yield per decare remained almost the same. It increased by 2.13% in the same periods (Table 1).

Corum province as of 2019 in terms of production and cultivated area of triticale is in first place in Turkey. The Corum's triticale cultivated area share is 26.47%, and production share is 26.78% of Turkey. Sivas is the second important triticale producers with 7.52% share of Turkey, Mugla is third with 6.02%, Denizli is fourth with 4.66%, Konya ranks is fifth with 4.09% (Table 2).

Table 1. Triticale production in Turkey

Years	Cultivation area		Production		Yield
	Da (1000)	Index	Tons (1000)	Index	Kg/da
2004-2006	287	100.00	94	100.00	329
2007-2009	278	96.70	93	98.94	335
2010-2012	296	103.19	101	107.45	341
2013-2015	358	124.84	118	125.53	328
2016	376	131.11	125	132.98	332
2017	456	159.01	150	159.57	329
2018	503	175.18	170	180.85	338
2019	641	223.32	215	228.82	336

Source: [11].

Table 2. Triticale production in Turkey by province

Provinces	Cultivation area		Production		Yield
	Decares (1000)	Share (%)	Tons (1000)	Share (%)	Kg/da
Corum	170	26.47	58	26.78	340
Sivas	48	7.52	13	6.11	273
Mugla	39	6.02	17	8.06	449
Denizli	30	4.66	10	4.78	344
Konya	26	4.09	9	4.21	345
Other	328	51.23	108	50.06	318
Turkey	641	100.00	215	100.00	336

Source: [11].

Triticale is a grain with resistance and tolerance to the research area's climate, cold and drought. Due to the low nutritional value of rye and low oat yield, triticale has become an alternative product in low wheat yield regions. For this reason, triticale has become a new crop for Turkish farmers [2].

Figure 4 presents the share of Corum province in Turkey according to the area of triticale production, and cultivation is presented. Corum is Turkey's highest triticale producer.

Corum province in 2004, a total of 95 thousand tons of triticale was produced by making 300 thousand decares of triticale in the field. The cultivation area has started to increase since 2015. The production also increased with an increase in cultivation areas. The last five years (2015-2019) of triticale production and cultivation of the Corum's share increased to about 30% in Turkey. As of 2004-2019 years of triticale production share's 0.70% to 26.7% in Turkey was carried out by Corum. In 2019, a total of 58 thousand tons of triticale was produced by making 641 thousand decares of triticale in the Corum.

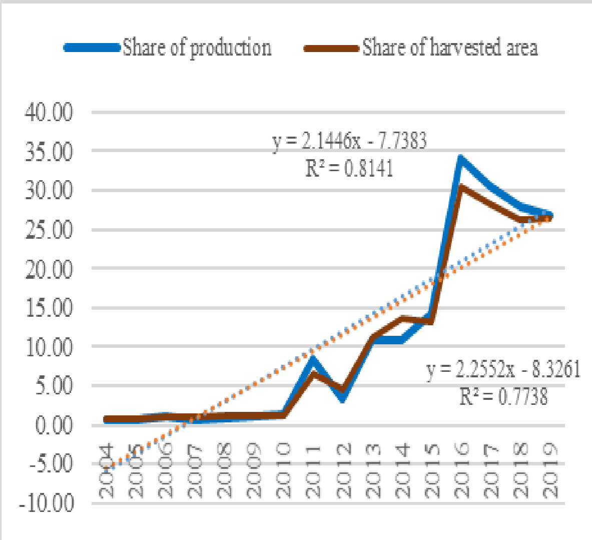

Fig. 4. Corum's triticale production and harvested area share in Turkey
Source: [11].

Studies on the socio-economic structure about triticale are very few. In this study, socio-economic structure and producing problems of triticale cultivation farms in Corum province were analysed.

MATERIALS AND METHODS

The study's primary material was comprised of original data obtained via face-to-face survey method from 53 triticale farms at the Sungurlu district of Corum province. Corum province has 24.47% triticale production area and 26.78% triticale production of Turkey. For this reason, Corum province was chosen as the study area. In addition to similar studies conducted by the related people and institutions, reports and statistics were used. Survey data belongs to the 2019 production period.

Neyman Method was used to determine the sample volume of the survey [13]. The number of samples was calculated with the formula given below.

$$n = \frac{(\sum N_h S_h)^2}{N^2D^2+\sum N_h S_h^2} \qquad (1)$$

n; Sample size, N; Total number of units in the population, Nh; Number of units in group h, Sh; Standard deviation of group h, Sh^2; Variance of group h, D^2; d^2/z^2, d^2; Allowed error from population average, z^2; Value of the allowed safety limit in the distribution table.

The producers participating in the research were divided into groups according to their triticale production areas. According to this, the farms were divided into three groups as "I. Group (15 decares and less; 18 farms), II. Group (15.01-25.00 decares; 16 farms) and III. Group (>25.01 decares; 19 farms)" (Table 3). The data obtained from the identified farms through questionnaires were uploaded to the computer environment and evaluated in tables by making calculations in Microsoft Excel and SPSS software.

Table 3. The sample volume of triticale producers

Groups	Triticale production area (decare)*	Number of farms	Percent
I	<15.01	18	33.96
II	15.01-25.00	16	30.19
III	25.01<	19	35.85
Total		53	100.00

Source: Own calculation.
*1 decares = 0.1 hectares

RESULTS AND DISCUSSIONS

Triticale farms were divided into three groups according to triticale production areas. The farms' average production area in the groups was determined as 13.06 decares for I. group farms, 21.25 decares for II. group farms, 45.79 decares for III. group farms and 27.26 decares for all farms. Of the 53 farms interviewed in the region; 18 farms were in I.

group, 16 farms were in II. group, and 19 farms were in III. group.

Table 4 presents the data on the age, education level, household population, farming experience and triticale cultivation experience. It was determined that the age averages of the producers varied between 45.56-47.44 years according to the farm groups, the duration of education varied between 7.83-8.26 years, the household size of the producers varied between 4.75-5.26 person, their farming experience varied between 24.56-25.00 years, and their level of experience in triticale cultivation varied between 1.89-2.26 years. It was determined that the region's farming experience period was high, but the triticale experience period was low. Tasci et al. (2014) [10], in a study, carried out in the same region, determined the average age of farmers at 54 years and the experience of farming at 33 years.

Although there were enough agricultural organisations in Turkey, there were problems in their economic activities and efficiencies [5]. Table 5 presents the membership status of triticale producers to agricultural organisations. It was determined that all farmers interviewed in the research area were members of agricultural organisations. The ratios of farmers who were members of the Chambers of Agriculture, Agricultural Credit Cooperatives, Agricultural Sales Cooperatives, Agricultural Development Cooperatives and Irrigation Cooperatives were determined respectively as 100.00%, 90.57%, 52.83%, 5.66% and 3.77%. It was observed that producers in all groups were members of the Agricultural Chambers. Besides, it was determined that all the producers in the I. group were members of the Agricultural Credit Cooperatives. Farmers' membership in the Agricultural Irrigation Cooperative was low (3.77%), as irrigated farming was limited in the research area.

Rotation is critical in reducing the population of post-harvest crop residues or disease organisms living in the soil. This system is very often used in the region, especially in grain cultivation. The application states of the rotation system of triticale farms were presented in Table 6. It was determined that farms that applied rotation varied 57.89% and 87.50% between groups, and the average of all farms was 75.47%. A quarter (24.53%) of farms did not implement the rotation system.

The land status of farms groups was provided in Table 7. It was determined that the triticale land size varied between 13.06 da and 45.79 da according to farm groups with an average of 27.26 da. The shares of owned land, rented land and sharecropped land in total land size were determined as 84.45%, 12.80% and 2.75%, respectively.

Table 4. Producers' features

Some social-economic indicators in triticale cultivation	Farm groups (da)			Average
	I	II	III	
Age (year)	47.44	45.56	46.00	46.36
Education level (year)	7.83	8.50	8.26	8.19
Population (person/family)	5.00	4.75	5.26	5.02
Agricultural experience (year)	25.00	24.56	24.74	24.77
Experience in triticale production (year)	1.89	2.19	2.26	2.11

Source: Own calculation.

Table 5. Cooperative membership of producers (%)

Agricultural organisations*	Farm groups (da)			Average
	I	II	III	
	Percent (%)			
Chambers Of Agriculture	100.00	100.00	100.00	100.00
Agricultural Credit Cooperatives	100.00	81.25	89.47	90.57
Agricultural Sales Cooperatives	61.11	50.00	47.37	52.83
Agricultural Development Cooperatives	5.56	12.50	0.00	5.66
Irrigation Cooperatives	0.00	6.25	5.26	3.77
Others	0.00	0.00	10.53	3.77

Source: Own calculation.
*Farmers are members of one or more agricultural organisations.

Table 6. The rotation application status of producers

Do you apply rotation?	Farm groups (da)						Average	
	I		II		III			
	N	%	N	%	N	%	N	%
Yes	15	83.33	14	87.50	11	57.89	40	75.47
No	3	16.67	2	12.50	8	42.11	13	24.53
Total	18	100.00	16	100.00	19	100.00	53	100.00

Source: Own calculation.

Table 7. Savings of triticale cultivation area in farms (da, %)

Land savings status	Farm groups (da)						Average	
	I		II		III			
	da	%	da	%	da	%	da	%
Own property	12.22	93.57	18.75	88.24	36.84	80.45	23.02	84.45
Rent	0.00	0.00	1.25	5.88	8.68	18.96	3.49	12.80
Sharecropper	0.84	6.43	1.25	5.88	0.27	0.59	0.75	2.75
Total	13.06	100.00	21.25	100.00	45.79	100.00	27.26	100.00

Source: Own calculation.

Table 8. Grown products in farms (da, %)

Products	Farm groups (da)						Average	
	I		II		III			
	da	%	da	%	da	%	da	%
Barley	60.67	27.39	80.94	27.62	102.11	30.29	81.64	28.69
Wheat	38.06	17.18	52.19	17.81	59.21	17.56	49.91	17.54
Sugar beet	32.61	14.72	33.75	11.52	52.11	15.46	39.94	14.04
Chickpea	18.44	8.32	46.88	16.00	28.42	8.43	30.60	10.75
Triticale	13.06	5.90	21.25	7.25	45.79	13.58	27.26	9.58
Onion	9.17	4.14	5.75	1.96	2.37	0.70	5.70	2.00
Sunflower	6.94	3.13	7.19	2.45	2.11	0.63	5.28	1.86
Fallow	42.56	19.22	45.06	15.98	45.00	13.35	44.19	15.54
Total	221.51	100.00	293.01	100.00	337.12	100.00	284.52	100.00

Source: Own calculation.

Table 9. Problems faced by farms in triticale production

Problems	Farm groups (da)			Average
	I	II	III	
	%			
High input costs	31.48	31.25	29.82	30.82
Proper credit supply	18.52	22.92	14.04	18.24
Fertilizer supply and fertilization	11.11	20.83	19.30	16.98
Low triticale sales prices	22.22	8.33	17.54	16.35
Cooperation and organization between producers	12.96	0.00	7.02	6.92
Quality seed supply	1.85	4.17	5.26	3.77
Water supply and irrigation problems	1.85	6.25	1.75	3.14
Other problems	0.00	6.25	5.26	3.77
Total	100.00	100.00	100.00	100.00

Source: Own calculation.

Table 10. Suggestions of farmers' for the improvement of triticale production

Suggestions	Farm groups (da)			Average
	I	II	III	
	%			
Triticale support fee should be increased	27.50	17.14	23.81	23.08
Irrigable land should be increased	22.50	31.43	16.67	23.08
Input prices should be reduced	17.50	14.29	19.05	17.09
Efficient seed varieties should be used	15.00	14.29	9.52	12.82
The sale price of the product should be increased	7.50	8.57	14.29	12.82
Supports should be paid on time	10.00	14.29	16.67	11.11
Total	100.00	100.00	100.00	100.00

Source: Own calculation.

The production pattern of the interviewed farms was presented in Table 8. The share of triticale cultivation areas in the farms' total land assets was determined as 5.90% and 13.58% within the group, with the average of all farms being 9.58%. It was determined that as the farms' size increased, the share of triticale production in total production also increased. Barley ranks first with a share of 28.69% in total land assets according to agricultural averages. This was followed by wheat (17.54%), sugar beet (14.04%) and chickpea (10.75%), respectively. Besides, onion (2.00%) and sunflower (1.86%) production was also observed in the farms' cultivated areas. The amount of fallow lands between farms groups varies between 42.56 decares to 45.06 decares. The fallow land average of all farms is 44.19 decares. The share of fallow lands in the total land area was determined as 15.54%.

In a study conducted in the same region [4], the production model of farms was determined as wheat (49.75%), barley (20.90%), vetch (13.68%), chickpeas (5.35%), onions (3.47%) and fallow land (2.27%), respectively.

Vural et al. [12] carried out a study entitled econometric analysis of wheat production in the same region. It was determined as a result of the study that the average land width of wheat at 83 decares.

The main problems faced by farms in triticale cultivation is presented in Table 9. According to the farms' average, the most important problem was determined as the high input prices (30.82%). This was followed by proper credits supply (18.24%), fertiliser supply and fertilisation (16.98%) and low selling price (16.35%), respectively. In addition to these problems, cooperation and organisation among producers (6.92%), quality seed supply (3.77%), water supply and irrigation problems (3.14%) was also observed in farms. It was determined that as the farms' size increased, the share of high input costs problem also decreased.

The farmers made some suggestions for the improvement of triticale production. These suggestions are presented in Table 10. According to the farms' average, the first suggestions were determined as the triticale support fee should be increased (23.08%) and irrigable land should be increased (23.08%). Input prices followed this should be reduced (17.09%), efficient seed varieties should be used (12.82%), the sale price of the product should be increased (12.82%) and supports should be paid on time (11.11%), respectively.

CONCLUSIONS

In conclusion, it was determined that the average ages of producers were 46.36 years, their duration of education were 8.19 years, their population of the household of the producers were 5.02 people and their farming experience was 24.77, their agricultural experience in triticale production was 2.11 years, cooperative membership share was 100%. It was determined that the most important problems of the farms having problems in triticale production; high input costs, proper credit and fertiliser supply, low triticale sales price, cooperation and organisation between producers, quality seed supply, water supply and irrigation problems.

If agricultural organisations' efficiency is increased, farmers can provide affordable inputs for production and sell post-harvest products at reasonable prices.

Triticale is advantageous compared to other grains due to its resistance to cold and drought, growing in poor and problematic soils, and high nutritional value. Therefore, it is thought that triticale production will increase in the region in the coming years.

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LPI-ASSESSMENT OF OUTSOURCING OF LOGISTICS SERVICES IN THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE

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Abstract

The article considers the types and functions of outsourcing of logistics services in the agro-industrial complex and the content of each level of the logistics concept of PL based on the International Classification. The article assesses the state and directions of attracting PL operators in the outsourcing services market in international and domestic practice, and systematizes the advantages and disadvantages of outsourcing for agro-industrial enterprises. It is proved that the degree of involvement of PL operators by enterprises depends on the level of development of the external logistics environment. It is proposed to use the Logistics Performance Index (LPI) to assess the level and prospects for the development of the outsourcing services market in the agro-industrial complex of Ukraine. The relationship between the quality of outsourcing services and the estimated indicators of LPI – "Customs", "Infrastructure", "International ships", "Logistics competence", "Tracking & tracing", "Timeliness" - is established. The identified problems of outsourcing logistics services in the agro-industrial complex of Ukraine and the reasons for their occurrence made it possible to structure the directions for improving all LPI components in the context of the prospects for delegating logistics functions to industry intermediaries.

Key words: *outsourcing, logistics services, agro-industrial complex, PL operators, Logistics Performance Index*

INTRODUCTION

The Fourth Industrial Revolution, which humanity is constantly striving for, involves the development and fusion of automated production, data exchange and production technologies into a single self-regulating system, with minimal or no human intervention in the production process. As Klaus Schwab, founder of the World Economic Forum in Davos, points out: "the latest technologies firmly connect the physical, digital and biological world. New business models are emerging, and production, consumption, transportation, and supply systems are being rebuilt. These changes – no more or less – are transforming humanity, so we need to learn how to manage them" [15]. This approach changes the quality of business process management of an individual enterprise and its relationships with counterparties, especially in the implementation of logistics functions. A professional approach to solving logistics problems actualizes the need to attract external operators to provide outsourcing services. This model ensures the transfer of non-core and highly specialized areas of customer activity to the existing business process and infrastructure of external companies, focusing on the implementation of a specialized type of activity in their enterprise.

The evolutionarily formed agro-industrial complex (AIC) of Ukraine is a consequence of integration intersectoral processes caused by the need to ensure organic unity between suppliers of material resources for agricultural production, direct production of crop and livestock products and interaction with processing enterprises and other service sectors that give agricultural products a marketable appearance and bring them to the end user [18]. Accordingly, the agro-industrial complex includes agriculture and certain industries, which is a complex sociotechnical system and partial or complete delegation of logistics functions to professionals will allow forming an effective logistics chain [8]. The quality of outsourcing services in the agro-industrial complex of Ukraine depends on the level of development of the external logistics environment, which requires an adequate assessment of the relevant indicators and the search for ways to use the identified reserves.

MATERIALS AND METHODS

To achieve this goal, we solved the following tasks: based on the dialectical method of cognition of objective reality and using the comparison technique, to assess the efficiency of logistics in Ukraine in the context of qualitative assessment logistics components adopted by the World Bank methodology in the global rating. Criteria for making appropriate decisions on the prospects for the development of the outsourcing services market in the agro-industrial complex of Ukraine are based on the method of structuring problems in the context of logistics components and determining the causes of their occurrence based on a historical approach. Using the monographic method of studying the activities of PL operators in the agri-food market of Ukraine, an abstract-logical research method was used for theoretical generalizations of the results of scientific research and the formation of conclusions and suggestions.

RESULTS AND DISCUSSIONS

The current stage of logistics development is characterized by the development of outsourcing as a method of focusing enterprise resources on the main activity with the delegation of non-core functions to ensure the smooth operation of individual systems to specialized companies for a long time.

The functions of outsourcing logistics services are shown in Figure 1. In international practice, 73.7% of warehousing functions, 68.4% of external, 56.1% of internal and 38.6% of direct transportation, as well as 61.4% of cargo clearance/payments and 40.4% of cargo consolidation functions are outsourced [14]. The importance of logistics outsourcing in the development of the global economy is evidenced by the annual expenses of business entities for contract logistics in the amount of 120-140 billion euros.

Development of logistics infrastructure capabilities, as evidenced by the experience of European countries, has led to changes in the ways and forms of interaction between logistics entities and this made it possible to distribute network organizational forms of business, virtualization of logistics processes, the use of electronic document management, electronic payments, and so on. In international logistics terminology, it is usually customary to refer to companies that provide services for manufacturers, suppliers and sellers of goods with the abbreviation PL (Party Logistics), which literally translates as “logistics side”. The logistics concept determines the degree to which other companies are involved in the customer's supply chain of services in order to solve their business problems. Logistics service operators in the EU are divided into five types: 1PL, 2PL, 3PL, 4PL, 5PL [12]. The higher the PL level, the more logistics functions are delegated to intermediaries.

The 1PL concept, as a rule, is autonomous logistics, when the cargo owner provides the implementation of logistics functions of transportation, storage, cargo handling, with his own resources.

2PL (Second Party Logistics) is a form of primitive outsourcing that involves solving issues of transportation and technical inventory management based on contractual obligations with a third – party specialized company.

3PL (Third Party Logistics) is a more developed form of outsourcing, which involves expanding the standard list of services with non – standard ones, namely performing cargo handling, sorting, packaging or other manipulations with cargo that form added value. A characteristic feature of this stage is that the participation of transport and logistics companies is reduced to the high-quality performance of a certain set of operations, and not the management of supply chains as a whole [10].

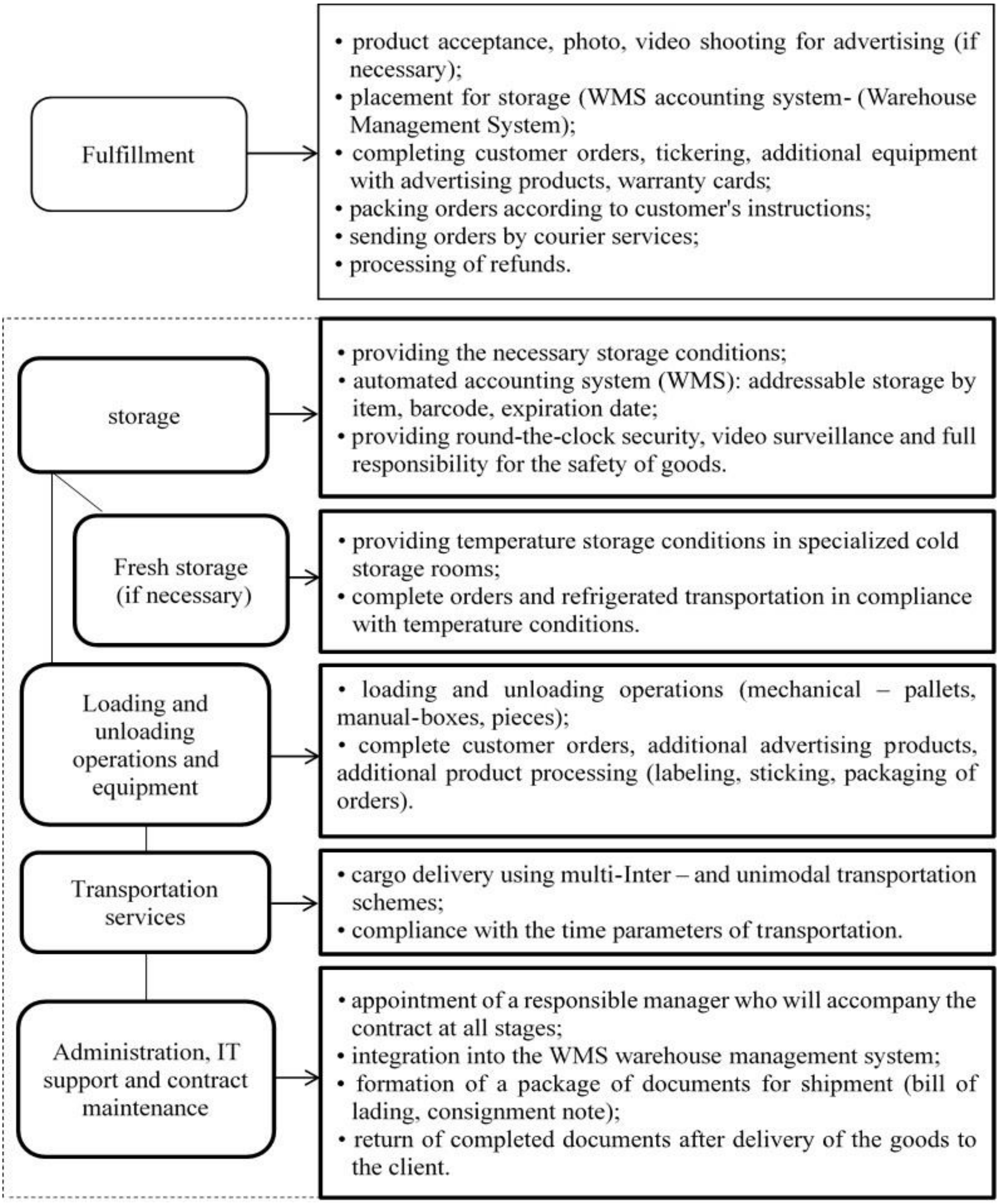

Fig.1. logistics service outsourcing functions.
Source: created by authors.

4PL (Fourth Party Logistics) – integration of all companies involved in the supply chain by an integrator company that accumulates its resources, capabilities and technologies with the potential of other, usually 3PL providers, to design and implement integrated supply chain management solutions. If the services of 3PL providers relate to the performance of tactical tasks of customers, then 4PL – strategic goals.

5Pl (Fifth Party Logistics) – the highest level of the conceptual model of logistics outsourcing, associated with the management of all components of a single cargo supply chain using modern network computer technologies. In fact, this is the orientation of the 4PL provider to a single virtual platform for performing a full range of logistics tasks using the global Internet. The 5PL concept is a strategic goal of Global Logistics, which is based on the creation of a single Logistics Information Network and takes time to implement.

The underdevelopment of logistics outsourcing in Ukraine is caused by the practical absence of 4PL and 5PL operators of logistics services. This determined the inefficient structure of services, in which 89% are transport services, 8% are storage services, and only 3% are forwarding and supply chain management [13, p. 138]. This indicates an underdeveloped institutional environment and an insufficient number of companies that provide the full range of logistics services, and are not limited only to transport and warehouse support for the movement of material flows. Creating a logistics service system at the expense of 4PL-and in the future 5pl-operators of logistics services is one of the ways to improve the efficiency of enterprises of the agro-industrial complex of Ukraine.

International experience in the development of logistics outsourcing in the agricultural market has shown the significant role of cooperatives in the implementation of logistics functions for agricultural enterprises. Thus, in the countries of the European Union, cooperatives engaged in the wholesale purchase of means of production with their subsequent supply to the farms of their members form the second largest group after the procurement, processing and Marketing Cooperatives of agricultural products themselves. In particular, in Finland, the Central Industry Supply Association of Finnish agricultural cooperation supplies agricultural producers with about 60% of the means of production [3, p. 11-12], including up to 40% of technical means and fuel [16, p. 67]. In Sweden, supply and sales activities account for about 30-35% of the total turnover of farmers ' cooperatives. Cooperatives supply the bulk of fertilizers, seeds, mixed feed, fuel and lubricants needed by farmers, 13% of tractors, 43% of combine harvesters, 35-60% of other land processing and harvesting equipment. In total, they provide about 60 % of the supply of means of production [17].

Polish, German, French and Dutch cooperatives have made significant progress in ensuring agricultural production. In Germany, they supply 36% of machinery and equipment, up to 40% of mixed feed, 44% of fuel, about 50% of fertilizers and feed. In France, two – thirds of grain seeds, about 50% of fertilizers and feed are supplied through cooperatives, and in the Netherlands, the share of cooperatives in the supply of equipment to farms is 75%, mixed feed-53%, mineral fertilizers and plant protection products-60 % [17]. Significant success in cooperation of logistics functions in agricultural production has also been achieved in the USA, Great Britain, Canada, Switzerland and this experience is worth of attention for study and use by Ukrainian enterprises.

In procurement logistics, the "*Make-or-Buy Problem*" method is widely used, which in the process of managing the supply of resources for the enterprise solves the problem of expediency of independent production of the necessary parts, components, etc.or purchasing them from external sources. By analogy, we will consider the motivation in favor of using outsourcing schemes for the enterprise, namely:

-the need for individual services is low, so it is not profitable to produce them independently from the point of view of using the scale effect;

-there is great flexibility in choosing the right service providers for the enterprise, which creates the advantages of a competitive environment for the consumer;

-the company does not have the necessary resources and capacities, as well as administrative or technical experience to implement non-core functions for the enterprise.

Outsourcing for an enterprise may not be appropriate if::

-the need for individual services is stable, predictable, and quite large;
-existing service providers cannot provide the necessary standards for the quality of services, or specific requirements of the customer;
-the company has the appropriate resource potential for independent implementation of the necessary functions.

The advantages of outsourcing are:
-more efficient use of financial resources and increased profitability indicators by focusing the company's efforts on the core business with delegation of non core functions;
-the implementation of the main activity increases the competitive position of the enterprise and allows you to use all the advantages of specialization of production;
-using the experience of an outsourcing company for the enterprise will provide flexibility in the scale of production, since if the production program increases/decreases, the enterprise will need to hire/fire employees, not to spend on their training, workplace equipment, pay additional taxes, compensation, and so on. For an outsourcing company an increase or decrease in the customer's production scale will only be accompanied by a review of the cost of providing outsourcing services;
-the outsourcing company specializes in a certain type of activity and serves a large number of enterprises, which allows it to perfectly navigate all current issues and use the accumulated experience;
-delegating individual functions will ensure their reliability and stability, since the outsourcing company is responsible for the work performed in accordance with the service agreement and current legislation.

The disadvantages of outsourcing include:
-the threat of leakage of confidential customer information to competitors regarding the specifics of the technology, production and sales program, etc.;
-the time lag between the order and its execution by an outsourcing company in the case of periodic cooperation is usually longer than the implementation of the necessary functions by their own efforts.

To assess the effectiveness of logistics outsourcing, the service consumer evaluates the future effect of cooperation in relation to the costs incurred to achieve it [9]. When choosing a logistics operator, the main evaluation criteria are the cost of logistics services and the efficiency of their provision, as well as the accuracy of order fulfillment. At the same time, these criteria should be considered systematically in interrelation and interdependence.

A comprehensive assessment of Ukraine's place in the international logistics system is reflected in an internationally recognized evaluation indicator-the logistics efficiency index (*Logistics Performance Index – LPI*) [5, 1]. Of course, the degree of involvement of PL operators by enterprises depends on the level of development of the external logistics environment, so we suggest using LPI to assess the prospects for the development of the outsourcing services market in the agro-industrial complex of Ukraine.

The index was developed and first implemented in 2007 by the World Bank's Department of international trade and transport, together with the Turku School of Economics (Finland). In addition, the index has been approved and supported by the International Federation of Freight Forwarders Associations (FIATA), the Global Facilitation Partnership for Transportation and Trade (GFP) and the Global Express Association (GEA). LPI is formed from 1 to 5 points by evaluating six indicators [5]: "*Customs*" – efficiency of cargo clearance at the border and customs; "*Infrastructure*"- quality of infrastructure support for transportation and trade; "*International shipments*" - ease of organization and affordability of international transportation; "*Logistics competence*" – competence and quality of providing logistics services; "*Tracking & tracing*" – the ability to choose routes and control traffic; "*Timeliness*" – compliance with time parameters of deliveries. The value of the country's LPI indicator indicates the level of development of its integrated logistics system. Most of the functions that generate these metrics are implemented by PL operators.

For all the time of international comparisons, LPI was calculated six times and according to the results of monitoring trends and the degree of logistics development among 160 countries of the world, Ukraine took the 66th position in 2018 (Table 1).

The integrated logistics system of Ukraine is characterized by the development of the Tracking & tracing parameter, which is equal to 3.11 and determines its 56th place in the world ranking, as well as compliance with the time parameters of deliveries (3.42 or 56th place). The least developed parameters include the quality of trade and transport infrastructure, which for Ukraine is equal to 2.22, determining its 119th Place among the 160 countries of the world for which the LPI rating is calculated.

The rating of the most developed countries in terms of logistics is consistently headed by Germany, where the final LPI value in 2018 was 4.20 points. Germany was the best country in the rating in three indicators – Customs (4.09 points), Infrastructure (4.37 points) and Logistics competence (4.31 points). The top five most logistically developed countries in 2018 also included Switzerland (LPI = 4.05 points), Belgium (4.04 points), Austria (4.03 points) and Japan (4.05 points). But in some indicators, these countries are ahead of others that are lower in the rating. For example, Finland, although ranked 10th in the global LPI, ranks first in the world in terms of Tracking & tracing (4.32), ahead of its closest competitor, Germany, by 0.08 points. The United Arab Emirates is only 0.01 points behind Germany in terms of Timeliness (4.38), but at the same time it is on the 11th place in the overall LPI rating.

Table 1. Rating assessment of Ukraine by the LPI index

Rating indicators		2007	2010	2012	2014	2016	2018
Logistic Performance Index (LPI)	place	73	102	66	61	80	66
	index	*2.55*	*2.57*	*2.85*	*2.98*	*2.74*	*2.83*
Customs	place	97	135	88	69	116	89
	index	*2.22*	*2.02*	*2.41*	*2.69*	*2.3*	*2.49*
Infrastructure	place	74	79	70	71	84	119
	index	*2.35*	*2.44*	*2.69*	*2.65*	*2.49*	*2.22*
International shipments	place	83	84	83	67	95	68
	index	*2.53*	*2.79*	*2.72*	*2.95*	*2.59*	*2.83*
Logistics competence	place	90	77	61	72	95	61
	index	*2.41*	*2.59*	*2.85*	*2.84*	*2.55*	*2.84*
Tracking & tracing	place	80	112	50	45	61	52
	index	*2.53*	*2.49*	*3.15*	*3.2*	*2.96*	*3.11*
Timeliness	place	55	114	68	52	54	56
	index	*3.31*	*3.06*	*3.31*	*3.51*	*3.51*	*3.42*

Source: Prepared by the authors based on [11].

Integrated assessment of the functioning of logistics chains, evaluated in the context of all components (Customs, Infrastructure, International shipments, Logistics Competence, Tracking & tracing, Timeliness), is the basis for using the corresponding reserves. To do this, Table 2 systematizes the problems of logistics outsourcing development in the agro-industrial complex of Ukraine.

Ukraine, exporting grain to more than 100 countries and providing more than 150 million people with relevant food products, is among the top 5 global grain exporters. In particular, in 2014, Ukraine ranked second among the world's countries in terms of grain and processed products exports, second only to the United States, and the domestic agro-industrial complex came out on top in terms of foreign exchange earnings to the state budget, ahead of the traditionally export-oriented metallurgical industry. In the world ranking, Ukraine ranked second after the United States in terms of grain and processed products exports in 2014, and in terms of foreign exchange earnings to the state budget, the domestic agro-industrial complex took first place, ahead of the export-oriented metallurgical industry. The growth in the volume of grain exports and processed products from 33.4 million tons in 2014 to 42.9 million tons in 2018 [2, p.39] was caused by the positive dynamics of grain production from 63.9 million tons of grain and leguminous crops in 2014, up to 70.1 million tons. tons in 2018. Positive trends are also typical for the export of sugar (from 40 thousand tons in 2014 to 594 thousand tons in 2018), oil (from 4.5 million tons in 2014 to 6.0 million tons in 2018) [2, p. 42], vegetables (from 294 thousand tons in 2014 to 434 thousand tons in 2018) [2, p. 40], poultry products, etc. These data indicate a significant burden on customs and the attractiveness, given the scale, of providing outsourcing services to PL operators.

Table 2. Systematization of problems of logistics outsourcing development in Ukraine by LPI component

Logistics outsourcing functions	Main problems
Customs	
Customs broker services: ✓ preliminary calculation of the cost of export-import of cargo; ✓ registration of all documents required for customs formalities; ✓ making customs payments; ✓ legal support of foreign economic activity.	✓ bureaucratic barriers; ✓ inconsistency of Foreign Economic Policy (frequent changes in legislation and ambiguity of its interpretation); ✓ selective approach to various participants in foreign economic activity; ✓ slow work of Customs and border authorities.
Infrastructure	
✓ cargo handling (loading and unloading operations, order completion, etc .); ✓ storage (including fresh storage); ✓ transportation; ✓ IT support	✓ insufficient quantity and capacity of trade and transport infrastructure; ✓ obsolescence and physical deterioration of infrastructure facilities and vehicles.
International shipments	
✓ documentary support of cargo transportation; ✓ information support of product flows; ✓ organization of container transportation	✓ bureaucratization of licensing procedures; ✓ high transaction costs.
Logistics competence	
✓ implementation of functions at all stages of moving the material flow through logistics chains; ✓ administration, IT support, and contract maintenance.	✓ insufficient competence and awareness of transport operators and Customs Brokers; ✓ underdevelopment of logistics outsourcing.
Tracking & tracing	
✓ transportation; ✓ IT support.	✓ it is possible that the existing route does not correspond to the actual possibilities of its operation; ✓ availability of places on the territory of Ukraine where there is no technical possibility of cargo tracking.
Timeliness	
✓ cargo handling (loading and unloading operations, order completion, etc .); ✓ transportation.	✓ violation of delivery deadlines.

Source: created by authors.

The customs parameter, which evaluates the speed, simplicity and predictability of the cargo clearance process for the work of Customs and border authorities, is quite low in Ukraine (2.49 in 2018), which determines its 89th place in the global LPI rating. The main problems are the significant bureaucratization of Customs and licensing procedures, the lack of a clearly defined strategy for implementing the State Foreign Economic Policy, and a selective approach to individual subjects of foreign economic relations in terms of granting personalized permits, priority refund of Value-Added Tax, unjustified provision of quotas, preferences, etc. Many foreign companies that wanted to carry out their activities in Ukraine were forced to abandon their intentions precisely after independent contacts with Customs and border authorities. Imperfect legislation, which is manifested in the absence of bylaws on licensing procedures, causes corruption risks that increase the cost of providing outsourcing services. To combat corruption in the licensing system of Ukraine, it is necessary to reform the public administration system and distance it from business, as well as improve the efficiency of the newly created anti-corruption bodies and activate public control over the activities of customs authorities.

In the global LPI rating, Ukraine ranks 119th in terms of the quality of trade and transport infrastructure, which is the least developed component of domestic logistics (Table 1). At the same time, this component is most attractive for PL operators in the process of implementing logistics functions.

A characteristic feature for Ukraine is unsatisfactory quantitative and qualitative parameters of existing vehicles and infrastructure facilities. For example, at the beginning of 2018, out of the existing 14.5 thousand grain wagons (Hoppers), only 84% were in satisfactory working condition, because their average age was approximately 26.4 years. The mobile hopper fleet in Ukraine is one of the weakest links in grain logistics, which limits the development parameters of other elements of the logistics system, since it satisfies only 50-60% of agricultural traders' request. For full-fledged grain transshipment by rail, at least 22 thousand hoppers are needed, this forces traders to use Road Transport for Port grain transshipment during peak periods, and this increases transport costs of transporting a ton of grain from $ 10 to $ 41.3 [7].

The Infrastructure indicator is also affected by the obsolescence of infrastructure facilities in Ukraine that were built during back in Soviet times [6]. This explains their physical wear and tear and obsolescence, which hinder the development of logistics systems in Ukraine, while reducing the export and transit parameters of cargo flows. For example, in the grain market, most grain elevators use floor-standing grain storage technology (54%) compared to tower grain storage technology (46%). Enterprises with predominantly floor-standing storage tanks can provide much lower shipment intensity than enterprises equipped with vertical silo tanks. In general, at high-power grain elevators in Ukraine, the average speed of loading grain into railway cars is approximately 12 cars per day, which is 4.5 times lower than the optimal speed (54 cars). The problem of cargo handling at Grain Elevators is complicated by the lack of modern receiving devices that are not able to serve heavy-duty grain carriers, which increases the harvesting time.

In Ukraine, the width of railway tracks is wider compared to European countries and is 1520 mm against 1435 mm., which creates significant barriers to transit transportation, since at the border cars need to either be overloaded or change wheelsets. This increases transportation time and costs by addressing additional organizational and technological issues.

Adaptation of railway tracks to European standards is hindered due to:

(i)lack of locomotives and railcars for the width of European rails, as well as other infrastructure facilities for servicing railway rolling stock in Ukraine;

(ii)limited train speed due to the use of 25-meter rails, which are monopolistically manufactured at the Azovstal iron and steel works, while the average length of the European rail is 100 meters.

The country's attractiveness for transit traffic is largely determined by the international shipments indicator, which for Ukraine is 2.83, determining its 68th place in the global LPI rating.

The ease of organizing international transportation at competitive prices is significantly hindered by the bureaucratization of licensing procedures. Against the background of the corruption of the licensing and control system in Ukraine, legislative contradictions and the low level of awareness of international transportation operators, transaction costs for organizing transportation are significantly increasing. To simplify transit through the country's territory in modern realities, it is advisable to transfer the vast majority of logistics functions to Ukrainian PL operators. However, in the future, the current situation requires simplification of licensing procedures and increasing their transparency for foreign transit, organization of Call centers to form an appropriate information field, as well as activation of container transportation.

For Ukraine, as a grain exporter and a powerful international transit country, container transportation is extremely relevant and qualitative changes are already noticeable in this direction. In particular, according to the results of 2018, Ukrainian seaports handled 846.5 thousand TEU of container cargo, which is 18.7% more than in the previous year. The ports of Odesa, Pivdennyi and Chornomorsk became the leaders in container transshipment, while the Port of Pivdennyi increased container cargo transshipment in 2018 by 75%, and the port of Odessa – by 15%.

Insufficient competence of transport operators and Customs Brokers, complicated by the underdevelopment of logistics outsourcing in the country, determined the 61st place of Ukraine in the global rating according to Logistics competence. The reason for the decline in this component of LPI is the lack of effective training programs and trainings adapted to global requirements. The imperfection of educational services and the lack of effective advanced training programs and trainings, as well as the lack of adaptation of the knowledge of Ukrainian specialists to global requirements, significantly reduce this component of LPI.

The ability to set routes and track the passage of goods (Tracking & tracing) is the most developed component and determines the 56th place of Ukraine in the global rating. It should be noted that the presence of a road track on the map, especially in rural areas, does not always correspond to the possibilities of using it due to the state of emergency. We see the solution to these problems in ensuring high-quality repairs of roads and transport infrastructure, improving cartography and communication systems.

The use of special systems for Transport Management is becoming relevant for logistics operators, which will allow them to quickly solve their production tasks, as well as optimize growing costs. The implementation of TMS (Transport Management System) helps to move cargo much more efficiently, and in combination with the warehouse management system ("WMS (Warehouse Management system) Logistics. Warehouse management") you can get a full-fledged supply chain management system, which encourage further cost reductions and reduce the inefficiency of the company as a whole. WMS automates and optimizes warehouse processes at the enterprise with an accuracy of 99.5%, and allows you to reduce the number of staff required by 30% and increase the warehouse capacity by 10-15%.

In the practical activities of national agro-industrial companies and in the food distribution system for logistics and transportation, the following software products are popular:

(1)Antor LogisticsMaster, which has a mobile version of the service on the Ukrainian market and is called ASTOR: TMS (users: Cash & Carry, The Coca Cola Company, Groupe Danone, Nestle S.A., Global Spirits (TM "Khortytsia"), "Slavutych", etc.);

(2)MapXPlus Distribution, which monitors the operation of vehicles using GPS/GLONASS (users: "Nebesna Krynytsia", "Heineken N. V.", "Royal Canin", "Ukrsoyuz", "Danone Ukraine", "Rud", "Lactalis-Ukraine", "Galnaftogaz", etc.);

(3)Logist.ua, which includes enterprise transport planning, GPS monitoring and management functions (users: "Kuehne + Nagel Ltd.", "Agromars" (TM "Gavrylov's chickens"), Acme Color, etc.) [7].

In addition, the Ukrainian market uses such software products as 1C BIT, which can be integrated with standard configurations of the 1C: Enterprise 8 platform ("Trade Management", "Integrated Automation" and" Production Enterprise Management"), as well as Rational Logistics, which is used by more than 50 companies. Individualization of software products is provided on the basis of outsourcing services of IT companies. Of course, the active use and implementation of new software products can significantly improve the Tracking & tracing indicator of the global LPI index, which is facilitated by the powerful IT sector of Ukraine.

Another indicator of the LPI rating is Timeliness, according to which Ukraine is on the 56th place in the world ranking (Table 1). This indicator is determined by subjective (human factor) and objective organizational and technical reasons. Inconsistency of actions between elements of the logistics chain (insufficient organization of Integrated Systems) [4] is particularly critical for the logistics of milk, dairy products and other food products that quickly deteriorate and require special temperature storage conditions.

CONCLUSIONS

Thus, the experience of Europe has that with qualitative changes in logistics systems, modern management methods based on the PL concept are being updated. This concept is based on the degree of involvement of other companies to solve the business problems of the service customer. For the effective functioning of the Ukrainian agro-industrial complex, priority should be given to the development of 4PL–, and in the future- 5PL-logistics service operators. In the development of 4PL-and in the future 5PL-operators of logistics services, which are practically absent in Ukraine, we see a way to improve the efficiency of the functioning of agricultural enterprises.

The degree of involvement of PL operators by enterprises depends on the level of development of the external logistics environment, so we suggest using the Logistics Performance Index (LPI) to assess the prospects for the development of the outsourcing services market in the agro – industrial complex of Ukraine.

The LPI methodology developed and implemented by the World Bank takes into account the assessment of six indicators: “Customs”; “Infrastructure”; “International ships”; “Logistics competence”; “Tracking & tracing”; “Timeliness”. At the same time, there is a direct proportional relationship between the country's LPI indicator and its integrated logistics system. The LPI Rating study covers 160 countries, among which in Ukraine the most developed components are “Tracking & tracing” and “Timeliness”, and the least developed – the quality of trade and transport infrastructure (parameter “Infrastructure”).

The identified problems and the reasons for their occurrence made it possible to structure the main directions for improving all components of the global index, as the proposed basis for assessing the level of PL, which will help improve the efficiency of outsourcing logistics services in the agro-industrial complex of Ukraine.

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ANALYSIS OF CASHEW MARKETING EFFICIENCY IN EAST SUMBA DISTRICT, EAST NUSA TENGGARA, INDONESIA

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Abstract

This study aims on examining market structure of cashew, examining market behavior of cashew, and analyzing cashew market performance in Lambakara and Nggongi village. Cashew farming has contributed to providing livelihoods and job opportunities for many farmers, both as a side business and as a main business. The result of this study showed that cashew marketing structure tends to oligopoly that cashew farmers become price taker condition, market behavior of cashew in Lambakara and Nggongi village is not efficient yet where farmers are limited to gain price information and market performance of cashew in Lambakara and Nggongi village is not efficient yet. Performance analysis of cashew market in Lambakara and Nggongi village individually obtains selling margin up to Rp. 6,000 until Rp. 6,250 with high farmer share level which is 75% caused cashew farmers to have low benefits. Based on market efficiency level obtained from Lambakara and Nggongi markets individually obtained up to 57.5% until 62.67%, market efficiency value in Lambakara and Nggongi village is higher than 30%.

Key words*: cashew, market behavior, market efficiency, market structure*

INTRODUCTION

Cashew is an important commodity for the Indonesian economy. The economic value obtained from the cashew nut commodity is a contributor to foreign exchange through cashew exports in 2012 which reached 58.8 thousand tons or the equivalent of 115.5 million dollars and as a main job for many Indonesian people [5].

The development of cashew plant area in 2017 is spread across 24 provinces in Indonesia, the largest one is in the East Nusa Tenggara region, namely 171,086 ha with a production of 49,880 tons and productivity reaching 576 kg/ha with the number of farmers cultivating cashew nuts as many as 249,758 households [3].

As with agricultural commodities in general, the problem faced is the unstable price of cashew at the producer and consumer levels, which is partly due to the amount of production and marketing efficiency in East Sumba District. The distance between Lambakara village to the city is around 90 km, while Nggongi Village with hilly and steep terrain conditions is in the southern part of East Sumba with the distance to the city around 143 km, this causes its high transportation costs incurred by middlemen so that it can affect the price of cashew nuts at farmer level. This study aims on examining market structure, market behavior and market performance in Lambakara village and Nggongi village at East Sumba District.

MATERIALS AND METHODS

The population in this study were 312 cashew farmers in Lambakara Village, Pahunga Lodu District, and 111 cashew nut farmers in Nggongi Village, Karera District. Samples are taken by using snowball technique. Primary data is collected by questionnaire, interview and observation, while secondary data is taken from literature study and documentation study.

Descriptive qualitative analysis is used to analyze the market structure and market behavior of cashew in East Sumba Regency, while descriptive quantitative analysis is used to analyze market performance based on marketing margins and profit margins, farmer share, cost share and profit share of cashew nut marketing.

Systematically, marketing margin can be formulated as follows:

$$\mathbf{M = Bp + Kp}$$

where:
M = margin (Rp/kg)
Bp = marketing costs (Rp/kg)
Kp = marketing profit (Rp/kg)

Farmers share is used to determine the percent of farmers' selling prices to final consumers (price efficiency) using the formula:

$$FS = \frac{FP}{CP} \times 100\%$$

where:
FS = farmers share (%)
FP = farmers price (Rp/kg)
CP= costumer price (Rp/kg)

For marketing efficiency, the following formula can be used:

$$EP = \frac{TB}{TNP} \times 100\%$$

where:
EP = marketing efficiency (%)
TB = total cost (Rp)
TNP = total product value (Rp/Kg)

The decision rules on marketing efficiency are:
0-33% = Efficient
34-67% = Less efficient
68-100% = Inefficient.

RESULTS AND DISCUSSIONS

Characteristics of Cashew Farmers

Age can affect a person's work productivity. The more mature the farmer, the more his ability and way of thinking will be affected. However, the older farmers also affect his productivity.

Most of the farmers in East Sumba Regency who cultivate cashew nuts are over 50 years of age. The percentage of farmers over 50 years of age in Lambakara Village was 52.6% and Nggongi Village was 52.8%.

Table 1. Age distribution frequency of cashew farmers

Criteria	Lambakara		Nggongi	
	Frequency (person)	(%)	Frequency (persons)	(%)
30-40 years old	10	13.2	14	26.4
41-50 years old	26	34.2	11	20.8
> 50 years old	40	52.6	28	52.8
Total	76	100.0	53	100.0

Source: Processed primary data, 2020.

Farming experience will influence a person's behavior in cultivating his farming. Usually people who have been farming for a long time will have a lot of experience compared to novice farmers, so that it will affect the way they make decisions in their farming. 80.3% of farmers in Lambakara Village have been farming cashew nuts for more than 20 years as well as farmers in Nggongi Village, most of them (64.2%) have started to cultivate cashew nuts for more than 20 years.

Table 2. Distribution frequency of farming experience

Criteria	Lambakara		Nggongi	
	Frequency (person)	(%)	Frequency (persons)	(%)
1-10 years	6	7.9	7	13.2
11-20 years	9	11.8	12	22.6
> 20 years	61	80.3	34	64.2
Total	76	100.0	53	100.0

Source: Processed primary data, 2020.

The number of cashew plants is one of the things that can affect the production of cashew nuts produced. In general, as with the land area, the more the number of cashew plants, the greater the amount of production produced. Most of the farmers with cashew plants in Lambakara Village (52.6%) ranged from 51 to 100 trees.

Table 3. Distribution frequency of cashew plants

Criteria	Lambakara		Nggongi	
	Frequency (person)	(%)	Frequency (persons)	(%)
1-50 years	15	19.7	2	3.8
51-100 years	40	52.6	30	56.6
> 100 years	21	27.6	21	39.6
Total	76	100.0	53	100.0

Source: Processed primary data, 2020.

Likewise with farmers in Nggongi Village 56.6% of farmers have cashew plants ranging from 51 to 100 trees.

Characteristics of Cashew Traders

Age can affect a person's work productivity. The more mature a trader is, the more his ability and way of thinking will be affected. 66.7% of traders in Lambakara Village are in the age criteria of 41 to 50 years. Meanwhile, 100% of traders in Nggongi Village are classified as young, ranging from 30 to 40 years. Most of the inter-island traders (50%) in East Sumba Regency belong to the age of 41 to 50 years.

Table 4. Frequency traders distribution

Criteria	Lambakara		Nggongi		Inter-islands Traders	
	Freq	%	Freq	%	Freq	%
30-40 years	1	33.3	3	100	1	25
41-50 years	2	66.7	0	0	2	50
> 50 years	0	0	0	0	1	25
Total	3	100	3	100	4	100

Source: Processed primary data, 2020.

The length of time a trader conducts his trading business is the period of time the trader starts to engage in the cashew business which is measured in years. Business experience will influence a person's behavior in processing his business. Usually people who have been trying to trade for a long time will have a lot of experience compared to novice traders, so that it will affect the way they make decisions in their business. Most (66.7%) traders in Lambakara Village and inter-island traders in East Sumba Regency have started to pursue cashew nut trading for more than 10 years. Meanwhile, 66.7% of traders in Nggongi Village have just started their business with a range of 1 to 5 years.

Table 5. Distribution frequency of trader frequency

Criteria	Lambakara		Nggongi		Inter-islands Traders	
	Freq	%	Freq	%	Freq	%
1-5 years	0	0	2	66.7	1	25
6-10 years	1	33.3	1	33.3	1	25
> 10 years	2	66.7	0	0	2	50
Total	3	100	3	100	4	100

Source: Processed primary data, 2020.

Analysis of Market Structure

Market structure is the classification of producers into several forms of market based on characteristics such as the type of product produced, the number of producers, whether it is easy to leave or enter the market [7].

Table 6. Cashew market structure

Marketing institution	Trader Total	Buyer Total	Product Differentiation	Resistance to enter market
Lambakara village Farmers	76	-	No	No
Nggongi village Farmers	53	-	No	No
Lambakara village Trader	3	3	No	Yes
Nggongi village Trader	3	4	No	Yes
Trader inter-islands	4	1	No	Yes

Source: Processed primary data, 2020

From the number of farmers/traders from Lambakara Village as many as 76 people and Nggongi Village as many as 53 people selling to 3 village-level collectors, then village-level collectors selling to 4 inter-island traders who are final-level traders in East Sumba Regency. Seeing the unbalanced composition between the number of sellers and buyers, the market structure for cashew nuts is a market that is not perfectly competitive. With this market structure, the market behavior that occurs is the weak bargaining power of cashew farmers in determining/fixing prices, and the dominance of market information, which is a form of strategy in maintaining market stability [9].

Product differentiation as an act of modifying a product to be attractive, namely product design, taste, packaging, size, brand, price even distribution channels. Broadly speaking, product differentiation is a company's product offering that has something better, faster and cheaper which will create higher value for customers than competing products [8].

The products produced by farmers up to the distribution process to the final marketing agency in East Sumba Regency are cashew nuts. The people of East Sumba Regency have not been able to produce processed products made from cashew nuts, this is influenced by the lack of information, knowledge and technology to process cashew nuts into processed materials to provide added value and also income for people in East Sumba Regency, especially those in Lambakara Village and Nggongi Village.

Barriers to entry and exit of the market are a form of limitation or freedom for farmers to carry out their farming activities [1]. Farmers as cashew nuts producers are free to enter the market, because the type of product needed is in the form of raw cashew nuts. This undifferentiated cashew product gives farmers in East Sumba Regency access to enter the market. In contrast to farmers, traders in Lambakara and Nggongi Villages as well as inter-island traders in East Sumba Regency, there are obstacles to entering the market, which is access to transportation to enter Lambakara and Nggongi Villages with steep road conditions make Village traders need relatively large cost in the transportation sector to reach the cashew market. Limited transportation costs become an obstacle for traders to enter the cashew market in Lambakara and Nggongi villages.

Market Behavior Analysis

Market behavior is the behavior of participants (buyers and sellers/traders). Strategies or reactions undertaken by individual or group market participants in competitive or negotiating relationships with other participants to achieve marketing objectives in a particular market structure. The relationship between buyers and sellers is a competitive relationship.

Table 7. Determining cashew price process and payment process

Marketing Institution	Determining Price	Payment System
Lambakara village farmers	Determined by village collectors	Cash/down payment
Nggongi village farmers	Determined by village collectors	Cash/down payment
Lambakara village farmers	Determined by inter-islands trader	Cash
Nggongi village traders	Determined by inter-island traders	Cash
Inter-islands traders	Bargaining, determining by processing industry	Cash

Source: Processed primary data, 2020.

Determining price is very important process in increasing farmers' income in farming [4].

In Table 7, it is known that the price setting system between inter-island traders as final-level traders in East Sumba Regency and processing industries in Surabaya, in East Java is carried out by bargaining. This shows that these two institutions have the same bargaining position. However, in contrast to the case of farmers, farmers both in Lambakara and Nggongi villages cannot bargain because they already have ties with the existing collector traders. Village collecting traders set the price for buying cashew nuts from cashew farmers based on the purchase price set by the inter-island trader. Meanwhile, inter-island traders set the purchase price for village-level traders based on the price set by the industry or the exporter they subscribe to. So by looking at these facts, the starting point in determining the price starts from the more dominant inter-island wholesalers, which influence up to the cashew farmers. Thus it stands to reason that cashew farmers are the party with the lowest bargaining position in determining the price, so they only act as price recipients.

Analysis of Market Performance

Several marketing agencies involved in the marketing of cashew nuts include farmers, village gathering traders and inter-island traders, which are the final marketing agencies in East Sumba Regency. The marketing agency will establish a marketing channel which is a network of all parties involved in the flow of products or services to consumers [6].

Table 8. Distribution of frequency of marketing actors

Market channel	Farmers		Village traders		Inter-islands traders	
	Freq.	%	Freq.	%	Freq.	%
Lambakara village	76	58.9	3	50	2	50
Nggongio village	53	41.1	3	50	2	50
Total	129	100	6	100	4	100

Source: Processed primary data, 2020.

As many as 58.9% and 41.1% of farmers in Lambakara and Nggongi villages directly sold cashew nuts to collectors in their respective villages. Each as much as 50% of village-level traders sell cashew nuts to wholesalers or inter-island traders in East Sumba District.

Table 9. Price, Cost, Profit dan Marketing Margin (Rp)

Description	Marketing plot	
	Lambakara	Ngonggi
Farmer		
a. Selling Price	15,000	15,000
Village Traders		
a.Purchase price	15,000	15,000
b.Marketing Cost	2,706,667	3,616,667
c.Seling Price	18,000	18,250
d.Profit	7,793,333	7,758,333
e.Margin	3,000	3,250
Inter-islands traders		
a.Purchase Price	17,000	17,000
b.Marketing Cost	7,700,000	7,700,000
c.Selling Price	20,000	20,000
d.Profit	10,300,000	10,300,000
e.Margin	3,000	3,000
Total Cost Marketing Cost	10,406,667	11,316,667
Profit Total	18,093,333	18,058,333
Margin total	6,000	6,250

Source: Processed primary data, 2020.

Marketing margin is done to determine the efficiency of marketing a product from the producer level to the consumer level. Marketing margin is the price difference that occurs in each marketing agency [2]. The marketing margin in Lambakara Village is Rp. 6,000, which is smaller than the value of the marketing margin in Nggongi Village, which is Rp. 6,250. This was influenced by the purchase price set by traders in Nggongi Village, which was higher than the price set by traders in Lambakara Village. This is influenced by the condition of the road access to Nggongi Village which is steep and rocky with a relatively farther distance than Lambakara Village, so that the transportation costs incurred by traders in Nggongi Village are greater.

Table 10. Farmer Share of cashew marketing channel

Marketing channel	Price (Rp/Kg)		Farmer share
	Farmers	Inter-islands trader	
Lambakara	15,000	20,000	75%
Nggongi	15,000	20,000	75%

Source: Processed primary data, 2020.

The farmer share value obtained by each village both in Lambakara and Nggongi villages is the same value, namely 75%. This means that farmers receive 75% of the price paid by inter-island traders. This high farmer share value is influenced by the pattern of short marketing channels, resulting in a fairly large share of the price received by farmers, namely 75%. The absence of a difference in the value of the farmer share between the two villages is influenced by the absence of a difference in the selling price set by traders at the village level Lambakara and Nggongi Village, which is Rp. 15,000/kg.

Marketing Efficiency

The level of marketing efficiency is the result of a comparison of the total marketing costs of cashew nuts with the total value of cashew nuts marketed. The level of marketing efficiency means that every time there is an increase in marketing costs incurred in the marketing channel, it will cause the marketing channel to be more inefficient because the efficiency value will be greater and vice versa. The value of marketing efficiency is seen by comparing the EPs value of one marketing channel with the EPs value of another marketing channel. If one marketing channel has an EPs value that is smaller than the EPs value of another marketing channel, then the marketing channel is more efficient than other marketing channels [10].

Table 11. Marketing Efficiency of Cashew

Marketing channel	Total Cost (Rp)	Total Value (Rp)	Marketing Efficiency (%)
Lambakara village	10,406,667	18,093,333	57.52
Nggongi village	11,316,667	18,058,333	62.67

Source: Processed primary data, 2020.

It can be seen that the value of marketing efficiency in the marketing channels of Lambakara Village and Nggongi Village is obtained by 57.52% and 62.67% respectively. The channel that has the smallest marketing efficiency value is the marketing channel in Lambakara Village at 57.52%. This indicates that the cashew marketing channel in Lambakara Village is a relatively more efficient marketing channel than the cashew marketing channel in Nggongi Village. Based on the criteria for marketing efficiency, the efficiency value of the marketing channels in both Lambakara and Nggongi villages on the efficiency criteria is greater than 30%. So it can be concluded that the marketing of cashew in Lambakara and Nggongi villages is not efficient, this means that every time there is an additional marketing cost incurred in the marketing channel, it will cause the marketing channel to be increasingly inefficient because the efficiency value will be greater.

CONCLUSIONS

The cashew market structure in Lambakara and Nggongi villages is declared inefficient. The cashew market structure tends to be oligopolistic so that cashew farmers are in a price taker condition. The cashew market behavior in Lambakara and Nggongi villages is declared inefficient. There are several marketing agencies, namely farmers, village gathering traders and inter-island traders, each marketing agency carrying out marketing functions causing farmers to be limited in obtaining price information. The cashew market performance in Lambakara and Nggongi villages is declared inefficient. Analysis of the cashew market performance in Lambakara and Nggongi villages each obtained a marketing margin of Rp. 6,000 and Rp. 6,250 with a high farmer share level of 75% which causes cashew farmers to receive lower benefits. Based on the level of marketing efficiency obtained in the marketing channels of Lambakara Village and Ngonggi Village, it was obtained respectively 57.52% and 62.67% of the efficiency value of the marketing channels in both Lambakara and Nggongi Villages on the efficiency criteria greater than 30%.

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THE IMPACT OF IRRIGATION ON THE HEAVY METALS DISTRIBUTION IN SOILS OF THE LOWER DNIEPER UKRAINE

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Abstract

The content of Cu, Zn, Co, Ni, Pb, Cd, Cr, Mn was determined in samples of irrigation water, irrigated and non-irrigated soils of the Lower Dnieper river of Ukraine. The vertical distribution of heavy metals in soils was also determined. The results indicated that irrigation water is not contaminated, and its use cannot lead to excessive accumulation of heavy metals in the soil. The content of heavy metals in the humiferous horizons of both soils is at the background level. The content of mobile forms of Zn, Cd, Ni, Cr, Mn in the humiferous horizon of irrigated soils is slightly higher than in non-irrigated soil. This may be due to a significant change in the soil hydrological regime during irrigation and an increase in the solubility of elements. Most of the elements are characterized by accumulation in the upper humiferous horizon, its content decrease in the first transitional horizon, and transition to the parent rock and in the gleyic horizons.

Key words**:** *heavy metals, distribution, irrigation, Lower Dnieper, soils.*

INTRODUCTION

The largest part of the territory of Ukraine is experiencing a shortage of natural moisture supply and the effective use of the country's agro-resource potential is impossible without its elimination. Recently, due to climate change, an increase in average annual temperatures, strengthening of drought and aridity, changes in precipitation distribution modes, additional risks have arisen and the unpredictability of crop yields has increased.
Global climate changes cause an increase in the role of irrigation in ensuring sustainable plant production and make irrigation an obligatory measure, and for many crops into the decisive element of intensive cultivation technology [11, 13]. At the same time, the environmental safety of irrigation, together with an increase in the volume of food production, irrigation increases environmental risks, especially in regions with a difficult environmental situation. In this contest, the heavy metals (HM) are one of the main indicators of anthropogenic pressure on the natural environment [1, 4, 6, 7]. The study of changes in the content of heavy metals in the components of the irrigated agricultural landscape of the Lower Dnieper River will allow to determine the possibility of their environmentally safe use, ways to increase productivity, to assess the possibility of sustainable soil functioning.
The objectives were: determination the mobile forms content of Cu, Zn, Co, Ni, Pb, Cd, Cr, Mn (HM) in irrigation waters of Dnieper River; in irrigated and non-irrigated soils of the Lower Dnieper meadow; determination the regularity of accumulation and vertical distribution of HM mobile forms in the soil profile deep under irrigation.

MATERIALS AND METHODS

Samples of irrigated and non-irrigated typical soils from the Lower Dnieper, Steppe zone of Ukraine were collected for determination the mobile forms of Cu, Zn, Co, Ni, Pb, Cd, Cr, Mn. Soil samples were selected on the irregular grid with GPS referencing. For carrying out the works provided by project the field pedological research and laboratory geochemical analyses the classical methods were used. Mobile forms of HM in the soils were determined by extraction with ammonium acetate solution at pH 4.8, using the 1:5 - soil : extract ratio. The HM content in water samples were analysed after drying and dissolving the precipitate in 1 M HCl. The determination of heavy metals was performed by atomic absorption spectrophotometry on the SATURN-4 device.

RESULTS AND DISCUSSIONS

Food security of Ukraine largely depends on the availability, condition and efficiency of irrigated land use. The largest area (2.6 million hectares) of irrigated land was occupied in the early of 90s of the last century [12]. After that, the area of irrigated land has significantly decreased for various economic and political reasons. Nowadays in the Ukraine only 500-600 thousand hectares are irrigated. However, the need to ensure the country's food security and adapt to climate change indicates an urgent need to restore, modernize and expand the irrigation. Therefore, in 2019, the Cabinet of Ministries of Ukraine approved the "Strategy for Irrigation and Drainage of Ukraine until 2030" [5].

The soils of the study territory contain a significant amount of nutrients and often have favorable physical and biological properties. Quite fertile soils are formed in the central floodplain of Dnieper, which makes them attractive for irrigation. Non-irrigated soils of the central floodplain of the Lower Dnieper are now considered as promising for the expansion of irrigation, therefore, the study of issues of environmental safety of irrigation in this region is very important. It is known that irrigation affects the direction of soil processes and soil evolution, often leading to the development of soil degradation, which requires the study of changes in soil properties under irrigation impact [2, 9, 12].

Soil contamination with HM is one of the most common types of irrigated soil degradation. These changes, first of all, depend on: the initial state of soils (geochemical background), the irrigation water quality, the water supply volume, the regional level of arable farming.

The study results of the irrigation water quality indicate that irrigation is carried out with water of the 1st class (norms of Ukraine), and not contaminated with heavy metals and are suitable for irrigation [10], which does not cause the contamination danger of soils and plant productions (Table 1).

Table 1. Content of heavy metals in irrigation water, mg/dm^3

Irrigation water		Zn	Cd	Ni	Co	Mn	Pb	Cu	Cr
Dnieper River		0.016	0.002	0.011	0.003	0.018	0.018	0.007	0.002
Steppe, average		0.013	0.005	0.023	0.023	0.022	0.032	0.008	0.009
The quality of irrigation water by heavy metals and microelements content for Ukraine	Class 1 - Suitable	0.50	0.005	0.08	0.02	0.50	0.02	0.08	0.05
	Class 2 - Limited suitability	05-1.0	0.005-0,01	0.08-0.20	0.02-0.05	0.50-1.00	0.02-0.05	0.08-0.20	0.05-0.10

Source: Own determination on the analysis of water samples.

The content of heavy metals in irrigation water is at the background level for Steppe zone of Ukraine. The background level was determined according to the results of long-term observations of the surface water quality during the plant growing season (about 280 water samples were analysed). In the studied region, the soil cover is characterized by significant variegation. In its formation, the diversity of geomorphological and lithological characteristics of the territory is decisive. It determines the lithological profile of soils, the humus accumulation, gleyzation and salinization processes, and determined the differences between the adjacent soils, with an insignificant height difference. The difference in the soils is very clearly manifested in morphological and genetically researches and is reflected in the soil profiles description.

Irrigated soil (Fig. 1a) - chestnut saline on the loess-like loam. In the irrigated soil profile the following horizons are highlighted: 0-28 cm – arable , grey-brown, moist, compacted, lumpy-granular, clear colour transition, smooth transition; 28-37 cm – the first transitional horizon, light brown, fresh, compacted, nutty-lumpy, weak colloidal varnishing, clear colour transition, smooth transition; 37-50 cm - the second transitional horizon, grey-fawn, fresh, compacted, structure less, gradual transition; 50-70 cm - loess-like loam, fawn with dark spots, humus flowing along the root paths, fresh, compacted, structureless, effervescence of 10% HCl from 58 cm, clear color transition; >70 cm - loess-like loam, fawn, fresh, calcareous, loose, bieloglasca - elongated shape, from 70 cm.

Non-irrigated soil (Fig. 1b) - meadow-chestnut weakly solonetzic clayey on gleyic loess-like loams. In the non-irrigated soil profile the following horizons are highlighted: 0-32 cm - arable horizon, grey-whitish, dry, loose, nutty-silty, medium-structured, silica powder, sharp transition on density; 32-72 cm - the first transitional horizon, dark grey, fresh, compacted, lumpy-nutty, weakly structured, the transition is clear in colour, smooth transition; 72-90 cm - second transitional horizon, greyish-brownish-bluish, fresh, rusty spots, compacted, structure less, black iron-manganese nodules, brittle, gradual colour transition; >90 cm - gleyic loess-like loam, light-grey, fresh, compacted, structure less, brown and rusty spots, black iron-manganese nodules, fragile molehills of humus, non-calcareous.,

Fig. 1. Profiles: a) irrigated saline chestnut soil; b) non-irrigated meadow-chestnut weakly solonetzic
Source: Own field survey.

The content of heavy metals mobile forms in the humiferous (arable) horizons of the studied soils is somewhat different (Table 2).

Table 2. Content of heavy metals in the arable horizon of irrigated and non-irrigated soils of the Lower Dnieper, mg/kg

Soil		Zn	Cd	Ni	Co	Mn	Pb	Cu	Cr
Irrigated	Average	1.45	0.018	1.01	0.27	22.69	0.72	0.10	0.47
	min	1.28	0.011	0.77	0.12	18.49	0.70	0.08	0.31
	max	1.77	0.034	1.21	0.42	28.91	0.75	0.43	0.57
Non-irrigated	Average	1.04	0.011	0.73	0.50	5.84	0.87	0.22	0.14
	min	0.47	0.008	0.46	0.17	3.45	0.50	0.14	0.10
	max	1.36	0.021	0.87	0.67	19.97	1.06	0.28	0.49
Background level		1.00	0.10	1.00	0.50	43.00	0.50	0.50	0.10
Maximum allowable concentrations		23.0	-	4.0	5.0	500.0	6.0	3.0	6.0

Source: Own determination of HM in the soil samples.

On average, the content of most elements is at the background level or slightly differs. The content of elements in the soils is significantly lower than the maximum allowable concentrations. The average content of Pb, Cu and Co mobile forms is slightly higher in non-irrigated soil (1.2-2.2 times); Zn, Ni and Cd in irrigated (1.4-2.0 times), that is associated with natural geochemical differences in soils. The average concentrations of mobile forms of Mn and Cr in the arable horizon of irrigated soil are much higher than in non-irrigated soil and the excess is 3.3-3.8 times.

The good quality of the irrigation water allowed to exclude the possibility of a significant supply of these elements from this source. At the same time, the Mn and Cr are elements with variable valence and the content of their mobile forms is largely determined by the conditions of soil moisture, by the development intensity of the recovery processes in them. Most likely, the higher content of these elements is associated with an increase of their solubility during prolonged irrigation process with high water rates.

The limiting values of the mobile forms content of Cd, Co, Mn, Cu, and Cr are characterized by significant variation. For most elements, the amplitude of fluctuations in the content of their mobile forms is in the range of 1.1-3.9 mg/kg. Large fluctuations amplitudes in the content were noted: for Cu in irrigated soil, which may be associated with the use of plant protection products with copper-containing preparations; for Mn and Cr in non-irrigated soil, which we associate with different levels of natural moisture in non-irrigated meadow chestnut soil at the sampling points. Cultivation of crops with intensive technologies significantly increases their yield. Under conditions with a lack of microelements in the soils, their deficiency in plant products, a decrease in standard consumption and effect of "hidden hunger" can occur [3]. Therefore, was evaluated the content of mobile forms of Mn, Zn, Co, Cu in the soils as trace elements necessary for plants growth and development, the formation of a high and high-quality crop yield [14], and the supply of plants with these trace elements.

The mobile forms content of Zn, Co and Cu in the irrigated soil corresponds to a low supply of plants grown in a high agricultural background, Mn - to an average supply. The content of Mn, Zn, Co, Cu in non-irrigated soil corresponds to a low supply of plants. To obtain a high and high-quality crop yield, it is necessary to introduce micro - fertilizers with the obligatory content of Mn, Zn, Co and Cu [3]. The profile distribution of HM mobile forms, as a rule, in similar soils, is characterized by the presence of biological accumulation (humus) and elluvial-illuvial horizons in accordance with the leading soil-forming process [8]. For mobile forms of biogenic elements (Cu, Zn, Co), the following tendencies are noted: an accumulation in the 0-30 cm; a decrease in their concentrations with an increase in the profile depth in the 30-70 cm; an increase in their content in the 70-90 cm layer. The mobile Ni, Cd, Mn are characterized by a relatively uniform distribution along the soil profile with a slightly increase in 30-70 cm layer. The uniform distribution in the soil profile deep is noted for Pb and Cr.

In the irrigated chestnut soil, in the presence of organic matter and high humidity, anaerobic conditions and vigorous activity of microorganisms, conditions arise for increasing the content of mobile forms of most elements.

Additional moisture created conditions for a more uniform distribution of mobile forms of elements along the profile of the irrigated soil.

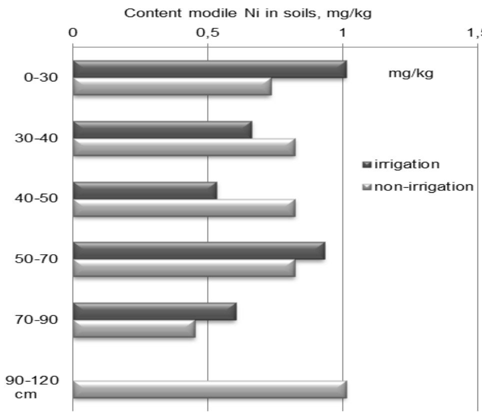

Fig. 2. The content of mobile Ni in the irrigated and non-irrigated soils
Source: Own design of the obtained results.

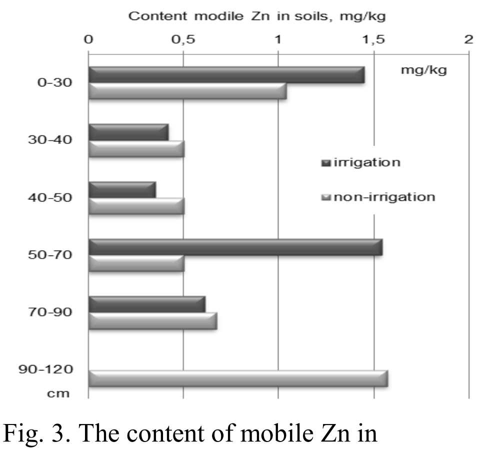

Fig. 3. The content of mobile Zn in the irrigated and non-irrigated soils
Source: Own design of the obtained results.

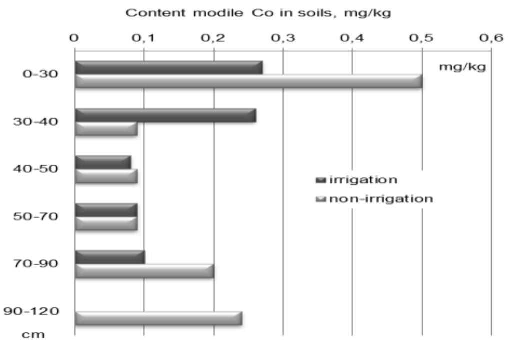

Fig. 4. The content of mobile Co in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

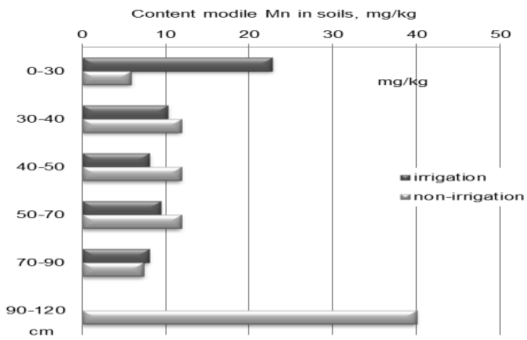

Fig. 5. The content mobile Mn in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

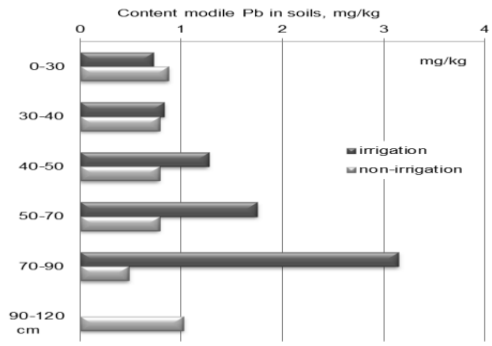

Fig. 6. The content mobile Pb in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

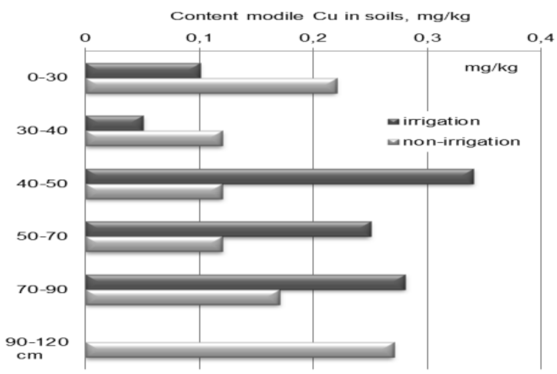

Fig. 7. The content mobile Cu in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

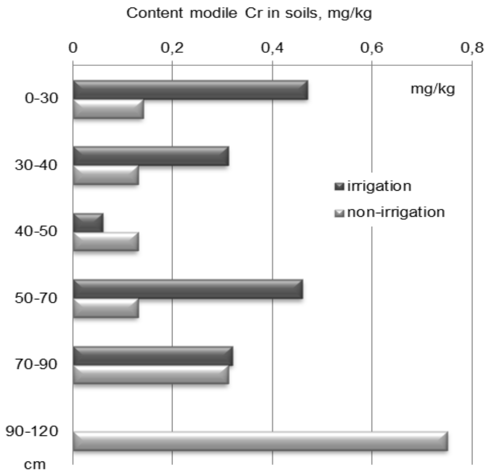

Fig. 8. The content mobile Cr in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

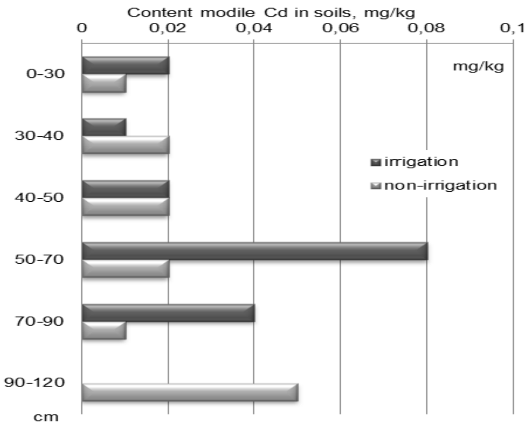

Fig. 9. The content mobile Cd in
the irrigated and non-irrigated soils
Source: Own design of the obtained results.

In non-irrigated soil, the distribution of HM along the profile depended more on the natural geochemical conditions, land use characteristics, intensity of agricultural technologies, and properties of heavy metals.

CONCLUSIONS

The content of Cu, Zn, Co, Ni, Pb, Cd, Cr, Mn in the irrigation water is at the background level. The irrigation water is not contaminated with HM and is suitable for irrigation according to the ecological criteria.The concentrations of Zn, Ni, Cd, Mn, and Cr are higher in the irrigated soil, which can be associated with natural geochemical differences in soils and an increase in the solubility of elements during irrigation. The content of HM mobile forms in soils is at a low level, which makes it necessary to use micronutrient fertilizers. In the irrigated soil, the HM are characterized by accumulation in the humiferous horizon, a decrease in the first transitional horizon, and an increase in the transition to the parental rock. In the non-irrigated soil, accumulation in the humiferous (arable) horizon was noted only for biogenic elements; most of the elements are characterized by a more uniform distribution along the profile; all elements are characterized by maximum concentrations in the parental rock (gleyic horizon). The research results will be used to develop measures and recommendations for sustainable use, protection and improvement the quality of irrigated soils in the Lower Dnieper River for implementation the Strategy for Irrigation and Drainage of Ukraine until 2030.

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DIGITAL BUSINESS MODEL OF THE AGRICULTURAL ORGANIZATION OF THE REGION

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Abstract

The aim of the work is to study the theoretical and applied aspects of digitalization of the agricultural sector for the formation of new management concepts and specific models. Their relevance is confirmed by their significance for the adoption of effective strategic decisions by the participants of the agricultural business. We used a combination of analytical and synthetic approaches, monographic, empirical, statistical-economic and abstract-logical research methods. The composition of the digital business model of an agricultural enterprise and its technological, information and management characteristics are determined. The principle of forming a process-oriented management system is applied. The novelty of the research consists in constructing the structure of the digital business model of the crop industry based on the digitalization of the technical, information and management components of its functioning and the industry-specific detailing of technologies. These elements of the business model are grouped and described for accounting of work and agricultural operations, monitoring of equipment, "assistant agronomist", reporting and analytics, cadastral accounting and scouting. The mechanism was studied and the results of the work of the agricultural organization of the region, which implements and develops digital technologies, were evaluated. The results obtained confirm the growth of economic efficiency in the implementation of digital technologies in agricultural production.

Key words: *digitalization, business model, digital model, system of production, agricultural organization, crop production*

INTRODUCTION

The theory and methodology of digitalization of business are stated in works of many scientists-economists, the first domestic publications on its basic technologies and problems of development in Russia and are abroad dated 2016-2018. The object of research is described as information and digital revolution and a form of manifestation of regularities of development of new economy [8, 9, 21], approaches to realization of "digital economy" in general are offered [2, 5, 13, 20]. A significant amount of works is devoted to an opportunity and expediency of use of digital technologies in various spheres of activity of the person, to questions of transformation of the existing traditional institutes owing to formation of new technological way, to technical character of digital economy.

The agro-industrial complex which is its major part undergoes high-quality changes in a type of agrarian policy on the basis of technological breakthrough and instruments of innovative development [1, 7, 16, 18, 19]. In the direction of creation of digital business models of the agricultural organizations of regions methodological approaches and the principles [15], expected and analytical and optimizing components are developed [3, 4, 10, 17]. Now the scientific community is faced by problems of formation of certain digital business models and development of a technique of assessment of their economic efficiency both of separate branches, and for the enterprises in general.

MATERIALS AND METHODS

During the forming of structure and creation of processes of a digital business model of activity of the agricultural organization in the region the combination of analytical and synthetic approaches since the modern enterprises are characterized by existence of close ties of the economic subjects entering them with the environment is applied and are based on creation of system of the interconnected models. Analytical approach in total with a monographic method of a research formed base for development of the general scheme of a digital business model, synthetic – for creation of private model of branch of crop production of the enterprise within which are used by authors empirical, statistic and economic; abstract and logical methods of scientific knowledge. In work materials of LLC “Infobis” — the Saratov IT company proposing solutions for digitalization of agriculture are used. LLC “Beryozovskoye” of the Engelssky municipal district of the Saratov region acted as an object of a research.

RESULTS AND DISCUSSIONS

For the purpose of justification of structure of a digital business model of the modern agricultural enterprise the technical, information, managerial characteristics relating to the stages "Agriculture 1.0" – "Agriculture 5.0" are revealed and systematized [6].

Agriculture 1.0 (– the 18th century of century):

-*concept* – traditional agriculture, prevail: labor-consuming small-scale enterprise, manual labour, disperse resettlement;

-*stages:* 1) internal consumption of production, 2) development of the commodity (exchange) relations;

-*technological aspects* – application manual and primitive instruments of labor;

-*information aspects* – use of experience of generations, holding pagan rites, application national (after Christian) calendars;

-*administrative aspects* – transfer of experience from the senior generation to younger (orally and on paper).

Agriculture 2.0 (the XIX-XX century of century - development of scientific and technical progress):

-*concept* – replacement of manual skills with means of mechanization;

-*stages:* 1) partial mechanization (primary mechanization with use of horse and manual agricultural cars), 2) complex mechanization (on the basis of the tractor, etc. cars, on the basis of electrification), 3) automation;

-*technological aspects* – processing of the soil and performance of other agricultural works and operations with the help of specialized cars and equipment (technical means), global use of agrochemicals;

-*information aspects* – at the last stage (automation, electrification) emergence of programs of systematization and data processing, computerization of accounts and finance (1-C);

-*administrative aspects* – the direction on increase in productivity of work, development of productive forces in direct ratio to development of relations of production.

Agriculture 3.0 (the 20-21st century of century since 1990):

-*concept* – condition of intensive and exact agrotechnological revolution, information agriculture with elements of exact agriculture and livestock production;

-*stages*: transition to digital agriculture;

technological aspects – use of labor-saving technologies, exact agriculture, GPS - signals, monitoring and control, the first scientific developments on adaptive landscape agriculture;

-*information aspects* – processing and the analysis of Big Data within separate objects (elements) of a production cycle;

-*administrative aspects* – the first steps of management taking into account use of the COMPUTER, realization within application computer programs of problems of optimization of agricultural processes, works and operations.

Agriculture 4.0 (21st century -since 2010):

-*concept* – use of intellectual technologies, agronomical modeling, integration of external and internal networks and operations in agricultural production;

-*stages:* digitalization of control and account at all stages of a production cycle;

-*technological aspects* – exact agriculture, the robots interacting with each other and also with the centers of collecting, storage, the analysis and data processing, integration with systems financial and business planning, warehouse account, AIoT-platforms (application), the means of mechanization and automation of production complemented with IoT (the Internet of things);

-*information aspects* – processing and analysis of Big Data;

-*administrative aspects* – geographical information and analytical system "Management of the Agricultural Enterprise", GIS "Agroupravleniye", realization within application computer programs of problems of optimization of agricultural processes, works and operations.

Agriculture 5.0 (perspective future) (XXI-...):

-*concept* – the created extensive digital ecosystem (total), universal digitalization of all stages from production before realization of agricultural production;

-*stages*: full automation – transition to artificial intelligence;

-*technological aspects* – robotics and artificial intelligence;

-*information aspects* – collecting, processing and the analysis of data, adoption (offer) of possible decisions on the basis of artificial intelligence;

-*administrative aspects* – development of systems of support of decision-making, based on artificial intelligence.

The received result demonstrates transformation of traditional paradigms of business management (emotional and rational) in the system of concepts of new level which is based on computer technologies. The offered model represents the evolutionary product created in the course of integration of modern digital instruments for support of decision-making into their classical algorithms, methods, approaches, including the systems of the automated planning of adaptive and landscape use of lands, databases and technologies of monitoring of a livestock, the appropriate digital technologies of business in crop production and livestock production, the key results united by the through intellectual system of support of decision-making of a full cycle [12].

Result of implementation of the offered theory and methodological provisions is the development and justification of a digital business model of the agricultural organization (Fig.1) as the most perspective form of strategic planning based on information and technological improvement of agricultural production with the expressed multiplicative effect (*KPI – Key Performance Indicator*) consisting in parallel modernization of production, administrative, logistic, economic, marketing and other business processes and the organization in general according to the main domestic and foreign tendencies [11].

Specification of the making elements looks as follows:

(1) technological block: the equipment of differential positioning on signals of GLONASS/GNSS and application of fertilizers and chemicals for systems digital and "exact agriculture", the platform of objective monitoring and management of transport and logistic infrastructures, the platform of "the Internet of things", the system of identification, life cycle and traceability of animals, other automated and robotic mechanisms;

(2) information block: databases of production technologies (including preserving and an organic), properties of means and objects of the labor, the regional selection and seed-growing centers on the basis of digital technologies, bases of local data of telemetric control, digital soil cards, a matrix of digital solutions of formation of crop rotations, the analysis of big data (soils, crops, wreckers, etc.), through digital chains of a full production cycle of production of livestock production, the through platform of control of processes of production for the systems of social food, the system of the auction, purchases, managements of export and import;

(3) administrative block: methods and algorithms of forecasting of a condition of agroecosystems, economic models of conducting agricultural business, technique, algorithms and technologies of management of "the digital enterprise", technical and economic models of use of the equipment and units, intellectual systems of support of decision-making.

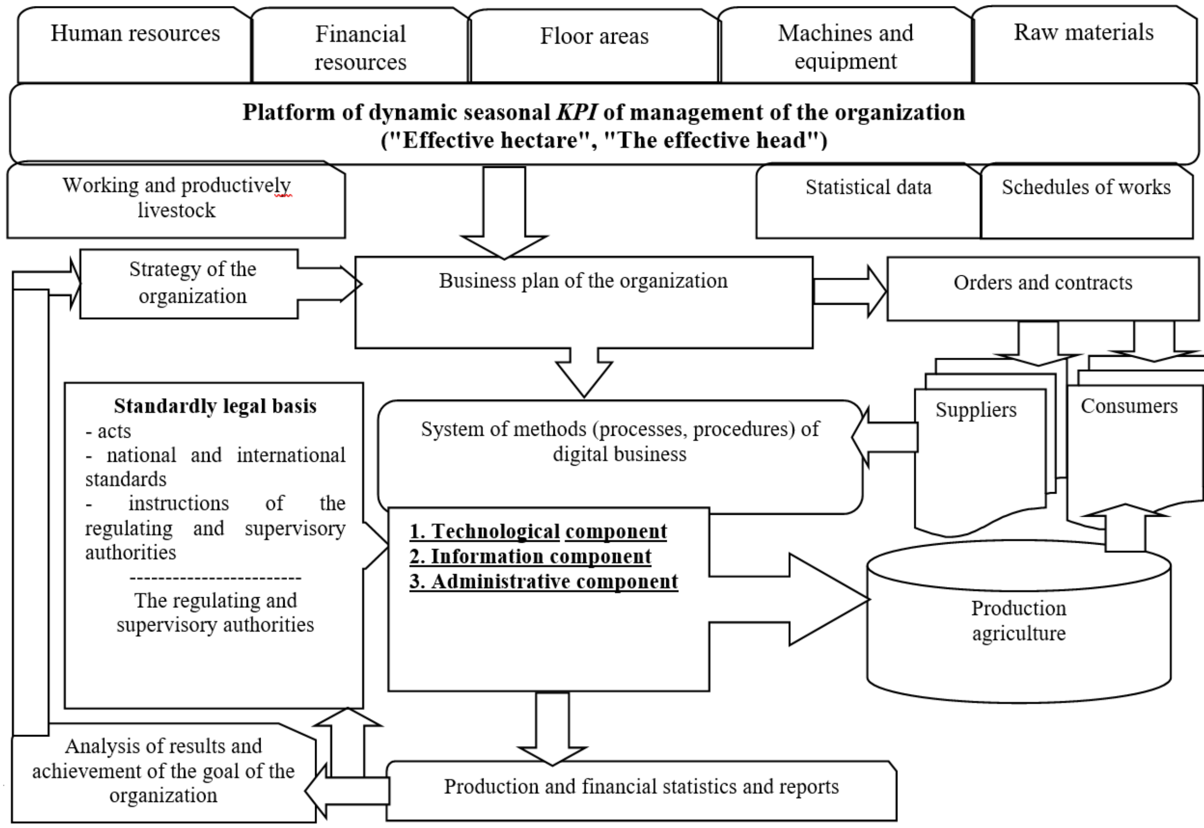

Fig. 1. The offered scheme of a digital business model of activity of the agricultural organization
Source: developed by authors.

The efficiency of digitalization of branch of crop production of the separate organization is investigated by us on the example of the agricultural enterprise LLC “Beryozovskoye” of the Engelssky municipal district of the Saratov region organized in 2006 in view of the enterprise of a course towards automation and digitalization of business processes chosen by the management. Primary activities – crop production (a winter wheat, a carthamus, soy, sunflower, a millet yellow, etc.) and livestock production (dairy cattle breeding, sheep breeding). The area of agricultural grounds in 2019 was 6,346 hectares, including arable lands – 5,619 hectares, of them irrigated – 645 hectares, the general number of cattle – 1,047, sheep – 620. The enterprise is one of perspective farms in the Saratov region in the sphere of dairy livestock production, since 2018 has the status of a breeding loud-speaker on cultivation of cattle of black and motley breed, cooperates with scientists of the Saratov State Agrarian University in the name of Vavilov N.I. and Bashkir State Agrarian University. In 2018-2019 reconstruction of the livestock placement on 150 heads is carried out (cost - 7 million rubles), the cattle feeder is acquired (cost – 2.5 million rubles), are conducted construction of the milking hall design power the 500th goal now. (cost - 25 million rubles).

The crop rotation is chosen taking into account production of cultures for creation of a steady food supply for cattle stock in economy, such as lucerne, a grain sorghum, corn on grain and on a silo, grain mix with a Sudanese grass on haylage, a part of soy is used on a forage. According to the head of economy, the 5-polny crop rotation allows to keep fertility of the soil and to observe the evidence-based system of agriculture. The irrigated site is engaged in the basic with forage crops. For the winter and stall period in 2019 it was prepared: a silo – 6.12 thousand tons, a haylage – 3.2 thousand tons, hay – 1 thousand tons.

Advanced technologies take root into productions of LLC “Beryozovskoye”, the modern high-performance equipment is bought. The agricultural enterprise has the modern machine and tractor park, a necessary set of hook-on stock and automotive vehicles.

For preparation of high-quality seed material the mechanized current is equipped not only sifted cars, but also an aerodynamic separator, as a result of it in economy try to obtain high viability of seeds (on a winter wheat – not lower than 99%). In due time there is an updating of seeds on the highest reproductions, for example, the winter wheat is sowed by seeds not below the second reproduction. For the purpose of management of the potential of cultures in economy seek to apply the modern integrated system of protection of plants.

In the organization since 2015 the platform "Agrosignal is introduced. Management", developed by LLC "Infobis" — the Saratov IT company proposing solutions for digitalization of agriculture. For providing with information for the purpose of adoption of strategic and operational decisions the digital system informs on history of fields, agrotechnical operations with dates of their actual performance, has dynamics of indicators of productivity, a fuel consumption, etc. For example, in real time it is possible to see where there is any tractor or the combine at what works the machine operator what development at it, how many to it is added salaries is engaged. The software product allows to operate remotely all processes and to exercise control, is intended for increase in productivity and allows to reduce the volume of losses of fuel and lubricants and influence of a human factor on any process by production of agricultural products, i.e. it is "Online service" of control and accounting of works in agrobusiness.

Table 1. The cost characteristic of the systems of satellite monitoring and account used in LLC "Beryozovskoye" of Engelsky district (selectively)

Payment order No.	Subject to application	Maintenance of system	Cost, rub.
1	The system of satellite monitoring and account on the combine harvester Terrion SR2010 of 2010 of release	telematic device	12,900
		housing	900
		fuel level sensors	15,900
		the readers RFID map marking	13,000
		unit adapter	2,700
		blocking of the screw without identification of the recipient	7,000
		connection to regular conducting for registration of operation of the harvester of the combine	3,600
		screw sensor	6,800
		the grain level sensor in the bunker	55,000
		in total	**117,800**
2	The system of satellite monitoring and account on the combine harvester ACROS– 550 of 2015 of release	blocking of the screw without identification of the recipient	7,000
		connection to regular conducting for registration of operation of the harvester of the combine	3,600
		the grain level sensor in the bunker	55,000
		tag on the unit	2,000
		in total	**67,600**
3	The system of satellite monitoring and account on auto repair shop 3813D0 on GAZ base 33081 of 2015 of release	telematic device	12,900
		housing	900
		fuel level sensors of 700 mm	15,900
		the readers RFID map marking	4,000
		in total	**33,700**
4	The system of satellite monitoring and account on the Versatile 23755 tractor – V24 2013 of year of release	telematic device	12,900
		housing	900
		fuel level sensors	20,000
		the readers RFID map marking	4,000
		unit adapter	2,700
		seeding control system	8,000
		tag on the unit	2,000
		deepening sensor	19,000
		in total	**69,500**

Source: made and calculated by authors.

The selective characteristic of the systems of satellite monitoring and account used in economy is provided in table 1. So, equipment sets on combine harvesters cost the enterprise in the sums from 67.6 to 117.8, on the tractor – 69.5 thousand rubles.

The comparative analysis of results of activity of LLC "Berezovskoye "before investments on acquisition, creation, modernization, reconstruction of fixed assets and introduction of elements of digitalization of business showed that equal rates revenue and cost of sales – for 60 %, net profit – by 3.2 times, profitability level – more than on 6 items (Table 2) increased. The quantity of the main production received counting on 1 thousand rubles of investments on digitalization increased considerably: grains – in 5.3, milk – by 9.5 times. Significantly indicators of effectiveness of business counting on 1 average worker and also the head and experts increased. Cost values of production and crop production, and livestock production counting on 1 people - increase hour equal rates.

Table 2. Indicators of activity of LLC "Beryozovskoye" of Engelssky district of the Saratov region at the initial stage of digitalization of business

Indicator	Years					Growth rate, %
	2015	2016	2017	2018	2019	
Investments on acquisition, creation, modernization, reconstruction and preparation for use of non-current assets, thousand rubles.	1,907	19,464	44,183	8,061	8,322	436.4
including on digitalization		1,166	3,983	207	206	
from them: a set of the software and sensors for maintenance of system		543	1,958			
sensors on combines, tractors, cars		410	1,817			
subscriber services of system		213	208	207	206	
Revenue, thousand rubles.	90,605	105,205	141,871	141,035	145,369	160.4
Cost of sales, thousand rubles.	81,365	83,645	122,686	128,956	129,924	159.7
Net profit, thousand rubles.	4,978	20,679	22,190	11,312	15,982	321.1
Level of profitability, %	6.12	24.72	18.09	8.77	12.3	201.0
It is received production counting on 1,000 rub of investments on digitalization:						
grains, c		51.74	19.34	226.53	274.36	530.3*
milk, c		16.09	5.45	135.71	152.08	945.2*
Revenue counting on 1 worker, thousand rubles.	1,104.94	1,143.53	1,493.38	1,439.13	1,468.37	132.9
Revenue per the number of heads and experts, thousand rubles.	4,768.68	4,782.05	6,448.68	5,641.40	5,814.76	121.9
Net profit counting on 1 worker, thousand rubles.	60.71	224.77	233.58	115.43	161.43	265.9
Net profit per the number of heads and experts, thousand rubles.	262	939.95	1,008.64	452.48	639.28	244.0
Labor input of production of grain, people hour/c	1.26	0.50	0.43	0.70	0.60	47.6
It is made production of crop production counting on 1 people - hour, rub	1,342.32	1,858.17	1,805.58	2,097.12	1,522.53	113.4
Labor input of production of milk, people hour/c	0.69	0.69	0.64	0.64	0.61	88.4
Production of livestock production counting on 1 people - hour, rub.	1,668.79	1,106.76	1,702.98	1,417.00	1,873.40	112.3

Source: for the reasons with lack of data in 2015 calculation is made relatively 2016; it is calculated by authors by data [14].

The elements of the digital platform and their functionality introduced in production and administrative processes and also the new making business model components recommended for development for branch of crop production of the agricultural organization are presented below.

The bold-face type allocated the new elements of digitalization recommended for development

The system of methods (processes, procedures) of digital business – complex digital platform of management of agrobusiness Agrosignal (elements):

(A) Administrative component:

(1) Strategic part – Module "Agrosignal. Planning":

- drawing up plans of a crop rotation,
- formation of the budget with the maximum profitability,
- annual planning and budgeting taking into account different cultures,
- formation of plans for needs of different divisions,
- creation of several variations of the budget for the choice optimum,
- design of an optimum logistics system,
- elaboration of optimum marketing strategy;

(2) Operational part – Mobile application "Agrosignal. Mobayl" (web interface):

- quick information on the performed works,
- creation and editing daily tasks, schedules of changes,
- receiving numerous reporting information on the presented forms.

(B) Technological component:

(1) Accounting of works and agrooperations – elements of the Agrosignal system are integrated with system 1C for formation of waybills for the purpose of automatic unloading of data on the carried-out works and development of machine operators;

(2) Monitoring of the equipment:

- the main sensors on vehicles – gps-trackers, sensors of operation of the engine, speed of the movement, fuel level, analyzers of discharges,
- additional sensors on vehicles - the level of fuel and unloading of the screw;

(3)Assistant to the agronomist – functionality for:

- definitions of the index of vegetation (NDVI) for each field, its certain sites and carrying out pointed inspections,
- differentiated application of fertilizers and means of protection with the indication of norms in each separate zone,
- monitoring of weather conditions with an opportunity to set own threshold values and maintaining notes in a digital format,
- **definitions of indexes of a stress of plants (MSI) and moisture security (NDWI);**

(4) Reporting and analytics:

- the system in real time reflects dynamics of key indicators of performance of agrooperations and provides information in a simple and clear look,
- individual control under needs of the specific user;

(5) Cadastral registration – the equipment of differential positioning on GLONASS/GNSS signals;

(6)Agrosignal. Skauting – mobile application for carrying out inspections and control of a condition of fields and plants:

- fast identification of problems,
- preservation of notes without Internet access,
- information transfer about work in the field to the chief agronomist even before return to office.

(C) Information component:

(1) Accounting of works and agrooperations:

- daily plans for the processed area and for each operation,
- schedules of changes of personnel for distribution of daily development,
- "Registration sheets of the tractor" with the indication of time, idle times, fuel and lubricants, weathers,
- individual and group operating plans,
- freight weight binding to data on operation, equipment, points of visit,
- control of development of the field equipment to which transportation was made;

(2) Monitoring of the equipment – platform Agrosignal collects data on location, movement and speed of the movement of the equipment from devices, it is possible to look at all information in system in real time and also to adjust any instant notifications:

- control of expenses, statistics of idle times, identification of discharges of fuel,
- definition of unauthorized unloadings and violations of technical norms,
- detection of inappropriate use of the equipment on foreign fields,
- control of following to the set routes and standards of speed,
- respect for quality of processing of sites and high-speed mode,
- correct calculation of the processed area taking into account different factors;

(3) Assistant to the agronomist:

- expeditious monitoring of a condition of crops and uniformity of shoots,
- identification of focuses of the disease of plants and appearance of wreckers,
- viewing and analysis of information on each field,
- arrangement of priorities when planning technological operations
- optimization of costs of fertilizer and chemical medicines,
- improvement of quality of the soil and control of phases of maturing and development of cultures;

(4) Reporting and analytics:

- the daily and annual analysis in the plan/ fact format,
- data on performance of work and course of separate agrooperations,
- monitoring of expenses of fuel and lubricants and idle times, movements on warehouses and weighing,
- observance of terms of works and control of technologies of cultivation of cultures,

- an opportunity to add/diminish key indicators for tracking,
- data on volume of the introduced fertilizers and means of protection of plants;

(5) Cadastral registration:

- full legal information on cadastral sites (comparison of the legal and actual areas), automatic detection of the crossed sites,
- reminder on the termination of term of rent and obligatory payments,
- confirmation that processing is conducted on the lands,
- the actual understanding, what fields and the areas are included into each cadastral site;

(6) Agrosignal. Skauting:

- identification of negative tendencies of development of plants at an early stage,
- drawing up notes on inspections of the soil and crops,
- cloudy data processing of satellite pictures and obtaining maps of vegetation,
- addition of media files and tags of a geolocation even without Internet access,
- algorithm of remote control of irrigation,
- reduction of time for receiving and data processing.

Values of labor input are indicative: decision-making on modernization and digitalization of branch of crop production was led to decrease in their values for the analyzed five-year period by production of grain crops more than twice. It allows to bring up a question of diversification of digitalization of the enterprise and transfer of the got experience on branch of livestock production. Increase in the outputs and size of revenue of the enterprise happened against the background of fixing of prime cost and reduction of labor costs of personnel. The specified factors visually emphasize efficiency of digital business models regarding removal for staff of the superfluous and released personnel at the expense of which economy blocks costs of introduction of digital technologies and complex system decisions.

For specification and increase in reliability of researches the digital business model has to be developed discretely on basic process and branch (crop production, livestock production, processing, sale) to elements. In crop production have to act as such elements the system of the automated planning of adaptive and landscape use of lands (including collecting, updating, monitoring of a condition of lands, multi-purpose assessment of suitability and modeling of potential productivity, forecasting of productivity, planning of placement of grounds and crops, design of agrotechnologies, cadastral assessment of sites and their mortgage cost) and also a complex of digital technologies of business in crop production (field collecting *Big Data*, monitoring of grounds and crops, data transmission for decision-making, robotic means of decrease in the limiting factors of productivity, technology of exact agriculture).

Planned implementation of digitalization by the agricultural organizations will allow to pass to intellectual management of productivity of plants that will lead up to 20% to its growth.

CONCLUSIONS

The digital business model of activity of the agricultural organization including administrative (strategic and operational parts), technical and information components with a specification is developed for branch of crop production of blocks of accounting of works and agrooperations, monitoring of the equipment, the assistant to the agronomist, the reporting and analytics, the cadastral registration and a scouting, on the principle of replacement of traditional receptions and ways of production economic activity with the progressive digital decisions introduced in process of creation of consumer cost of production.

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ASSESSMENT OF THE SERVICE QUALITY IN A SMALL FAMILY HOTEL IN THE RURAL TOURISM OF BULGARIA

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Abstract

It is expected that after the COVID-19 pandemic, mass travel is unlikely to be as popular, although it will be relatively cheaper. Tourists will look for more individualization and consumer interest to be focused on a better quality tourist product, guaranteeing them greater security and safety. It is through family hospitality that customers' preferences are satisfied for comfortable, secluded and safer accommodation, with an original atmosphere, such as family hotels and guest houses, with reasonable prices, with fair cleanliness, combined with natural and unadulterated natural and social environment, in ecologically clean areas. In the present study, an assessment of the quality of the hotel product in family sites for accommodation in rural tourism in rural, mountain municipalities in Bulgaria. An evaluation methodology has been developed. The selected quality assessment criteria are divided into basic and additional. Each criterion is formalized by five quantifiable indicators. The aim is to fully cover the composition, structure, specifics and activities of the family hotel business. The obtained results were analysed and conclusions were made.

Key words: *family hospitality, quality, assessment, criteria, indicators, rural tourism*

INTRODUCTION

The crisis caused by COVID-19 in 2020, as well as the new rules for social distance and the change in consumer attitudes gave a chance to small hotels and resorts in Bulgaria - not only by the sea, but also elsewhere in the country. The demand for guest houses and small family-owned hotels in the past 2020 had a great consumer interest. The attitudes of tourists have changed when taking a tourist trip. They are already looking for a safer and more secure place, more privacy and less risk of meeting other tourists. Large hotels and resorts can hardly offer such a product. Already at the beginning of the summer months in the segment of small family hotel sites, the number of trips has increased, as the interest is focused not only on the Black Sea coast, but also on mountains, dams, rural and other types of alternative tourism. This trend continued until the end of 2020. In fact, many international experts believe that the crisis caused by COVID-19 will change the way people travel in the long run, and perhaps forever. It is expected that after the pandemic, mass travel is unlikely to be as popular, although it will be relatively cheaper. Tourists will seek more individualization and consumer interest to be focused on a better quality tourist product, ensuring greater security and safety….and at the same time with small family hotels there are some new advantages that are manifested as qualities that were almost unknown until now“[10].

Based on the analysis of the characteristics and features of family hospitality, in particular in rural tourism, we derive the following definition of family hospitality: Family hospitality is a major sector in the hotel industry in rural tourism and is: family owned and/or managed by entrepreneurs, mainly a small hotel business, supported by family members, which produces and sells a territorially determined hotel product that meets the needs of tourists, this product is characterized by authenticity, hospitality and atmosphere, recreating rural identity and providing direct contact with the host (owner). Small family-owned hotels satisfy customers' preferences for comfortable, secluded and safer accommodation, with an original atmosphere, such as family hotels and guest houses, with reasonable prices, with fair cleanliness, combined with natural and unadulterated natural and social environment, in ecologically clean areas. The needs of various forms of leisure time are met [3].

As a type of superstructure, the family hotel industry includes the main objects for accommodation in rural tourism: a guest house with/without agriculture, villas and a family hotel in mountainous and rural areas, private rooms, boarding houses, etc. [under the Ordinance for categorization of tourist sites, 2020] [8]. All of them are similar mostly in the following main feature in the context of the superstructure - small capacity of the bed base. Rural houses are the main means of accommodation for tourists [5, 6]. Their appearance and interior design are subject to the characteristics and requirements of the region.

Family hospitality is extremely important for the development of alternative forms of tourism - rural, ecotourism, cultural and cognitive, culinary, wine, extreme tourism and others. Family hospitality as an economic activity is of economic importance because it contributes to increasing family income, provides employment for family members, provides livelihoods in rural areas, stimulates small businesses, stimulates traditional crafts, increases employment and welfare of local people, preserves the cultural and historical heritage in the region, creates an opportunity for direct realization of own agricultural production, etc. Revenues in municipal budgets, from tourist taxes and through the patent tax paid by the small family hotel business are also increasing. Therefore, tourism services in the rural areas are able to support local population and communities in developing economic diversity [9]. The family hotel industry has good market positions with its unique product, aimed at market niches looking for local cultures, traditions, nature, history, hospitality [1].

Tuchman defines quality as the synonym for excellence [11]. This is what makes it difficult to measure, and „the quality of service is much more difficult to measure as compared to the product quality“[4]. Recently, there is a tendency to introduce higher quality criteria for the product "family hotel". These criteria cover the development and appearance of the building, the authenticity of the product related to local traditions, lifestyle, culture, offering local cuisine and specialties, impeccable hygiene, safety and security for guests and staff, effective communication with guests and care for them, offering more opportunities for spending free time. The quality of the family hotel product is determined by several other specific criteria: a higher degree of uniqueness and authenticity of the product; creating an atmosphere and coziness for guests close to the family; individualized service and customer care; higher degree of application of the principles of sustainable development.

In our opinion, the following three main types of tourist resources should be evaluated: material and technical base; intangible conditions - the entire cycle of hotel service to the guest; additional services - social responsibility and environmental protection, the specifics of the location and style of the site. In a quality hotel product, the tangible and intangible elements are combined in an optimal way and therefore this product is able to satisfy the needs of the customer and to be competitive. Kotler states that „American society for quality control defines quality as the sum of the features and characteristics of the product or the service that support its ability to satisfy the customer's need. Definitions that are customer-oriented suggest that quality begins with the needs of the customer and ends with their satisfactio“ [2]. Our research interest is focused on the quality of both tangible and intangible elements.

The purpose of this article is based on a developed methodology to assess and analyze the quality of the hotel product in family-type accommodation in Bulgaria.

MATERIALS AND METHODS

The selected quality assessment criteria are divided into: basic and additional. The aim is to cover the entire composition, structure, specifics and activities of the family hotel business [3].

The main criteria are 6, as each criterion is specified by 5 mandatory indicators. The additional criteria are 3, as each criterion is formalized by 5 indicators.

The additional criteria are 3, as each criterion is formalized by 5 indicators. The main evaluation criteria are in fact synthesized by the criteria for categorization of the respective site, specified in the Ordinance in the Ordinance for categorization of accommodation facilities (2020). The fulfillment of these criteria guarantees full coverage of customer expectations. These criteria are mandatory because a local quality brand is awarded only to those family hotels that meet the categorization criteria and guarantee customer satisfaction. The main criteria include indicators that aim to consider the originality and uniqueness of the family hotel.

The main criteria are: 1. improvement and maintenance of the building and the common premises; 2. the room - furniture and condition; 3. actual customer service; 4. nutrition; 5. organization of the free time; 6. offered additional services. The additional criteria consider additional activities forming the complex character of the offered tourist product, related to the protection and preservation of the environment, local traditions and culture, etc.

The additional criteria are: 1. environmental protection; 2. feedback from the client; 3. acquaintance with the local culture. The criteria and their corresponding indicators are presented in the following Table 1.

Table 1. Assessment criteria and indicators

Criteria	Indicators
Main criteria	
Building and common areas	hygiene and maintenance - entrances, corridors, stairs, lobbies
	yard, garden, availability and condition of swimming pool, green areas, parking, barbecue
	lighting, ventilation, space heating
	safety and security - the presence of fire extinguishers, signs, amenities for people with disabilities
	originality, uniqueness of design and layout
Room	amenities - furniture, lighting, heating, air conditioning, terrace
	level of hygiene in the room and bathrooms
	technical serviceability of the equipment in the room and the bathrooms
	calm, noise, security
	originality of the furniture of the room in accordance with local traditions
Actual service	welcoming, check in, accompaniment to the room, assistance in carrying luggage, acquaintance with the hotel, etc.
	customer service (service during the stay)
	check out, sending, payment options, ordering transport, invitation for the next visit, issuing a relevant document
	degree of individual approach to the guest - knowledge of specific requirements, assistance if needed
	emergency preparedness - power and water cuts, fire, guest indisposition
Nutrition	availability of an organized dining room
	serving breakfast in the room (room service) - home-cooked food
	offering local cuisine and specialties
	guarantees for compliance with food and beverage safety standards
	offering purchase of agricultural farm products, own production, organic products
Leisure's organization	material base for outdoor and indoor games: chess, backgammon, cards, computer games, etc.
	library with books, children's books, newspapers, magazines
	corner in the living room for watching TV, movies, listening to music
	organization of excursions, visits to cultural-historical, architectural landmarks
	participation in local folklore festivals, fairs, festivals, cooking courses
Additional services	cleaning, laundry room
	providing transport when needed
	information and communication services - internet, wireless internet in the rooms, post office, etc.
	items for rent - for sports, for the beach, for SPA, for mountain hikes
	specialized services for people with disabilities, care for children, the elderly
Additional criteria	
Environmental protection	availability of local heating
	alternative sources of electricity
	base for separate waste collection
	inclusion of guests in training in local folklore
	environmental protection briefing
Customer feedback	database with regular customers and their requirements
	book for registration of complaints and quick and adequate response
	conducting surveys among the guests for opinion, evaluation and recommendations for the quality of service
	inclusion in internet-based reservation and information systems
	liaison with travel agencies for the purpose of distributing advertising materials
Acquaintance with the local culture and its preservation	acquaintance with the individual interests and desires of each guest
	visits to craft workshops and local crafts
	participation in local initiatives for preservation of local folklore
	providing a guide for longer hikes
	dinners by the fireplace and barbecue with the family

Source: Author's development.

The indicators used are quantitative and qualitative. Quantitative indicators consider the number of funds, facilities, services, information materials, offers, etc. The quality indicators cover the level of hygiene, personal approach to the guest, atmosphere and comfort, etc.

The evaluation is carried out by applying a point system as the number of points express a certain evaluation and correspond to a certain level of quality. Points are awarded for each indicator. The sum of the points on the main criteria indicates whether the minimum established quality level is met. Achieving this level is the first condition for certification and awarding a local quality mark. The sum of the points according to all criteria determines the level of quality of the hotel product in the family hotel and the category that can be acquired. The grading system used in the present study is four-point to indicate a minimal, negative, unsatisfactory grade; average; high level assessment; and maximum, extremely positive assessment - level of luxury.

The rating scale is from 1 to 4 points for each indicator, and the ratings mean: level 1 means a low, unsatisfactory level of quality.

The rating scale is from 1 to 4 points for each indicator, and the ratings mean: grade 1 means a low, unsatisfactory level of quality; grade 2 - average level; grade 3 - high level; rating 4 - luxury level.

According to each of the main criteria, a maximum of 20 points can be obtained by indicators, giving a maximum of 4 points for each of the 5 indicators. A minimum of 5 points or a total of 30 points from all 6 criteria must be obtained for each of the main criteria.

If 30 points are not received, they cannot be compensated by the additional criteria and indicators. The maximum number of points that can be obtained from the main criteria is a total of 120. The additional criteria, which are 3 criteria with 5 indicators each, can give a maximum of 60 points. According to the proposed methodology, the level of quality is determined according to the number of points received from surveyed respondents as follows:

- with a total evaluation of up to 30 points - the hotel site does not meet the requirements for the level of product quality in the family hotel industry, even if it has been awarded an official category under the current mandatory ordinance for categorization.
- with a total assessment from 31 to 80 points - third category/level/of quality
- with a total assessment from 81 to 130 points of the second category/level/of quality
- with a total assessment from 131 to 180 points first (highest category/level/for quality.

This scale was developed by the author and adapted to the needs of the present study.

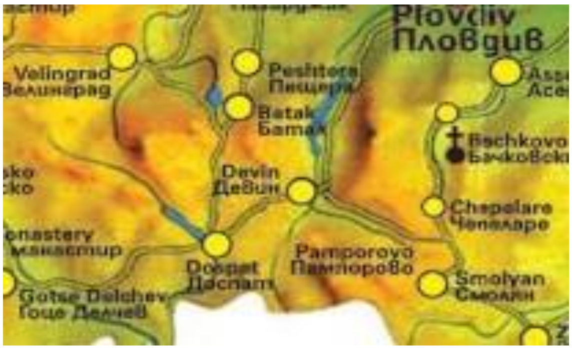

Fig. 1. The studied municipalities in the Western Rhodopes, Bulgaria
Source: Own determination.

The developed methodology for product quality assessment in family hospitality is applied to study the quality of family hotel products in rural mountain municipalities in the Western Rhodopes (including the municipalities of Nedelino, Borino, Smolyan, Chepelare, Batak, Dospat) implemented in June 2019 - September 2020 The following methods were used to collect primary information: - survey to study the quality of the product "family hospitality" among 153 customers, guests of family hotels, guest houses, villas in the Western Rhodope region during the period June 1, 2019 - February 31, 2020; - a survey to assess the quality of the hotel product among managers of 30 family hotels, 23 guest houses and 12 villas in the Western Rhodope region during the period:
June 1, 2019 - February 31, 2020. Visits and observations were made in family hotels, guest houses, villas in the mountainous rural areas of the Western Rhodopes, sites of these types of accommodation sites on the Internet

were also analyzed, surveying the satisfaction with the service. of the tourists who stayed in them, in-depth interviews were conducted with the owners and managers of these family hotels. The survey of the opinion of the clients staying in family-type sites on the territory of the Western Rhodopes region (including the municipalities of Nedelino, Borino, Smolyan, Chepelare, Batak, Dospat) was carried out through specially developed questionnaires.

They are provided to managers for distribution to hotel guests through the reception, by rooms and in person. The total number of completed questionnaires by customers is 153, and by hotel owners 65.

RESULTS AND DISCUSSIONS

According to the applied methodology for quality assessment in the family hotel industry, we perceive the following "... average ratings have the following meaning: - a score below 1.0 means a low level of quality (corresponds to a number of points below 30); - a score of 1, 1 to 2.0 - medium quality level (from 31 to 80 points) - rating from 2.1 to 3 - high quality level (from 81 to 130 points) - rating from 3.1 to 4 - luxury quality level (from 131 to 180 points) "[3].

Table 2. Quality assessment scale

Rating	Quality level	Number of points
below 1.0	low level	under 30
from 1.1 to 2.0	intermediate level	from 31 to 80 points
from 2.1 to 3	high level	from 81 to 130 points
from 3.1 to 4	luxury level	from 131 to 180 points

Source: author's development.

The results of the consumer survey of the **main criteria** and their indicators for the quality of the hotel product in the surveyed family hotels in the region of Western Rhodopes are the following:

The study on the criterion "***buildings and common areas***". Not all family hotels in the western Rhodope region have a traditional Rhodope-style exterior. The interior design and design to a greater extent preserve the Rhodope tradition. It is clear from the surveys that this requirement is not among the main ones for the guests.

70% of customers are satisfied with the maintenance and the level of hygiene in the common areas and give a rating of 3, ie. high assessment of the condition of the common areas in the hotel. This result shows that the maintenance and condition of the building and especially the level of hygiene attracts the attention of customers. Some respondents also noted that there are guest houses in which the rooms and corridors are cluttered with objects that are not even of authentic local origin. Their opinion is similar regarding the green areas and the yards. A low score is given to the second indicator of this criterion, where there is no possibility for parking.

After the "level of hygiene", this is the second factor that lowers the assessment by the criterion "building and common areas". In terms of hygiene, lower ratings are also given to dining rooms. For 40% of the dining rooms, customers give a rating of 1.8, which corresponds to 31 to 80 points - an average level of quality. This lowers the arithmetic mean of this criterion. The fashion in this statistical order is 2.9, which means that many customers give high quality by this criterion. The arithmetic average score on this criterion is 2.82, which corresponds to from 81 to 130 points - high quality of buildings and common areas in family hotels. The location of the hotel is essential for the consumer value of the hotel product. For the most part, family hotel sites, with their location, valorize valuable natural and anthropogenic resources. In many regions they are the basis of the tourist destination and form its appearance.

According to the criterion "***condition of the room***": furniture, equipment and hygiene, customers give positive ratings, finding a wide range of ratings. The coefficient of variation is 65%. The fashion in the statistical order is 3.1, which is on the border between high and luxury level. The indicator of technical serviceability of the equipment is also highly rated. The average score on the criterion "condition of the room" is 3.15.

Regarding the "***actual service***" criterion, the clients combine the actions of the reception and dispatch staff, with large differences in assessments. These two indicators show the largest amplitude between the minimum and maximum score. The coefficient of variation is over 70%, which shows that there is great diversity in the studied statistical order. The fashion for the average score for the criterion is 2.3, which corresponds to from 81 to 130 - a high level of quality but is very close to the border between medium and high level. This result is negatively affected by the service in guest houses and in separate rooms, where the service is reduced to handing over the key and fleeting instructions. Clients give a high assessment of the personal attitude towards everyone - addressing by name, welcoming, expressing kind hospitality, help in transferring personal belongings to the client and getting acquainted with the main points of information orientation. The indicator "service during the stay" - customers assess the satisfaction of individual requests, assistance in ensuring a full stay. A score of 4, however, on this indicator is rare. Statistical mode, the most common case in the studied population is 3.

The provision of "assistance and care for the client in specific and emergency situations" is highly valued in family hotels - grade 4, and in guest houses there is a decrease in the rating to 2 - medium quality, mainly due to some delay in assistance. The arithmetic mean of this indicator shows the number of points in the range from 81 to 130 and gives high quality of the hotel product in family hotels.

In the criterion of **"nutrition"**, the indicator "local cuisine" is highly valued, its arithmetic mean value is 3.6 (points 131 to 180). This result shows that in the guest houses and family hotels great attention is paid to home-made specialties with organic products, with good taste and attractively served. The coefficient of variation is low and the mode in the statistical order is 3.5. The indicator "guarantees of compliance with food and beverage safety standards" receives average and high scores in the range from 31 to 130 points. The coefficient of variation is 58%, which is indicative of the relative heterogeneity of the statistical order. In many cases, the type and aesthetic design of the food when served, rather than its content, raise doubts in some customers. However, the high score on this indicator is predominant. A high score of 4 on the indicator "serving breakfast in the room" is given mainly by younger customers, while older customers do not pay much attention to this element of the hotel product. The arithmetic mean score on this indicator is between medium and high -3. The indicator collects 123 points.

The criterion "***organization of leisure time***" receives between average and high marks from customers. The statistical order includes units, scores from 1.4 to 2.8, collects from 40 to 120 points. The indicator "availability of material base for outdoor and indoor games" receives an unsatisfactory assessment and it lowers the overall assessment according to this criterion. The average score of 1.4 on the indicator "availability of a corner in the living room for watching TV, movies" indicates that customers are not looking for this service. The coefficient of variation has the lowest value, which means the uniformity of the statistical order. Such homogeneity - coefficient of variation of 30% is found in the indicators "organization of excursions, visits to cultural, historical, architectural landmarks" and "participation in local folklore festivals, fairs, festivals, cooking courses" of this criterion, only that the score is high - 3.6 - from 131 to 180 points.

The facilities and conveniences for spending free time, opportunities for communication, information are crucial for the formation of uniqueness and specialization of the hotel product, for the provision of services of special interest and for active recreation. The evaluation according to this criterion once again confirms the essence of the alternative forms of tourism, incl. and rural tourism - to escape from everyday life and look for the exotic.

Criterion "**additional services**" - in all family hotels and guest houses are created conditions to meet small household needs of customers - laundry, ironing. However, sports equipment and rental items are not available everywhere. This indicator collects from 81 to 130 points. Customers give a score of 2.78, which corresponds to a high quality of service according to this criterion. The service in the hotels is characterized by a personalized approach to the client and emphasized hospitality. The unique atmosphere, the personalized service technology and the customer care, which are not subject to standardization, all this creates the image of the hotel. Satisfaction with the service during the stay creates popularity and loyal customers who recommend it to relatives and acquaintances.

Regarding the **additional criteria** for assessing the quality of the hotel product in family hotels:

By criterion "***environmental protection***": Few family hotels have created alternative sources of electricity; also a base for separate waste collection. But since many family hotels have local heating and hot water all year round, according to this criterion, customers give an average rating - 2.9, which means high quality. The protection of the environment is carried out in ways that do not require financial resources, but rather work by the staff and the owner and the participation of the client.

According to the criterion "***acquaintance with the local culture and its preservation***", the clients give high marks to the indicator "maintaining the local culture" - 2.9, which means from 81 to 130 points and shows a high level of work of family hotels in this regard. The clients of the guest houses give a low grade according to the indicator "acquaintance with the individual interests and desires of each guest" regarding acquaintance with all the surrounding historical, architectural, natural and other landmarks - arithmetic average 1.5, which corresponds to 31 to 80 points, very close to the negative assessment. For family hotels according to these indicators the rating is over 2.8 in the range -2.1 - 3, which corresponds to from 81 to 130 points and means a high rating of the hotel product in family hotels.

Regarding the "***customer feedback***" criterion. Customers are interested in the indicator "inclusion of the hotel in the Internet reservation and information systems" and, where available, give it the highest rating - 4. But since there are guest houses and villas that do not meet this criterion, the average rating is decreases to 3.2. Most family hotels and almost all guest houses do not have a database of regular customers. This is a negative side of their activity. The creation of such a database will raise to a much higher level the personal approach to customers, the relationship with regular customers of the hotel and will improve the quality of their service and the overall quality of the hotel product in family hotels.

The average customer ratings on the indicators of the main and additional criteria are reflected in the following Table 3.

Table 3. Average customer ratings

basic criteria	average grade	additional criteria	average grade
building and common areas	**2.82**	**environmental protection**	**2.9**
the room	**3.15**	**customer feedback**	**2.6**
actual service	**2.73**	**getting to know the local culture**	**2.2**
nutrition	**3.64**		
organization of leisure	**2.57**		
additional services	**2.78**		

Source: Own calculation.

The evaluations of the owners and managers of family hotels according to the main criteria are:

The average arithmetic score according to the **main criteria** with which we perform evaluation is 2.79, which is on the border between high and luxury level of quality of the hotel product. The range in which it is located is from 2.1 to 3, which corresponds to points 81 to 130, it follows that the level of quality is high. The average ratings of owners and managers are mixed. The largest number are the grades over 3 - a total of 33. 23 estimates are between 1.5 and 2.5, ie. owners and managers give high marks to the quality of the hotel product. There is no score below 1, ie. under 30 points. Definitely high marks are given to indicators such as: offering traditional local cuisine; created amenities through furniture, air conditioning; high level of hygiene in the room and common areas; quality consumables - frequent change of bed linen, towels; organized dining room in traditional Rhodope style and atmosphere, etc. There are many ratings that are close to the maximum score of 4. At the same time, there are ratings that confirm an average level of quality. These ratings are primarily for guest houses.

According to the main criteria, the average arithmetic rating is 2.79, which means the border between high and luxury level of quality of the hotel product. It is in the range of 2.1 to 3, which corresponds to a number of points from 81 to 130, therefore the level of quality is high. The average ratings of owners and managers are mixed. The largest number are the grades over 3 - a total of 33. 23 are ratings between 1.5 and 2.5, which means that owners and managers give a high rating to the quality of the hotel product. There is no score below 1, similarly below 30 points. Definitely high marks are given to indicators such as: offering traditional local cuisine; created amenities through furniture, air conditioning; high level of hygiene in the room and common areas; quality consumables - frequent change of bed linen, towels; organized dining room in traditional Rhodope style and atmosphere, etc. There are a large number of ratings that are close to the maximum score of 4. At the same time, there are ratings that confirm an average level of quality. These ratings are primarily for guest houses.

According to the **additional criteria**: The evaluations of the owners and managers according to the criterion “getting to know and maintaining the local culture” are in the range 1.6 - 2.5, which corresponds to medium and high quality of their activity on this issue. The coefficient of variation is over 50%, which shows that the individual units, cases in the statistical order are very different. The median is 2.15, which is on the border between medium and high quality. This shows that opportunities should be sought to improve the work in this area. The maintenance of the local culture, historical, architectural, natural and other landmarks is an activity that requires coordinated actions of the owners of family hotels and the municipal administration. According to the criterion "environmental protection": the owners/ managers give ratings in the range 1.3 - 2, which corresponds to an average level of quality. This means that the owners and managers themselves assess their environmental protection activities, as well as the information and instructions they provide to guests on this issue, as unsatisfactory. Regarding the criterion "customer feedback", the ratings are average. As mentioned above, most of the family hotels have not created databases for their regular customers. Investments are needed to create web-based systems for reservations, information services, customer feedback.

It is clear that the owners and managers of family hotels have managed to offer facilities and conditions for accommodation that meet quality requirements and customer expectations. The atmosphere in the family hotels is friendly, informal, close to the comfort of home. The service is mainly through personal contacts between the owner/ manager and customers, individually and leads to the creation of friendly relationships between staff and customers. The protection of the environment is carried out in ways that do not require financial resources, but rather work by the staff and the owner and the participation of the client.

The shortcomings are mainly due to: lack of flexibility in supply (various offers); organization of leisure services; means to diversify the stay; lack of a database for regular customers.

Family hoteliers need to look for ways to introduce and improve their distinctive features and in combination with the application of “newer approaches focused on Magaš [7]:

• how the company will meet the needs of consumers
• achieving a unique competitive advantage
• offer greater (added) value to the guest
• constant monitoring of the needs of the guests ",

they will contribute to the creation of a better and more competitive hotel product.

The opportunities for improving the quality of the product in the family hotel industry of the Western Rhodopes region are in the following main directions: - improvement of the tangible characteristics of the product, with the emphasis on changes in the superstructure; - raising the professional and language qualification of the staff and development of its key competencies; - enrichment of additional services in order to better use the free time of the clients and increase the quality of the experience; - improving the quality of the intangible characteristics of the product - personalization of the service; creating a database for customers to study in more detail their needs and desires, to seek feedback from customers, to analyze feedback on social services and web-based systems for booking and customer feedback; - unification of the family hotel sites in the Western Rhodopes region in a voluntary local system for product quality certification.

In conclusion, it can be summarized that family hospitality in the region of the Western Rhodopes can highlight its product as attractive, high quality and sought after, which will contribute to the specific appearance of this region as a destination.

CONCLUSIONS

Based on the study and analysis, the following conclusions can be made:

The family hotel sites in the Western Rhodopes region have a high degree of identity and distinctive image, are associated with local culture and nature, reflect the spirit and appearance of the region; the atmosphere, the conditions, the services, the cuisine are unique and specific. However, the distinctiveness of the sites, based on the design and the atmosphere, does not guarantee them a sustainable competitive advantage.

It is necessary to apply a specific methodology for product quality assessment in the family hotel industry. It will assist owners and managers in making decisions and finding ways to maintain high quality and create loyal and regular customers who are not only satisfied but also exceeded expectations. The specific methodology for product quality assessment must be part of a comprehensive system for certification and award of a local quality mark. The development and application of such a system imposes the need to unite family hotels in the region and cooperation both between them and between them and industry organizations and educational institutions.

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THE NEED TO MONITOR THE WATER FOOTPRINT UNDER THE CONDITIONS OF SMART DEVELOPMENT APPLICATION

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Abstract

In this paper we set out to analyze the need to monitor the "water footprint", starting from the fact that water is an indispensable resource for the development of life, and its lack is one of the biggest problems facing the world today, one of the biggest concerns and, at the same time, one of the biggest challenges. Water scarcity is a risk both for the economy and for communities and ecosystems, being influenced by climate change, but also by the irresponsible behaviour of people. Finding solutions to protect this resource is a concern of the modern world in trying to protect sustainable development. The research methodology involved the analysis of the literature, data collection and processing, formulating opinions and conclusions on how to apply smart development principles to find viable solutions to reduce the "water footprint".

Key words*: *water footprint, smart development, climate changes, social responsibility

INTRODUCTION

Sustainable development, smart development, sustainable economy are increasingly used terms in the conditions in which humanity faces serious environmental problems, which although they have been discussed over time and which have been the subject of long debates in the attempt to raise awareness of the danger that threatens Planet Earth, have long remained at the stage of discussion or have been postponed in the hope that future generations will find solutions.

The risk of environmental degradation, depletion of resources, and impoverishment of the planet has existed and will continue to exist, and the postponement of measures to combat these dangers does nothing but confiscate the possibility of future generations to benefit from the right to enjoy what nature offers us all.

Under these conditions, issues related to the "carbon footprint" are discussed, and more and more often we talk about the "water footprint", given that water, the vital liquid for humanity, is an inexhaustible resource, it is an insufficient resource, but obligatory for the continuation of life on Earth. Climate change and population growth contribute to increasing pressure on water resources, especially freshwater resources, the lack of which affects a significant part of humanity.

If the "carbon footprint" is the amount of carbon dioxide produced by each person as a result of their activities, the "water footprint" is an environmental indicator that reflects the amount of water needed to carry out these activities on which our daily lives depend. And this includes not only the visible water consumption, but also the water consumption necessary to obtain the food and non-food products necessary for each person. Therefore, this "water footprint" refers to the volume of fresh water that is needed to obtain a product and which includes in addition to the volume consumed and the volume of wastewater that occurs throughout the production chain [4].

The concept of "water footprint" was first used in 2002 as an environmental indicator to express water consumption and to complement other indicators used up to that date, but which only quantified production issues.

This new indicator provided information not only on the volume of water consumed, but also on the volume of water resulting from the production activity, the location of consumption, being thus an explicit indicator regarding the geography of this consumption [5] and being able to influence decisions related to existence, availability and mode use of existing resources worldwide.

In this context we can talk about the role of monitoring the "water footprint" and its role in smart development, which in turn contributes to smart growth, first regionally and then globally.

Intelligent development is directly linked to the application of innovations that offer intelligent solutions that are economically efficient, friendly to the environment and human health, both physical and mental, which can provide them with the comfort they need as their consumers [11]. Intelligent development is thus based on the use of information, on the use of technologies, on the efficient communication between all the factors involved in any process [9]. In this way, regional development policies can in turn influence this intelligent development, taking into account the different restrictive factors [2].

MATERIALS AND METHODS

In order to determine the need to monitor the "water footprint", in this paper we aimed to identify from the bibliographic study of scientific papers that analyze this topic to identify ways to reduce water consumption. Various databases were consulted that allowed us to collect data, process them and interpret them using graphs. The evolution of the analyzed indicators was achieved by using indices with a fixed base, determined as follows:

$IFB = (x_n/x_1) \times 100$ according to [1]

where:
x = variable subject to the study;
n = 1,2,3 ... n, chronological series

Based on the analyzed data, conclusions were formulated regarding the topic of the paper.

RESULTS AND DISCUSSIONS

Marc Buckley, starting from the fact that "water is the most valuable resource we have" [8] showed that water is not only an important resource, but also a cross-cutting resource given that it directly or indirectly influences the objectives rural development proposed through public policies.

Hoekstra A. Y. [6] affirmed since 2008 that there are 3 categories of water footprints that differ depending on its origin and how to use it in the manufacture of a product, thus proposing a "network of water footprints". We can thus speak of a "green water footprint" which is represented both by water from precipitation, but also by evaporated water and which can be used to obtain production. There may then be a "blue water footprint" resulting from surface water and groundwater, either natural or artificial, and there may also be a "grey water footprint" which represents "the volume of freshwater that is required to assimilate the load of pollutants given natural background concentrations and existing ambient water quality standards" [7].

Viewed from the point of view of the place of consumption, the literature highlights an "internal footprint" which is given by the amount of water consumed in a country for the production of goods and services that are consumed by the population of that country and a footprint external water supply ”which is represented by the water consumption necessary to obtain goods and services imported by the respective country.

There is also water use for import, virtual water import and virtual water for export, virtual water for re-export, elements that underlie the determination of the "water footprint" and a virtual water budget. The relationship between these categories of elements is presented in Figure 1.

In order to be able to move to measures to reduce the consumption of fresh water, this consumption must first be determined. Existing methods allow this, so that for each product, category of products or goods can be established "water footprint".

Of the total water consumed, over 90% is hidden in food and other consumer goods, in

the energy used or in the services we use, so that the average "water footprint" is about 3,000 liters/day/capita.

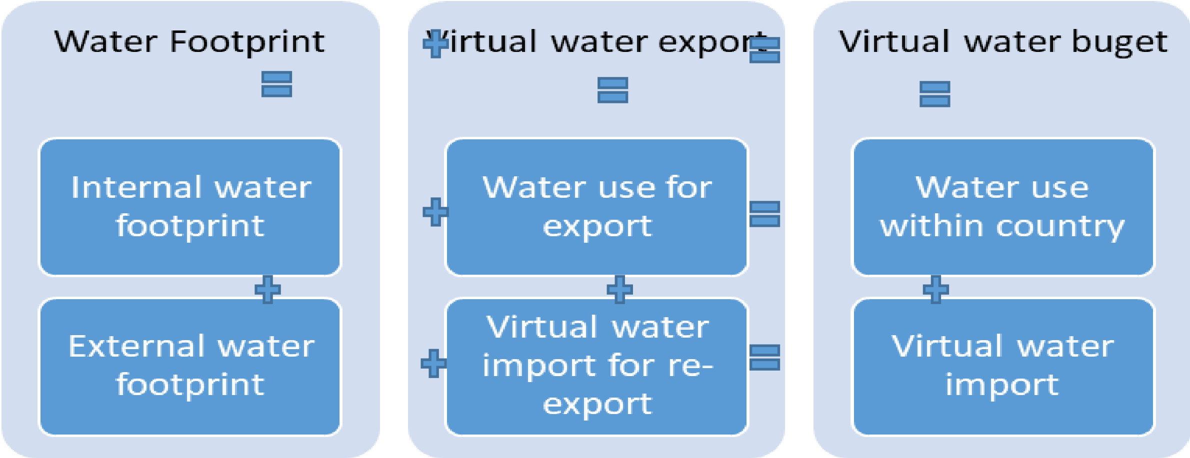

Fig. 1. National water accounting method
Source: Own determination.

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Of the total water consumed, over 90% is hidden in food and other consumer goods, in the energy used or in the services we use, so that the average "water footprint" is about 3,000 liters/day/capita.

Obtaining food, and therefore agriculture as an important branch of the economy [12], is one of the most important consumers of water. This means that obtaining agricultural production is in turn a large consumer of water. The processing and marketing processes are also water consuming.

Obtaining a single kilogram of cereal requires a consumption of 1,644 liters of water [3]. According to the calculations, the production of one kilogram of meat requires a consumption of 51,779 liters of water for horse meat, 15,415 liters of water in the case of beef, over 8,700 liters of water for obtaining goat and sheep meat, almost 6,000 liters of water in the case pork and over 4,000 liters of water for 1 kg of chicken.

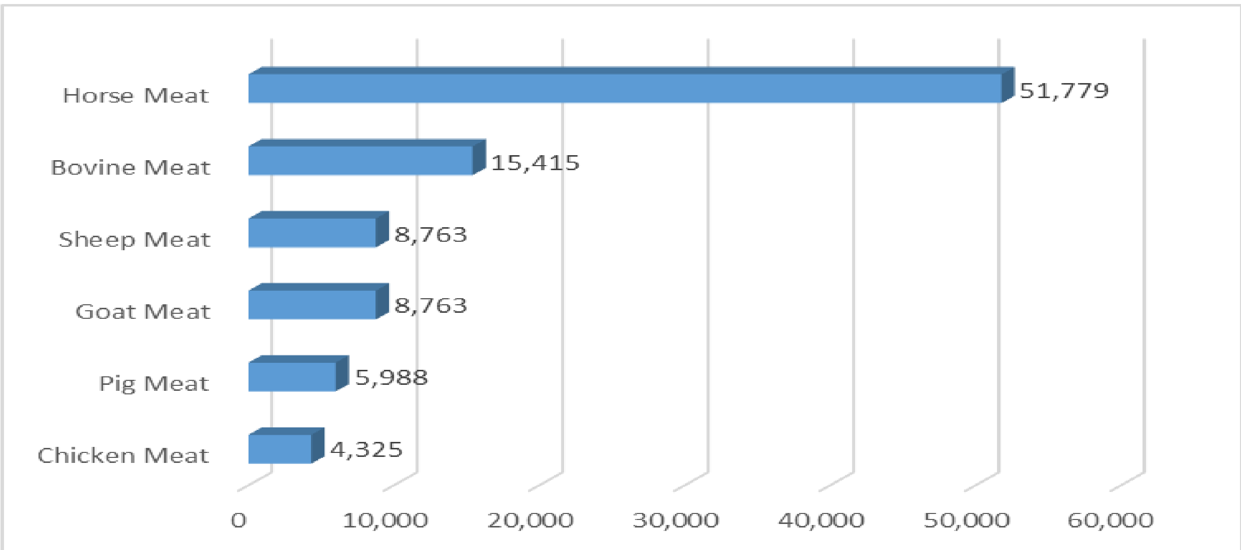

Fig. 2. Water consumption (in liters) required to obtain one kg of meat for different species
Source: Own determination [3].

The production of various other foods requires a high consumption of fresh water to obtain a single kg of product (5,677 liters for 1 kg of ham, 1,020 liters for 1 kg of milk) (Figure 3).

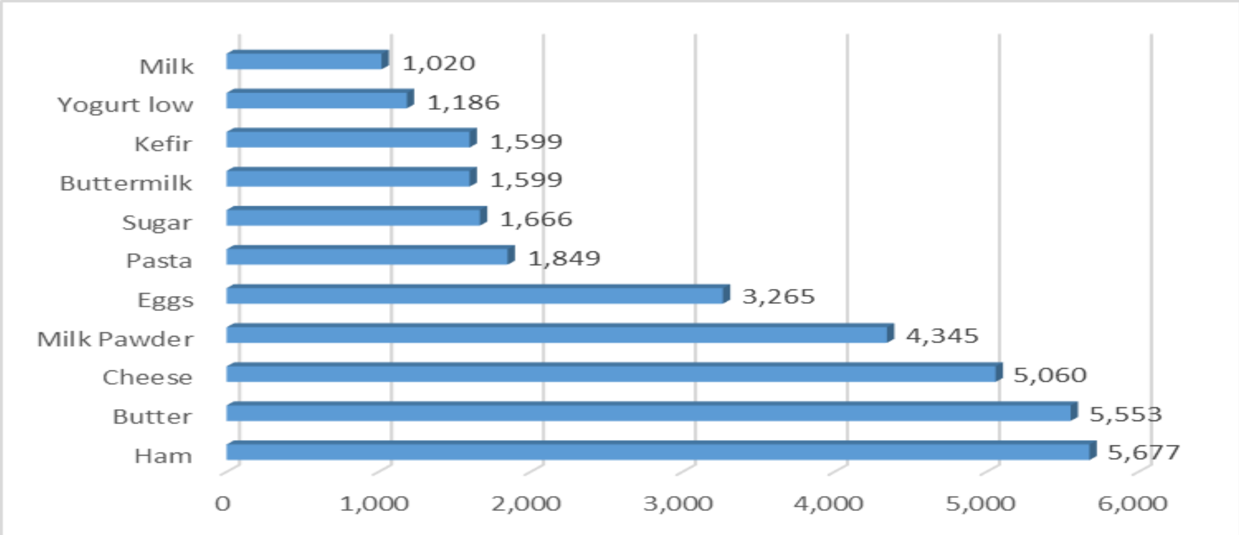

Fig. 3. Water consumption (in liters) required to obtain one kg of one kilogram of product
Source: Own determination [3].

It is therefore found that the "water footprint" is the larger the more complex the technological process. Therefore, for example, switching to a healthier diet would also be an advantage in terms of resource consumption.
A United Nations study shows that by 2030 the world's population will grow from 7 billion (2020) to 8.5 billion and reach nearly 10 billion by 2050 [13].

Given the limitation of the "water footprint" to the existing one at this time, there would be an exponential increase in water consumption from 21 trillion litres to over 29.1 trillion litres, which shows that an increasing part of the population will face with lack of water (Figure 4).

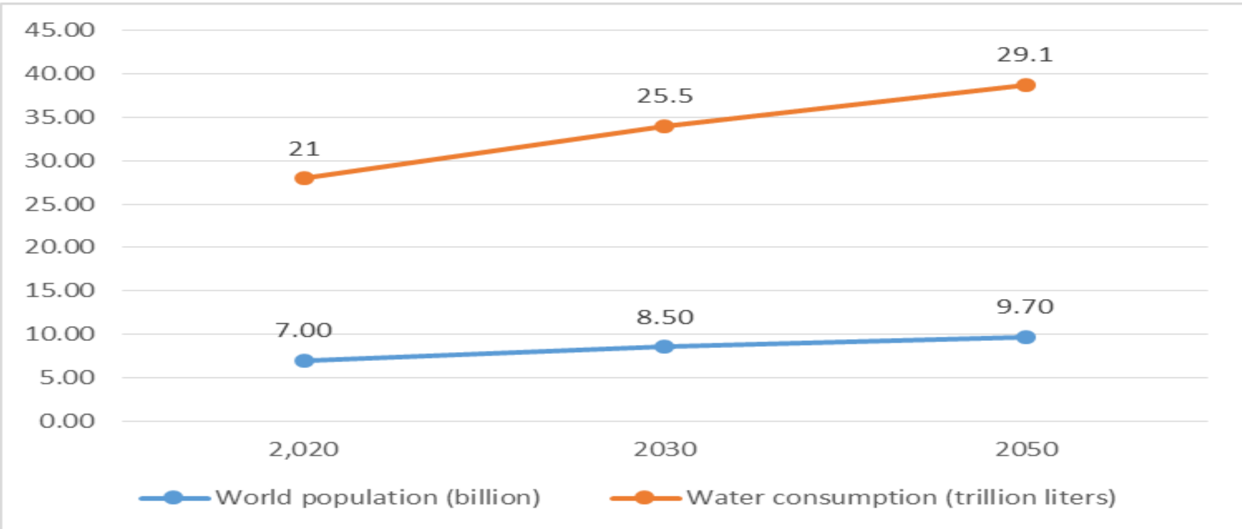

Fig. 4. Population evolution and water consumption
Source: Own determination [13].

Starting from the water consumption specific to each product, we find that, for example, the food of a single person in a single day involves a consumption of over 5,000 liters of water (Table 1).

Table 1. Water footprint, in liters, to ensure a person's food / day

	Food	Water consumption (liters)
Breakfast	Milk with cereals - 250 ml of milk - 30 gr cereal	**304** - 255 - 49
Lunch	Hamburger + 1 drink - 1 little bread - 2 slices of tomatoes - 1 chicken patty - 1 slice of cheese - 1 lettuce leaf - 1 drink	**1,050** - 85 - 12 - 737 - 90 - 1 - 125
Diner	Steak + potatoes + 1 salad - 1 beef steak (250 gr) - 1 potato - 1 salad	**3,850** - 3,495 - 105 - 250
Water footprint		**5,204**

Source: Own determination.

The solutions that exist, however, require the use of new technologies, educating the population, reducing the negative effects of pollution, etc. We find that there is a direct link between smart development and water footprint. Renewable energy production, for example, means not only a reduction in the consumption of natural resources, but at the same time a reduction in water consumption and the application of circular economy criteria, which although still confused with many barriers can be supported by its own advantages [10].

Regarding the producing companies, by reducing the "water footprint", by applying water conservation programs, they will be able to reduce their costs, simultaneously with the contribution they will bring to reducing pollution and increasing environmental sustainability. However, water conservation is also possible in household consumption, the use of "gray water" in homes or office buildings, hotels, etc. represent possible solutions.

In agriculture, "gray water" can also be used or water use solutions can be used to reduce the volume subjected to evaporation; hydroponic crops that benefit from low water consumption can be promoted; the system of so-called green sponges, etc. can be used.

Reducing consumption and waste, educating consumers, implementing innovative technologies, using renewable energy are solutions that can be applied today and will contribute to both reducing climate change and financial benefits for all those involved in this complex process of saving.

CONCLUSIONS

In conclusion, the water footprint is an environmental indicator that tracks the pressure that people exert on fresh water consumption and that reflects the relationship between use, consumption and how to manage it. Knowing this footprint will allow the identification of water use patterns, both at the level of each platform and at national and global level.

In this way, a frame of reference can be created through which economic activities can become more efficient, smarter, more environmentally friendly, more sustainable. At the individual level, the visualization of the water footprint will be able to contribute to the awareness of the fact that there is a need for a reduction of water consumption, of a rational use of it, but also regarding the importance that water has in our life.

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EMPIRICAL TREND ANALYSIS OF INTEREST RATE AND VALUE OF FORMAL AGRICULTURAL FUNDING IN NIGERIA (1986-2017)

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Abstract

The paper dealt on empirical trend analysis of interest rate and value of agricultural finance in Nigeria between 1986 and 2017. It was the specific objectives of the study to: describe trends of interest rate and value of formal agricultural funding in Nigeria for the period 1986– 2017; determine the path of progress of interest rate and value of formal agricultural finance in Nigeria for the period under review; compare rate of growth of interest rate and value of formal agricultural funding in Nigeria within the reference period; and analyze trend of interest rate in Nigeria within the reference period; explain the cause and effect relationship of interest rate and value of formal agricultural finance in Nigeria within the reference period. Secondary data was used for the study and these were subjected to descriptive statistics and econometric analysis. However, the trend revealed a persistent increase in the interest rate between 1986 and 1998 coinciding with the Structural Adjustment Policy era. The interest rate then dropped slightly between 2000 and 2006 and then began to trend upwards from 2007 to 2017. These are manifestation of volatility of interest rate to agricultural funding. In overall status, interest rate exhibited negative non-considerable trend while volume of formal agricultural finance exhibited positive trend within period 1986-2017 in Nigeria. The study therefore recommended that the monetary authorities in Nigeria should maintain a stable interest rate policy to ensure that adequate formal financing flow from banks to the agricultural sector. Commercial banks should concentrate on mobilizing savings by charging lower interest rate and providing handsome return to depositors which would increase funds flow and make it available for formal financing of agriculture.

Key words: *formal credit supply, interest rate, agriculture, Nigeria*

INTRODUCTION

Agriculture has played important roles in the development of Nigeria's economy justified by its relevance in provision of food for the teaming population, generation of employment, provision of industrial inputs and in generation of foreign exchange [4, 2]. Advancement of agriculture in the country requires judicious financing and investment of funds. One practical way of sourcing such funds is securing farm credit. Credit is an input and a catalyst in production as well as a "change factor" in agricultural production. The provision of this input is important because it functions more than just another resource (labour, land, equipment and raw materials) by determining access to the provision of the inputs. [7] observed that farm credit is a major input in development of the agricultural sector as it facilitates adoption of new and improved systems of farming. Agricultural credit forms an integral part of the process of modernization of agriculture and commercialization of the rural economy [19]. It provides farmers with ample opportunity to increase their income and improve their living standard. Agricultural financing policy in the country had earlier advocated charging of concessionary interest rate on agricultural loans same as it was to loans to other real sectors of the economy. To encourage farmers, apply for loans for investment purposes, there was an understanding that they (farmers) being risk averse and not have the collaterals required often for loans by commercial banks, be charged concessionary interests [8]. Interest is the charge paid on loans or on debt securities, either at regular intervals or as part of a lump sum payment when the loan matures. In case of bank loans, interest is paid in instalments through the life of the loan based on agreed annual rate. It is an important economic price determined by various factors and useful in gauging financial market conditions. The direction and magnitude of changes in market interest rate are primarily important to policy makers as it shows the growth path of the economy. The role and effect of interest rate can be determined following link between the financial sector and real sector of the economy. Interest rate has the problem of increasing cost of agricultural production which cause hike in domestic food price, and where the price of imported food items is cheaper than that of domestic production causes a downward shift in demand for domestic food products and lead to discouragement of farmers in going into food production [20]. Over the years, interest rate in Nigeria is managed by the monetary authority as a monetary and credit policy tool aimed at inflation control, investment inducement and economic growth [21]. Poor financing of the agricultural sector hampers agricultural development. Prior to the structural adjustment policy (SAP) era in Nigeria, there was consistent increase in lending portfolios of banks to the agricultural sector but at concessionary rates. The agricultural lending was considered riskier, problematic and unprofitable relative to other sectors. Then came the deregulation policy which however, erased the idea of concessionary lending by banks. Bank credit to the agricultural sector in nominal terms, over the years increased from about ₦230 million (then about $233 million) in 1978 to over ₦262 billion ($2.23 billion) in 2005 [1]. The growth rate of investment in agriculture was less compared with that in other economic sectors in Nigeria. With deregulation, interest charges on agricultural loans rose and volume of formal lending to the sector fell resulting in shortage of funds. Shortage of funds for agricultural financing and poor access to loans by farmers remained another problem in agricultural financing. Inability of farmers, especially small-scale farmers, to access credit for improved agricultural production, hampers their willingness and desire to adopt farming innovations, and thus establish executionary down turn effect on overall farm productivity [6]. [5] earlier observed that continuous shortage of capital to fund investments in agriculture remained a major constraint in Nigeria's domestic food production. Considering willingness of the farmers to take loans, [17] was of the opinion that the rate of interest charges on loans by farmers was an implicating factor. It was in recognition of these facts that the Federal Government of Nigeria at various periods put in place credit policies and created multiplicity of credit institutions and schemes that have enhanced farmers' access to credit [13, 9, 12]. Other impressive agricultural financing policies include the establishment of Agricultural Credit Guarantee Scheme Fund (ACGSF) [12]; the Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB), now Bank of Agriculture (BOA), and Nigeria Export-Import Bank (NEXIM). These development institutions are preoccupied with macroeconomic policies which promote the agricultural sector and maintain continuous inflow of funds to sustain agricultural development. A broad understanding of implications of interest rate is quite essential. The need to empirically understand trend of interest rate and the value of agricultural finance in Nigeria cannot be overlooked especially now that there is a downturn in the economy. It was against this backdrop that this investigation specifically described trends of interest rate and value of formal agricultural finance in Nigeria for the period 1986– 2017; compared rate of growth of interest rate and value of formal agricultural finance in Nigeria within the reference period; measured and analyzed trend of volatility of interest rate in Nigeria; and explained the cause-and-effect relationship of interest rate and value of formal agricultural financing in Nigeria over the referenced period.

MATERIALS AND METHODS

Area of Study

This study was carried out in Nigeria, a country situated along the coast of West Africa between Latitudes $10^0\ 00^/$ North of Equator and between Longitudes $8^0\ 00^/$ East of Greenwich Meridian. It is bounded on the

West by Benin Republic, on the North by Niger Republic, on the East by Cameroon Republic and on the South by Gulf of Guinea. Nigeria occupies a land area of 923,768,622km^2 (98.3 million hectares) out of which 71.2 million hectares is suitable for cultivation. Nigeria is a geo-political and sovereign entity that is composed of 36 States and the Federal Capital Territory (FCT)-Abuja. In 2006, the total population of the country was 143 million people [15].

Data Collection

This investigation applied a mixed study approach and used secondary time series data from Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), and Food and Agriculture Organization (FAO), covering the period 1986-2016 on many variables. Data collected among others included: Agricultural financing, Interest rate, Inflation rate, agriculture contribution to Gross Domestic Product, Foreign Direct Investment, Cash Reserve Ratio, Monetary Policy Rate, Liquidity Ratio, Loans and Advances to agriculture, Liquidity Ratio, and Real Money Supply.

Analytical Technique

Data obtained were analyzed using both descriptive statistics and econometric tool (Generalized Autoregressive Conditional Heteroscedasticity (GARCH)). In describing trend of interest rate and volume of formal agricultural finance in Nigeria for the period 1986 – 2017, time trend analysis was used. In investigating dynamic variation (acceleration, deceleration or stagnation) in growth of interest rate and volume of formal agricultural finance in Nigeria for the period 1986 – 2017 the logarithmic quadratic time trend analysis was used. The model:

$Y_{it}=\exp^{(\beta 0+\beta 1+ei)}$ …(1)

Linearized and applied by [10] and [17] as follows:

$LnY_{it}=\beta_o+\beta_1T+e_i$ …(2)

where:

Ln= Natural logarithm; Yit= Interest rate in period t, or Volume of agricultural financing in period t. Agricultural financing or funding was measured as sum of Government (public) and private sector spending in agriculture (ie. Domestic investment in agriculture). Government (public) spending in agriculture was proxied by government capital expenditure in agriculture in period t, while private sector spending in agriculture was proxied by commercial bank's loans and advances to agriculture in period t. T=Time trend variable (years); β0 and β1 were parameters estimated, and ei, the error term was used in this analysis. In relating growth rate of interest rate with value of formal agricultural finance in Nigeria within the reference period the Z-test of difference in means of the variables was used. To measure and analyze trend of volatility of interest rate in Nigeria within the reference period, the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) was used; and to explain the cause-and-effect relationship between volatility of interest rate and volume of formal agricultural finance in Nigeria within the reference period this investigation used Granger causality test as used previously by [11, 14].

RESULTS AND DISCUSSIONS

Trend of Interest Rate in Agricultural Financing in Nigeria Between 1986 and 2017

The trend of interest rate is presented as Figure 1. The Figure shows that there was persistent increase in the trend of interest rate between 1986 and 1998. This increase was probably due to the Structural Adjustment Programme (SAP) policy implemented then and liberalized the financial system in 1986. The Figure also revealed that volatility of interest rate dropped slightly between 2000 and 2006 and then began to trend upwards from 2007 to 2017. The upward trending of interest rate over the period (2007 to 2017) could be attributed to the various economic crisis that hit Nigeria beginning from the global financial crisis of 2008 and the economic recession that began in the second quarter of 2016. This implies that the level of volatility of interest rate in Nigeria was very high over this period. This result gave credence to [24] who observed the upward trending of interest rate from 2010 to 2011.

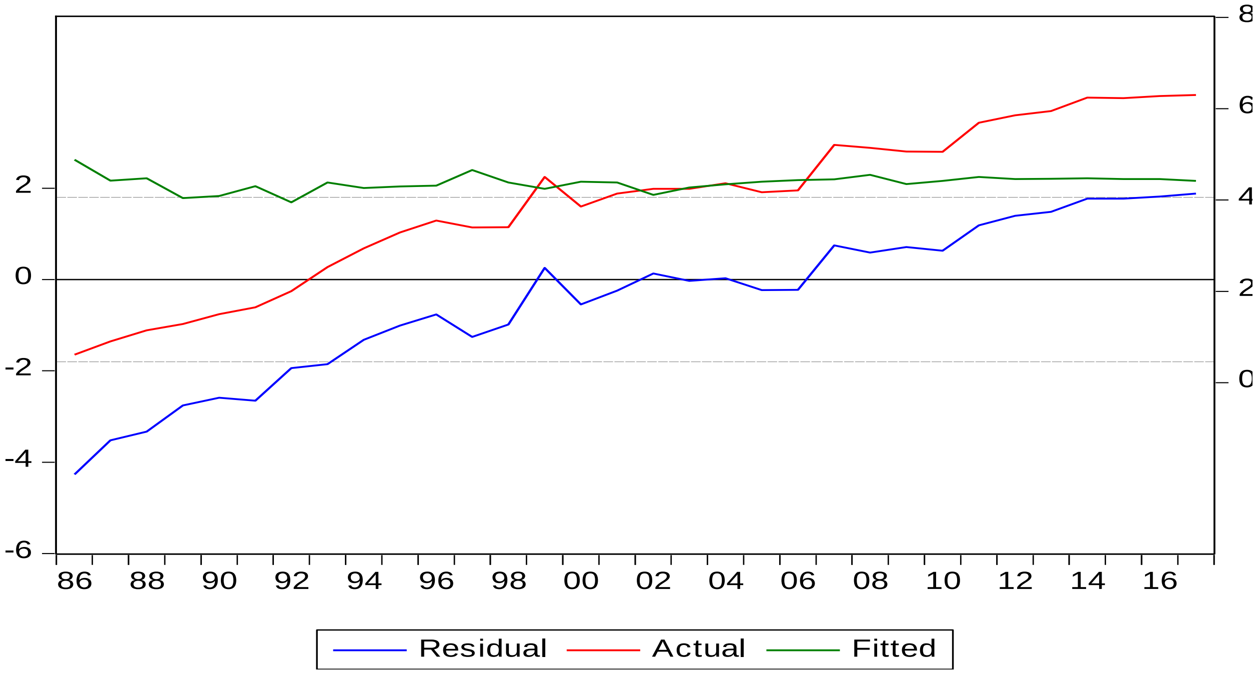

Fig. 1. Trend of interest rate in Nigeria from 1986 to 2017
Source: Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), and Food and Agriculture Organization (FAO).

Relationship of Trend of Interest Rate and Value of Formal Agricultural Financing 1986-2017

The comparative estimated regression coefficients of time trend variables of interest rate and volume of formal agricultural funding is presented as Table 1. The Table showed interest rate exhibiting negative trend while the volume of formal agricultural finance exhibited positive trend within period 1986-2017 in Nigeria.

Table 1. Regression Estimates of Trend in Interest Rate and Value of Formal Agricultural Finance in Nigeria from 1986- 2017

Variables	Constant (b_0)	b_1	R^2	$R^{\wedge 2}$	F- value
Interest rate	1.301 (42.84)***	-0.002 (-1.34)	0.057	0.025	1.81
Volume of formal Agricultural finance	0.404 (6.90)***	0.078 (25.33)***	0.955	0.954	641.72***

Source: Output of Data from CBN (STATA Estimates, 2021).
Figures in parentheses are t-test values, ***, **, * represent significance at 1.0%, 5.0% and 10.0% probability levels respectively.

The coefficient of the trend variable for volume of agricultural finance was positive and significantly different from zero at 1.0% alpha probability level. The trend coefficient for interest rate was negative and not significant even at 10.0% alpha probability level of significance. The coefficient of volume of volume of formal Agricultural finance was 0.078 suggesting that there was about 7.8% increase in the volume of agricultural investment during the period under review. This positive trend of volume of formal agricultural finance was expected. The theory of demand for credit shows that availability of financial resources drives economic growth. The cumulative combination of government and banking sector funds invested in agriculture gave a reasonable growth in productivity of food and fibre in the country.

Growth of Interest Rate and Value of Formal Agricultural Financing, 1986 -2017

The growth of interest rate and value of formal agricultural finance in Nigeria from 1986 -2017 is presented as Table 2. The Table showed that the volume of formal agricultural finance grew at a compound growth rate of 8.11% over the 21 years period. This was a relatively slow growth in investment of productive funding to agriculture. The Central Bank of Nigeria (CBN) records confirm the low annual budgetary allocation to the agricultural sector and the high borrowing cost from the banking sector.

Table 2. Compound Growth of Interest Rate and Volume of Formal Agricultural Financing in Nigeria from 1986 -2017

Variables	Rate (%)
Interest rate	-0.20
Volume of formal Agricultural Financing	8.11***

Source: output of data from CBN (STATA Estimates, 2021).
*** significant levels at 1.0%

The [18, 16] reported that the percentage of agricultural bank credit to total credits was highest in 1995 (17.49%) and sharply reduced of less than 5.0% from 2000 to 2014, except for 2003 when it was 5.16%. This is an evidence of neglect of the agricultural sector in terms of granting credit facilities from formal financial sources.

Dynamic Variation (Acceleration, Deceleration or Stagnation) in Interest Rate and Volume of Agricultural Finance

The quadratic estimates of interest rate and volume of Agricultural finance is shown as Table 3. The quadratic term (t^2) allows for the possibility of acceleration, deceleration or stagnation in interest rate and volume of agricultural finance growth process. The Table shows that the coefficient for value of formal agricultural finance was positive and significant implying an accelerated growth in agricultural funding during the period of study. According to [3], agriculture, fishing and forestry sectors had accelerated growth in Foreign Direct Investment (FDI) inflow during the period under study as its R^2 is positive and F ratio significant.

Table 3. Regression Estimates of Dynamic Variations of Interest Rate (Acceleration, Deceleration and Stagnation) and Value of Formal Agricultural Finance in Nigeria

Variables	Constant (b_0)	b_1	b_2	R^2	$R^{\wedge 2}$	F-value
Interest rate	1.249 (26.82)***	0.007 (1.08)	-0.000 -(1.46)	0.121	0.0607	0.1533
Value of Formal Agric. Finance	0.180 (2.38)*	0.118 (11.19)***	-0.001 (-3.87)**	0.9705	0.9685	477.75***

Source: Output data from CBN (STATA Estimates, 2021).
*, **, *** denote significant levels at 10.0%, 5.0%, and 1.0% respectively.

Testing for Auto Regressive Conditional Heteroscedasticity (ARCH) (1) Effect on Interest Rate

Interest rate volatility generated using ARCH model was presented as Table 4.

The output from ARCH model was divided into two parts; first part (upper part) gives the output of the mean equation and the second part (lower part) presents the result of variance equation.

Table 4.0 showed that the estimated means and variance equations were significant at 1.0% level. This suggests that Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) (1) model was well fitted in modeling interest rate volatility {log(IV)} in Nigeria from 1986 to 2017. Further, to check evidence or presence of heteroscedasticity in the residuals, an ARCH (1) LM test revealed that, there was no evidence of ARCH effects. This was based on the insignificance of p-value of F-statistic which stood at 0.1939.

From the test results, it was concluded that, there was evidence of volatility in the interest rate. Hence, the Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) (1) model was suitable for modeling interest rate volatility over the period under study. Thus, the interest rate in Nigerian agricultural loans has been volatile. According to [23] GARCH (1,1) model is successful at capturing the volatility clustering behavior, as the coefficients for ARCH and GARCH terms have statistically significant z-values. The sum of the coefficients was less than 1, which means that the volatility process was covariance stationary. Thus, the discrete-time GARCH (1,1) model was good for conditional variance modeling.

Table 4. EView Test for ARCH (1) Effects in Interest Rate

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LOG(IV)	-0.230716***	0.028149	-8.196394	0.0000
C	2.109698***	0.331160	6.370639	0.0000
Variance Equation				
C	-0.000102	0.000358	-0.285118	0.7756
RESID(-1)^2	-0.090110***	0.021446	-4.201664	0.0000
GARCH(-1)	1.128939***	0.054670	20.65018	0.0000
R-squared	0.992110			
Adjusted R-squared	0.989809			
Durbin-Watson stat	1.886827			
ARCH LM Test:				
F-statistic	1.768477			
P-value	0.1939			

Source: Data from CBN (EViews computations, 2021).
Where: IV= Interest Volatility; ARCH= Auto Regressive Conditional Heteroscedasticity; GARCH= Generalized Auto Regressive Conditional Heteroscedasticity.

Test For Stationarity

The test for stationarity of the data was carried out using Augmented Dickey Fuller (ADF) unit root technique to ensure that none of series was integrated beyond order one i.e. I (1). The result obtained from the unit root tests was presented as Table 5.

Table 5. Summary of ADF Test Estimates

Variable	ADF @ Level: I(0)		ADF @ First difference: I(1)		Order of integration
	t-Statistic	P-value	t-Statistic	P-value	
Log(AF)	-2.756824	0.2227	-7.289810	0.0000***	I(1)
Log(IV)	-4.345105	0.0111	--	--	I(0)
Log(FIMP)	-2.707199	0.2407	-7.051485	0.0000***	I(1)
Log(INF)	-3.566793	0.0496	--	--	I(0)
Log(RGDPA)	-1.984673	0.5865	-5.274833	0.0009***	I(1)
Log(CRR)	-2.594987	0.2849	-6.267966	0.0001***	I(1)
Log(NER)	-2.447840	0.3497	-5.758605	0.0003***	I(1)
Log(NS)	-0.722273	0.9623	-4.032982	0.0183**	I(1)
Log(MPR)	-3.198598	0.1032	-6.691258	0.0000***	I(1)
Log(LR)	-3.395145	0.0704	-6.235485	0.0001***	I(1)
Log(RMS)	-2.886399	0.1802	-6.976580	0.0000***	I(1)
ADF critical values:					
1% = -4.284580					
5% = -3.562882					

Source: CBN data (EViews computations, 2021).
Where: AF= Agricultural Financing; IV= Interest rate Volatility; INF= Inflation rate; RGDP=Real Gross Domestic Product; CRR=Cash Reserve Ratio; MPR=Monetary Policy Rate; LR=Liquidity Ratio; LA=Loans and Advances; LR=Liquidity Ratio; RMS=Real Money Supply.

The ADF test revealed that none of the variable series went beyond integration order of one i.e. I (1). The ADF test results showed that volatility of interest rate and inflation rate were all stationary at level value i.e. I (0), while other variables were stationary at first difference value i.e. I (1). This is because, in absolute term, their actual values (t-Statistic) are greater than their respective critical values, which indicates that; null hypothesis which stipulates that, the series are not stationary was rejected. Consequently, with the combination of I (1) and I (0), the

Autoregressive Distributed Lag (ARDL) was applied.

Relationship between Interest Rate and Value of Formal Agricultural Funds in Nigeria.

For the analysis of cause-and-effect relationship between interest rate volatility and value of formal agricultural finance in Nigeria, Granger causality test was used. The Granger causality test measures the direction of relationship between variables. The result of the pairwise Granger causality test is presented as Table 6.

Table 6. Granger causality test Estimates of Formal Agricultural funding and Interest rate in Nigeria (1986 – 2017)

Null Hypothesis:	Obs.	F-Statistic	Prob.
LOG(AF) does not Granger Cause LOG(IV)	30	4.58176	0.0202
LOG(IV) does not Granger Cause LOG(AF)		0.14430	0.8663

Source: CBN Data (EViews computations, 2021).

The Granger causality test between logged values of interest rate {LOG(IV)} and formal value of agricultural funding {LOG(AF)} reveals that there was a unidirectional relationship running from agricultural fund to interest rate changes. The p-value of the F-statistic (4.58176) associated with the nexus between log (AF) and log(IV) is significant based on the probability value (0.0202) which was less than 0.05 critical value. This implies that it was the mechanism of agricultural financing that cause interest rate to be volatile in Nigeria and not the other way round since the probability value (0.8663) of the causality from log (IV) to log (AF) was greater than critical value of 0.05, adjudged insignificant. A plausible reason for this could be the inverse relationship between the formal agricultural funding and volatility of interest rate; the fact that as the supply of funds increased, the price of borrowing (interest rate) decreased and vice versa. Thus, increased money supply brought about effective and efficient financial intermediation such that interest rate was lowered on obedience to the law of demand. This corroborated with findings of [22] that reported unidirectional causality of institutional credit to agricultural and economic growth.

CONCLUSIONS

This study concluded as follows:

(i)From 1986 to 2017 there was a recognized negative trend of interest rate regime in Nigeria. Within the same period in the country, volume of formal agricultural funding exhibited positive trend.

(ii)There was a unidirectional relationship running from agricultural fund to interest rate changes. A test for Granger causality between interest rate and formal agricultural funding revealed that causation go from formal agricultural financing to interest rate rather than from interest rate to formal agricultural funding.

(iii)The orders of integration of macroeconomic variables (monetary policy rate, liquidity ratio, nominal exchange rate, inflation rate and real money supply) showed no mixed order of integration in Nigeria within the period.

(iv)Increase in interest rate caused formal agricultural finance to reduce.

The following recommendations were made in consequence:

(i)The study therefore recommended that the monetary authorities in Nigeria should maintain a stable interest rate policy. This is to ensure that adequate formal financing flow from banks to the agriculture sector.

(ii)Commercial banks should concentrate on mobilizing savings by charging lower interest rate and providing handsome return to depositors which would increase available funds for formal funding of agricultural sector.

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INTERNATIONAL TRENDS OF THE UNIVERSITY AUTONOMY IN ROMANIAN HIGHER EDUCATION SYSTEM - CASE STUDY UNIVERSITY OF AGRONOMIC SCIENCES AND VETERINARY MEDICINE OF BUCHAREST, ROMANIA

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Abstract

The paper analyzes the university autonomy as a fundamental principle of action in Romanian higher education system with examples from the University of Agronomic Sciences and Veterinary Medicine of Bucharest (UASVMB). The research is based on four major dimensions proposed by European University Association: staffing autonomy, organizational autonomy, academic autonomy and financial autonomy. The paper employed qualitative analyses of the measurement indicators for each dimension involving a comparative approach at an international level, based on the information collected from 47 countries, in order to underline the current tendencies in relation with the international implementation of university autonomy principle.

Key words: *university autonomy, agronomic higher education, international*

INTRODUCTION

The university autonomy represents an actual topic in numerous scientific papers at international level as the definitions, measurements and impact on quality of higher education system are subjects of major interest nowadays. The development of the concept has started in 1960s, when the International Association of Universities (IAU) formulated the most widespread definition of university autonomy as the authority to make decisions related to who and what will be taught, who will graduate and what will be researched with limited reference to financial matters [9]. Later on, in the late 70s, Organization of the Economic Cooperation and Development - Center for Educational Research and Innovation launched the first survey based on 20 elements referred as indices of autonomy [8]. The ongoing monitoring of the concept implementation in higher education is realized by European Association of Universities [2, 3, 5, 6], using as a starting point the Lisbon Declaration: Europe's Universities beyond 2010: Diversity with a Common Purpose (2007) [7].

Other relevant sources are represented by OECD that published starting with 2008 reports analyzing main trends of institutional autonomy, governance, accountability and the role of the state [12]. In 2010, the Center for Higher Education Policy Studies released an in-depth analyses of autonomy reforms over 30 countries from Europe [1].

A more recent research, conducted by UNESCO, International Institute for Educational Planning [18], focuses on Asia and analyzes recent developments of institutional autonomy in six countries.

All the international comparative studies published underline the historical development of the university autonomy concept. Each country has its own progress and common features can be identified.

Romania, as a European country since 2007, guarantees university autonomy through the Constitution, representing a principle of action regulated by the Education Law No.1/2011 [11]. According to the legal definition, "the autonomy entitles the university community to define their own mission, institutional strategy, structure, activities, organization and functioning, as well as to manage their human and material resources, in strict compliance with the legislation in power". (Education Law No.1/2011, art. 123(1)). The university senate, as the highest decisional structure, guarantees the academic freedom and university autonomy. The University Carta - a document elaborated and approved by the University Senate, in compliance with the legislation in power - expresses the elements related to the implementation of the autonomy principle.

In this context, the purpose of the paper was to analyze the university autonomy as a fundamental principle of action in Romanian higher education system with examples from the University of Agronomic Sciences and Veterinary Medicine of Bucharest (UASVMB), based on four major dimensions proposed by European University Association.

MATERIALS AND METHODS

To measure the extent to which the principle of university autonomy is implemented, it has been used the dimensions proposed by the European University Association [5] and illustrated in the following diagram:

Fig.1. University autonomy dimensions
Source: Own contribution based on the information from the official website of European University Association (https://www.university-autonomy.eu) [5].

Each element is analyzed based on the framework of Romanian higher education system, with correspondence at international level. Specific examples are identified from University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAVMB), as a study case.

RESULTS AND DISCUSSIONS

The organizational autonomy indicates the university capacity to decide on its internal organization. For this dimension, the European University Association proposes seven indicators:

(i)selection procedure for the rector
(ii)selection criteria for the rector
(iii)dismissal of the rector
(iv)term of office of the rector
(v)inclusion of external members in the university's governing bodies
(vi)capacity to decide on the academic structure
(vii)capacity to create legal entities.

Starting from these indicators the analysis of the Romanian higher education system is based on the legislation in power, e.g. Education Law No.1/2011. The selection procedure for the rector is provided by art. 209, while the application norms are provided in Order 4062/2011 [10], as follows: the rector is elected following a public contest or by the professors, researchers, students in the university senate and the councils of the faculties. For example, at UASVM Bucharest, the selection procedure, as stipulated in art. 30 from the University Carta [15], is set up based on referendum – the professors, researchers, students in the university senate and the councils of the faculties decide through secret vote the way the rector will be elected. Noteworthy, the designated rector needs to be validated by an order of the minister of education. Thus, Romania lines up to the countries where a validation procedure from an external authority is required (Austria, Croatia, Denmark, Estonia, Finland, Belgium, Ireland, Lithuania, Norway, Poland, Portugal, Serbia, Slovenia, Great Britain).

As for the second indicator, the Romanian legal framework stipulates that the university's senate elaborates and approves the methodology for the publicity, selection and recruitment of the rector.

In terms of specific selection criteria, art. 210, par. 4 of the Law No.1/2011 stipulates that: "national and foreign scientific or academic personalities can participate in the contest for the election of the rector based on prior approval of the university's senate, following a hearing in the general assembly of the senate".

Taking into consideration the selection methodology at UASVM Bucharest [16], it can be noted that includes the law criteria (art. 34) and details the main criteria of eligibility for the rector (art. 7):

-advanced knowledge of legislation related to higher education system and finance mechanism from Romania, EU and other countries; high experience in project development;

-very good managerial capacity in relation with partnership activities with other universities, public institutions and business stakeholders;

-passion and professional interest for development of research and production at university level;

-respectful behavior as member of academic community.

Therefore, Romania belongs to the group of countries where the selection methodology is provided by the law and where the future rector is requested to hold an academic position (Croatia, Denmark, Estonia, France, Hungary, Italy, Luxemburg, Poland, Portugal, Serbia, Spain, Sweden).

The dismissal of the rector is also stipulated in the Education Law No.1/2011: the university's senate can dismiss the rector based on the terms of the management contract and the university Carta.

Besides the senate, the Ministry of Education can decide on the rector's dismissal based on the proposal of the Council for ethics and university management, in consultation with the university's senate, if the rector has failed to fulfill the following public responsibilities, as stipulated in art. 123 (Fig. 2).

Fig. 2. Rector's public responsibilities
Source: Own processing following art.123 of the Education Law No.1/2011 [11].

Analyzing the UASVM Bucharest Carta, the dismissal conditions are described in art. 32 in the same line with legislation. Beside the general conditions, the University Carta includes the absence from more than half of the meeting during one academic year as a condition for rector dismissal.

In conclusion, in Romania the procedure for the dismissal of the rector is stipulated by law (like in Iceland, Luxembourg, Slovakia, Spain) and can be carried out both by an external authority (like in France) or by the university's senate.

In the Romanian higher education system, the rector has a 4-year mandate, as provided by the Law No.1/2011, art.123. A person cannot have more than two successive mandates in the same institution, in compliance with the amendments provided by the Emergency Ordinance No. 49/2014 [14]. The University Carta of UASVM Bucharest mentions the same criteria in the art. 23, par. 3.

Such regulations align Romania to practices in countries like Austria, Croatia, Estonia, France, Iceland, Italy, Lithuania, Luxembourg, Norway, Poland, Portugal, Serbia, Slovakia, Switzerland.

The inclusion of external members in the university governing bodies is optional. Art. 214, par. 7 stipulates that, according to the

University Carta, the university can develop structures that involve the economic environment or external personalities. It is the university that decides on this matter, there is no legal obligation in this respect, like in Great Britain, Denmark, Estonia, Finland, Italy, Lithuania and Portugal.
The capacity to decide on the academic structure is provided by Law No.1/2011 only as a general reference (art 131, par.1), as Romania is one of the countries where universities can decide on their internal structure without any constraints.
The right to establish legal entities as stipulated in art 129, par.1 of the Education Law is the last of the evaluation criteria. Any higher education institution can set up associations, foundations, companies with the approval of the senate. For example, UASVM Bucharest has 3 research and production facilities: Istrita – specialized in fruits production (apples, plums, cherries), Moara Domneasca – as a training center and good practices for sustainable agriculture and Pietroasa – as a research and production of vine from 737 types of grapes. The Emergency Ordinance No. 49/2014 also provides the obligation to contribute to the performance of the institution without hampering the education, research or consultancy activities. Such regulations place Romania among the countries that allow universities to create legal entities.
To conclude, the analysis of the seven indicators proposed by the European University Association reveals a clear picture of the organizational autonomy in the Romanian higher education system and enables correlations with other countries, based on similar elements.
The staffing autonomy - that is the freedom to decide on personnel issues – is the second element analyzed. The ability of a university to attract, manage and retain quality human resources, both academic and administrative, ensures its success in the global higher education environment. Eight evaluation indicators are presented:

Fig. 3. European evaluation indicators of staffing autonomy dimension
Source: Own processing after the official website of European University Association (https://www.university-autonomy.eu/dimensions/staffing/)[5].

Art. 293 of the Education Law No.1/2011 stipulates that universities decide on recruitment, hiring, evaluation, motivation, continuous training, and dismissal of the teaching and research staff in higher education, as provided in the methodological framework established by the Ministry of Education and the university Carta.
Based on the methodological framework each university decides on its own methodology which needs the senate's approval as provided by art. 123. par. 2. UASVM Bucharest has a specific methodology for organizing the hiring process of didactic and research vacant jobs, approved by the Senate in 2018 [17]. The document is structured per chapters, including:
-procedures for contest organization for vacant didactic jobs
-procedure for contest committee nomination
-minim conditions for eligibility as candidate
-procedures for enrolling to the job contest
-responsibilities of the contest committee
-procedures for appeal.
In addition, art. 312, par. 11 from Education law stipulates that the head of the department, the leader of the doctoral school or the dean are responsible for the staff's selection, periodic evaluation, training, motivation and

termination of the labour contract, according to the University Carta.

In case of wrongdoings, the university's senate can impose sanctions, as provided by the methodology, including the dismissal of the rector or of the deans. The salaries of the teaching staff comply with the legislation and the decisions of the university's senate. UASVM of Bucharest elaborates an annual procedure for payment of didactic and research staff, respecting the legislative framework [17]. The document includes the description of the didactic and research functions, the didactic norm and sets up the calendar for elaboration and approval of the organizational chart and payment.

The academic autonomy defines the capacity of the university to manage independently internal academic elements related to the students' admission, academic content, quality, etc.

Twelve items are proposed for the measurement and evaluation of this aspect:

(1)procedure for establishing the number of available places

(2)admission procedure for the bachelor's programme

(3)admission procedure for the master's degree programme

(4)introducing bachelor's programmes

(5)introducing master's degree programmes

(6)introducing PhD programmes

(7)termination of degree programmes

(8)language of instruction for the bachelor's programmes

(9)language of instruction for the master's degree programmes

(10)selection of quality assurance mechanisms

(11)selection of the quality assurance providers

(12)capacity to decide on the content of the degree programmes.

In Romania, according to art. 138, par. 5 of the Education Law, every year a government decision, published by the Ministry of Education before March 31, decides on: classification of the degree programmes, the areas and programmes of the degree studies, the type of education, number of credits that can be transferred, the language of instruction and the maximum number of students that can enroll, as proposed by the agencies for quality assurance that have evaluated each programme.

The Ministry of Education prepares annually a methodological framework for the admission procedures. Each university develops its own admission regulations for the degree programmes, in compliance with the general framework of the Ministry of Education. For 2021-2022, UASVM Bucharest issued the Methodology for organization of the admission contest approved by the Senate on 12th of February 2021. The document includes all the details related to the programs, number of available places, required documents for the admission for each program, language of instruction, the calendar of the admission process and it can be downloaded from the university website. A specificity of the methodology for 2021-2022 is the online feature, due to the pandemic situation.

The admission procedures for bachelor's and master's degree programmes have similar elaboration mechanisms.

The Education Law No.1/2011, in art. 150, par. 1, art. 155, par. 1 and art. 158, par. 4 regulates the introduction of new bachelor's, master's degree and doctoral programmes, respectively.

Any bachelor's or master's degree programme has to be accredited by a government decision, following an external evaluation conducted by ARACIS – Romanian Agency for Quality Assurance in Higher Education [13] or by another quality assurance agency from Romania or abroad, registered in the European Quality Assurance Register for Higher Education [4].

Following the accreditation of the master's degree area of study, the university's senate decides on the degree programmes and informs the Ministry of Education. As for the doctoral school, ARACIS - or another similar agency - conducts an individual evaluation for each area of study. An order of the Ministry of Education establishes the evaluation criteria and methodological framework.

As provided by art. 10 in the Education Law, the university programmes are taught in Romanian, minority languages or languages of international circulation. In over 80% of the

29 countries surveyed, universities can choose the language of instruction for all degree programmes.

ARACIS or another national or foreign agency – provided to be registered in the European Quality Assurance Register for Higher Education - can assure the quality.

The freedom to choose the quality assurance agency includes Romania in a group of eight countries (Austria, Estonia, Finland, Switzerland among them) out of 29 countries surveyed.

The Education Law, in art. 137, stipulates that universities decide on the content of the degree programmes. In compliance with par. 2, the curriculum is approved by the university's senate and has to be correlated with the qualification as reflected in the national register of qualifications. This correlation is a mandatory criterion for the evaluation of the quality assurance. UASVM Bucharest has stipulated the didactic autonomy through the following elements (art 3.3 University Carta):

-the possibility to set up, cancel, reorganization of the faculties, departments, institutes, research centers, university study programs;

-approval of the number of available places for university programs according to the legislation, ARACIS, UASVM financial possibilities and own institutional development strategy;

-approval al all university and post university training plans;

-setting up the standards, criteria, procedures related ot the evaluation of the didactic process.

Thus, Romania lines up to 26 countries (out of the 29 countries surveyed by the European University Association) where universities have the freedom to establish the content of their degree programmes.

The financial management – the fourth dimension of autonomy – analyses the extent to which the university is free to allocate resources to budgetary lines. Eleven evaluation items are proposed to evaluate this dimension (Table 1).

Table 1. Evaluation items of financial autonomy dimension

No.	Financial autonomy – evaluation items
1.	length of public funding cycle
2.	type of public funding
3.	right to borrow money
4.	ability to keep profit
5.	right to own property
6.	ability to charge fees for bachelor's programmes for national and EU students
7.	ability to charge fees for master's degree programmes for national and EU students
8.	ability to charge fees for doctoral programmes for national and EU students
9.	ability to charge fees for bachelor's programmes for non-EU students
10.	ability to charge fees for master's degree programmes for non-EU students
11.	ability to charge fees for doctoral programmes for non-EU students

Source: Own processing after the official website of European University Association (https://www.university-autonomy.eu/dimensions/financial/) [5].

In Romania, according to the legal provisions, - art. 223 of the Education Law – there is a multiannual financial cycle, covering a whole cycle of studies.

The revenues of the higher education institutions come from the state budget, on a contractual basis with the Ministry of Education, for the basic funding, complementary funding and supplementary funding.

Basic funding is based on the equivalent average cost per student, per study area, per study cycles, and per tuition language. Complementary funding covers subsidies for accommodation and boarding, funds for endowments, investments and refurbishment, funds allocated on competitive basis for academic scientific research.

Supplementary funding encourages excellence of degree programmes, both for public and private universities.

As for the right to borrow money, art. 122, par.5 of the Education Law stipulates that the funding of higher education can be secured from other sources, loans included, without any other special mention.

Universities in Romania are non-profit and are organized as non-profit entities. However, they own their patrimony as stipulated by the university Carta. If a state university disbands, its property becomes state property, as provided by art. 226, par. 10 in the Education Law.

In Romania, universities have the right to set the amount of the tuition fees for various degree programmes.

According to the law, the Council of Administration sets the amount of the fees and informs those concerned. The fees are calculated based on similar procedure irrespective of the level of the degree programme or the student's profile (EU or non-EU). According to 2021-2022 methodology for admission of UASVM Bucharest, the Romanian students from all over the world and the EU citizens have the same admission conditions, including the same fees for studies (between 3,000-3,500 RON per year). The EU citizens have to equivalate their studies following the procedure of Ministry of Education – National center for Diploma Recognition and Equivalation. The non-EU citizens can apply for the study programs, according to a special procedure realized by UASVM and Ministry and Education. The study fee has to be paid in advance for the first year and there are some supplementary admission fees.

CONCLUSIONS

The analysis of the higher education system in Romania, based on the four dimensions of the university autonomy, stresses the legal framework and the responsibilities of the Government, the Ministry of Education, and the leading bodies in the academic environment.

The current analysis reveals a medium-level autonomy compared to the other European countries surveyed by the European University Association report, in compliance with the EU regulations and recommendations.

The importance of the university autonomy is underlined by all documents of educational policy resulted from the cooperation of significant European institutions and bodies: Global Forum for Academic Freedom, Institutional Autonomy and Democracy, Council of Europe, International Consortium for Higher Education, Civic Responsibility and Democracy, Organization of the American States, Magna Carta Observer, International Association of Universities.

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AN ANALYSIS OF FISH FARMERS' MANAGEMENT PRACTICES AND INFORMATION NEEDS IN ADAMAWA STATE, NIGERIA

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Abstract

This study analysed the management practices and information needs of fish farmers in Adamawa State, Nigeria. The study adopted a multistage sampling technique to collect primary data from 166 fish farmers. Descriptive statistics, Likert Scale, and Ordinary Least Square regression model were used to analyse the data collected. The findings of the study indicated that the prominent information sources among the farmers were the internet and acquaintances/friends. Similarly, the study established that the majority of the respondents need information on most aspects of fish farming and that the socio-economic characteristics of the farmers influence these information needs. Furthermore, high-cost of fish feed, lack/inadequacy of capital, lack of good/reliable market information, and poor breeds of fish were identified as the leading respondents' constraints in fish production. Based on the findings of the study, it was recommended that there is a dire need for the government and other agricultural development actors to employ and also motivate more agricultural extension agents in the area to enable the fish farmers to access them for information. The findings of this study will substantially contribute to aquaculture planning in the country so as to enhance gains from the sector.

Key words: *aquaculture, agricultural extension, fisheries*

INTRODUCTION

In Nigeria, the fishery sub-sector plays a very prominent role in the livelihoods of a large percentage of the nation's populace over the years [8; 16]. Available records have shown that the country has the largest market for fish and fish products in the whole of Africa, and it is ranked second in the region in terms of production of the commodity [2; 24]. Fish consumption accounts for over 40% of the protein sources consumed in the country. Currently, in terms of consumption per capita, the country holds the 68th position on the global ranking [20; 45]. Apart from the role of the sector in the provision of food, it creates employment opportunities for all classes of people regardless of their age and social status, hence, foreign exchange can hugely be generated from the sector as obtainable in other climes [38; 28; 50]. Traditionally, capture fisheries have been the most popular in the country, however, it is becoming hugely depleted owing to various climatic and social challenges [24; 40]. This has led to a huge deficit in both production and consumption [34; 31]. Generally, the country's average fish production in recent years is about 1.123 million Metric tons per annum, while the annual deficit is over 2 million metric tons [24]. Yet, an average of 221,412.6 metric tons annually has been the contribution of aquaculture to the overall production by an average of 13,215 fish farmers [13]. In monetary terms, the country over the years has been importing fish and other fish-related products to the tune of about USD 1,461 Million [43]. Similarly, the contribution of the sub-sector to the gross agricultural Gross Domestic Product (GDP) of the country has been marginal (0.48%) [46]. This trend is also obtainable in some of the nation's neighbouring countries, particularly the republics of Benin and Cameroun [37; 19]. To adequately bridge the gap, there is a need for a sustainable increase in production. The African Union developed a policy framework and reform strategy for fisheries and aquaculture aimed at enhancing livelihoods by creating wealth from the sector through better governance [5; 22]. Specifically, the framework was aimed at creating awareness of the potentials and importance of the sector, especially for small-scale fisheries actors. In line with this regional effort to maximise gains from the fishery sector, attempts were made by the Nigerian government to reduce the effects of some of the factors limiting aquaculture development were contained conspicuously in the second phase of the National Development Plan [17; 30; 48]. Sequel to that, the Nigerian National Fisheries Policy was developed to increase domestic fish production from all sources on a sustainable and renewable basis to the level of self-sufficiency and fish export in the medium to long term [23]. The policy provided blueprints for the development and harnessing of the blue economy through fishery management for the sustainable production of fish to adequately satisfy the demand for ensuring food security and earning foreign exchange via international trade [13]. This will ensure that the gains made in other regions of the world, particularly in Asia (producing about half of the world's total capture fisheries production and about 90% of the world's aquaculture production) are replicated in Nigeria. Due to the proper implementation of fishery policies in those areas, farmed fish production has increased 12 times at an average annual growth of over 8% in the last three decades [28]. The inability of the nation's fishery sub-sector to adequately meet demands is attributed to the myriads of challenges affecting the sector caused by climatic, social, and economic factors. Prominent among these challenges was the inability to add value, low technical knowledge on the part of fish farmers, and the high cost of inputs [40]. Therefore, focus on these areas will substantially contribute to achieving productivity from the sector [25]. But, these challenges vary with location in the country. This is because the development of aquaculture in Nigeria is not evenly distributed as the growth rate and contribution are higher in the southern part of the country compared to the Northern parts [15]. The development in aquaculture is not only in output, but also the practices and operations which has cut across the chains of activities in the production, including culture practices, culture systems, water quality management, and feed types and feeding system. Similarly, there has been a consensus in the literature about the role of information access by fish farmers as a key challenge of the sector, thereby making the average fish farmer ill-equipped for successful and sustainable fish production [3; 30; 15; 47; 50]. Adamawa State is notable for both artisanal fishery and aquaculture which is conducted across various parts of the State [33; 21]. Inadequate access to information on innovations and technologies has limited the capacities of fish farmers to maximise gains from the venture [49]. This is because fisheries technology is continuously changing, hence, the need for farmers to access information sustainably. However, there is a paucity of literature on the management practices and information needs of the fish farmers in the area. Therefore, the main objective of this study was to analyse fish farmers' management practices and information needs in Adamawa State, Nigeria. Specifically, the study sought to describe fishers' socio-economic characteristics, assess the management practices being adopted by the farmers, determine the farmers' information needs, identify factors influencing the fish farmers' information needs and also identify constraints affecting fish farming in the study area.

MATERIALS AND METHODS

Description of the Study Area

Adamawa State is situated in the North-East geopolitical region of Nigeria. The area lies between Latitude 70◦ and 110◦N and between Longitude 11◦ and 140◦E and stretches over a landmass of about 38,700 km^2. In terms of climate, the area has a tropical climate that is notable for having high temperatures and humidity as well as marked wet and dry seasons [1]. The mean annual rainfall of the State ranges between 197mm and 700mm along with the Southern and North-Western parts of the State. The State has an estimated population of more than four million people who mostly (about 80%) rely on agriculture for sustenance [21].

Data Collection and Analysis

The study's targeted population were fish farmers spread across the entirety of Adamawa State. A survey research design was adopted using both online and offline media. For the online data collection, a snowball sampling technique was used while the questionnaire's weblink was posted on Facebook, WhatsApp, Twitter, and LinkedIn. Similarly, snowball and convenience sampling techniques were used for the face-to-face method in which questionnaires self-administered. Data for the study were collected over a period of eight weeks (1 August to 30 September 2020). At the end of the data collection period, 166 fish farmers responded to the survey (42% online, and 58% face-to-face). The instrument for data collection being a semi-structured questionnaire covered various aspects of fish farming, especially the farmers' sociodemographic characteristics, routine management of the fish farm, feeding, biosecurity, information sources, and constraints. In analysing the data obtained from the study, both descriptive and inferential statistics were used. The socio-economic characteristics of the respondents were described using frequency distribution, means, and percentages. In the same vein, frequency distribution was used to assess management practices and identifying fish farming constraints among the respondents. Similarly, a three-point Likert scale was used to identify the information sources and also determine the information needs of the respondents. Responses of the respondents concerning the identified information sources in the area were coded from "3-1" based on the frequency of usage (3=Frequently, 2=Occasionally, 1=Not at all). Regarding the respondents' information needs, the responses were coded from "1-3" based on the level of information access (1=High, 2=Moderate, 3=Low). The decision rule is based on the mean score (2.0). Responses having scores below the mean were considered to be incorrect, while those with scores equal to or higher than the mean were considered to hold. The three-point Likert-scale model is shown as follows;

$$\bar{x} = \frac{\sum F}{Nr} \quad \text{.................................}(1)$$

where:

$\bar{x}s$ = Mean Score
$\sum$ = Summation
F = Frequency of the Respondents
Nr = Number of respondents to the item

The decision rule is computed thus;

$$3 + 2 + 1 = \frac{6}{3} = 2.0$$

Equally, the ordinary least square (OLS) regression was used to assess the factors affecting the information needs of the respondents. The OLS model is specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots + \beta_9 X_9 + U \quad \ldots\ldots\ldots(2)$$

where:

Y= Information need (mean score)
β_0 = Constant
X_1 = Age (years)
X_2 = Gender (Male=1: Female=0)
X_3 = Marital status (Married=1: Unmarried=0)
X_4 = Household Size (Number of people in the house)
X_5 = Educational Level (Number of years spent in school)
X_6 = Stock Size (Number of fish in ponds)
X_7 = Farming Experience (Years)
X_8 = Access to Credit (Yes=1: No= 0)
X_9 = Membership of Fish Farmers' Association (Yes=1: No= 0)
U= Error term

RESULTS AND DISCUSSIONS

Socio-Economic Characteristics of Fish Farmers

Table 1 present the socio-economic characteristics of fish farmers in the study area.

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Table 1. Socio-Economic Characteristics of the Respondents

Variable	Frequency	Percentage	Mean
Gender			
Female	11	11.8	
Male	82	88.2	
Age			
<30	35	37.6	34.28
30-39	36	38.7	
40-49	10	10.8	
>49	12	12.9	
Marital Status			
Married	40	43.0	
Single	53	57.0	
Household Size			
1-5	15	16.1	7
6-10	58	62.4	
>10	20	21.5	
Level of Educational			
Primary school	5	5.4	
Secondary school	15	16.1	
Tertiary level	73	78.5	
Farming Experience			
1-5	10	10.8	6.5
6-10	52	55.9	
>10	31	33.3	
Stock Size of the farm			
<500	33	35.5	
500-999	11	11.8	
1,000-1,499	12	12.9	
1,500-1,999	16	17.2	
>1,999	21	22.6	
Number of Ponds in the farm			
1-5	56	60.2	5
6-10	25	26.9	
>10	12	12.9	
Number of Employees in the farm			
1-5	59	63.4	4
6-10	25	26.9	
>10	9	9.7	
Access to Credit			
No	73	78.5	
Yes	20	21.5	
Membership of fish farmers' association			
No	58	62.4	
Yes	35	37.6	

Source: Field Survey, 2020.

The distribution of the respondent by gender reveals that 88.2% were male, while 11.8% were female. In terms of age, the findings of the study show that 37.6% were less than 30 years, 38.7% were aged 30-39 years, 10.8% were within the age range of 40-49 years, while 12.9% were 49 years and above. Considering the mean age of the respondents (34.3 years), it can be deduced that majority were young people that can be economically active in fish production.

The respondents' household characteristics indicated that 57% were single while 43% were married. With respect to household size, the findings of the study revealed that households having 1-5 members were 16.1%, while households with 6-10 people and those with more than 10 people constituted 62.4% and 21.5% respectively. The average household size was 7 people, implying the availability of family labour for enhanced production. The respondents' educational attainment revealed that all the fish farmers were educated, the majority (78.5%) had tertiary education, while those with a primary and secondary level of education were 5.4% and 16.1% respectively. Similarly, the respondents' experience in fish farming showed that 10.8% had 1-5 years' experience, 55.9% have been farming for 6-10 years, while 33.3% were farming for more than 10 years. The study also assessed the characteristics of fish farmers. Findings of the study revealed that in terms of stock size, 35.5% had a stocking density of fewer than 500 fishes, while 11.8%, 12.9%, 17.2%, and 22.6% have a stocking density of 500-999, 1,000-1,499, 1,500-1,999, and those with more than 1,999 fishes respectively. Based on the farms' number of ponds, 60.2% had between 1-5 ponds, 26.9% had 6-10 ponds, while 12.9% had more than 10 ponds. The average number of ponds in the area was 5. The distribution of the respondents by the number of employees revealed that 63.4% had 1-5 employees, while 26.9% and 9.7% had 6-10 employees and more than 10 employees respectively. The respondents have 4 employees on average. Regarding the respondents' access to a credit facility, 78.5% lack access while 21.5% had access. Similarly, 62.4% were not members of the fish farmers association, while 37.6% were members. Fish farmer's socio-economic characteristics are key determinants of information access and the profitability of fish farms [39]. In this study, persons of the male gender constitute the majority of farmers, and they are mostly educated. This finding lends credence to the submissions of [2] and [42] who reported similar trends in Kwara and Osun States of Nigeria. This implies that fish farming is mostly considered an elitist trade since the bulk of the farmers are educated persons as compared to other forms of animal farming. Hence, the need to encourage people with every level of formal education to participate in fish farming. This can be achieved if fish farming information is relayed to farmers to stir interest in the trade. As revealed by this study also, fish farmers in the area do not have access to agricultural extension agents as they should. This has serious implications for how profitable such ventures could be. This is because [7] established that there is a positive relationship between farmers' access to extension services and their profitability. This outcome is expected since agricultural extension agents access trusted information from reliable sources that farmers can adopt without hesitation.

Management Practices

Table 2 presents the management practices being adopted by the respondents to manage their fish ponds. Findings of the study on pond management indicated that 5.4% use collapsible mobile fish ponds, 35.5% use concrete ponds, while those having earthen ponds and liner were 26.8% and 32.3% respectively. The distribution of the respondents by type/species of fish under cultivation revealed that 76.2% were into catfish production, while 23.8% cultivate tilapia. Similarly, water in the farms is sourced mostly (78.5%) from boreholes, followed by wells (10.8%), and then reservoirs and roof catchment for rain (5.4% each). The study further revealed that visual evaluation is the most widely (62.4%) adopted method of testing water quality among the respondents, while 37.6% use test kits. The frequency of changing the water in the ponds was also assessed, and the result indicated that 10.8% change water daily, 30.1% do it once a week, 43% carry out the activity twice a week, while those that do it thrice a week were 16.1%. In terms of fishery production systems of the farms, 43% adopted the grow-out system only, while 57% were practicing hatchery and grow-out systems. The findings of the study also discovered that 78.5% of the respondents sourced their fingerlings from a commercial hatchery, while 21.5% used their hatcheries.

Table 2. Respondents' Fish Pond Management Practices

Variable	Frequency	Percentage
Pond Type		
Collapsible Mobile fish pond	9	5.4
Concrete	59	35.5
Earthen	44	26.8
Liner	54	32.3
Fish type/Specie		
Catfish	126	76.2
Tilapia	40	23.8
Source of Water		
Borehole	130	78.5
Reservoirs	9	5.4
Roof catchment for rain	9	5.4
Wells	18	10.8
Method of Testing Water Quality		
Test kits	62	37.6
Visual evaluation	104	62.4
Frequency of Changing Water		
Daily	18	10.8
Once a week	50	30.1
Twice a week	71	43.0
Thrice a week	27	16.1
Fish Production System		
Grow out	71	43.0
Hatchery and grow out	95	57.0
Sources of Fingerlings		
Commercial hatchery	130	78.5
Personal hatchery	36	21.5
Type of Aquaculture System		
Cage culture	71	43.0
Flow-through system	50	30.1
Pond	9	5.4
Recirculating Aquaculture system	36	21.5
Ability to Formulate Feed		
No	104	62.4
Yes	62	37.6
Types of Feed		
Animal offal	54	32.3
Food waste	9	5.4
Pellet	104	62.4
Type of Pellets		
Imported floating pellet	86	51.6
Local floating pellet	63	37.7
Sinking pellet	18	10.8
Feeding Method		
Broadcasting	89	53.8
Point	77	46.2

Source: Field survey, 2020.

The distribution of the type of aquaculture system being used in the farms revealed that 43% were into cage culture, while those practicing the flow-through system, pond, and recirculating aquaculture system were 30.1%, 5.4%, and 21.5% respectively.

Feed constitutes a large portion of the production costs of fish farms. The feeding methods being adopted by the farmers as shown in Table 1, and indicated that the majority (53.8%) broadcast, while 46.2% use the point feeding method. The distribution of the respondents' most widely served feed revealed that 62.4% offer pellets, 32.3% serve animal offal, while 5.4% rely on food waste. Similarly, the result showed that the imported floating pellet was the most (51.6%) widely used type of pellet being used, followed by the local floating pellet (37.7%), and then the sinking pellet (10.8%). The study also assessed the respondents' ability to formulate feeds, findings revealed that 62.4% cannot formulate ration, while 37.6% have the ability.

Fish Farm Biosecurity Measures

The ability to prevent or manage diseases in the fish is to a large extent dependent on the biosecurity measures the farmer adopts. Figure 1 assessed some of the farmers' management practices. Findings of the study show that 67.7% of the farmers regularly sample/sort fish on the farm and that 89.2% can recognise disease symptoms, while78.5% are knowledgeable in disease control and prevention. In the same vein, 67.7% can select broodstock, and that 51.6% know how to use pesticides on the farm to manage pests.

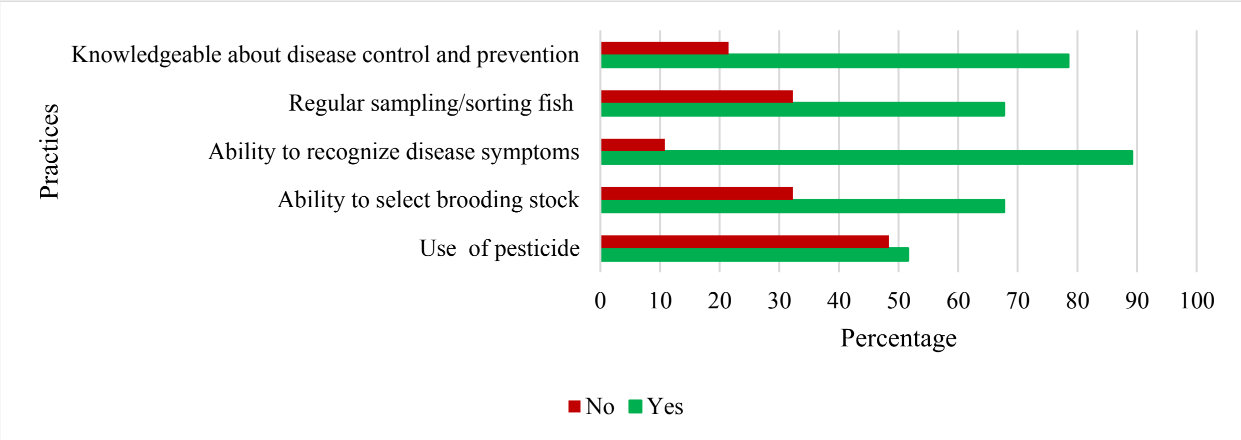

Fig. 1. Some Fish Farm Biosecurity Measures

Fish Value Addition

For fish farmers to maximise gains, there is the need for value addition on the produce. In this study, Table 3 presents some value addition practices the farmers use in the study area. Findings of the study showed that most (64.9%) of the respondents add value by keeping the harvested fish in cold-room/ refrigeration, while others use basins/ holding tanks (19.4%), sales directly (5.4%) to consumers, or smoke (10.8%) the produce.

Table 3. Fish Value Addition Strategies

Method	Frequency	Percentage
Basins/ Holding tank	32	19.4
Cold-room/ Refrigeration	108	64.9
Sale directly	9	5.4
Smoke	17	10.3

Source: Field Survey, 2020.

Information Sources

Modern techniques of raising fish are normally passed to fish farmers through agricultural extension services that are saddled with the responsibility of disseminating new agricultural innovations and technologies that farmers are expected to adopt. Table 4 presents the distribution of the respondents' information sources. The findings of the study revealed that the main information sources of the respondents were the internet (85%), acquaintances/friends (75%), religious bodies (52.5%), agricultural extension agents (40%), and fish farmers' association (37.6%). Other sources included radio (37.5%), television (25%), and family members (12.5%) among others. This suggests that the majority of the respondents hardly rely on the mass media (both electronic and print) or agricultural extension agents for agricultural information. In this study fish farmers rely heavily on the internet and acquaintances/friends for information on fish farming activities. This has a negative implication on the quality and relevance of the information the respondents can access [44]. This finding conforms to the submission of [18] who reported the inadequacy of agricultural extension agents in Nigeria which has encouraged farmers to rely on other alternatives affordable to them. The implication of this as stated by [42] is that the government and all other stakeholders in the aquaculture sector should focus more attention on the usage of these identified sources of information when making efforts in capacity building and extension of information among the fish farmers. However, the finding of this study is contrary to that of [11] who revealed that agricultural extension agents play a significant role in disseminating information to fish farmers across Uganda.

Table 4. Respondents' Information Sources

Variable	Frequency	Percentage *
Family members	21	12.5
Acquaintances/friends	125	75.0
Traditional leaders	21	12.5
Extension Agents	66	40.0
Internet	141	85.0
Radio	62	37.5
Television	42	25.0
Magazines and Newspapers	21	12.5
Religious bodies	87	52.5
Fish farmers' association	62	37.6

Source: Field survey, 2020. *Multiple Responses.

Information Needs

This study also determined the fish farmers' information needs, and the result is presented in Table 5. The findings of the study disclosed that the respondents require information on enterprise combination, site selection for housing, pond construction, and transportation of fingerlings. Similarly, information on stocking operations, hormones identification, selection of broodstocks, and fish breeding are also needed by the respondents. In the same vein, the farmers need information regarding water treatment, feed formulation, preservation/processing techniques, weeding, and environmental sanitation. Other information needs of the respondents were on-farm keeping records and accounts, sourcing of formal credit, membership of fish farmers association, and the marketing of produce. The provision of this information will substantially influence farmers' performance.

It is expected that fish farmers adopt certain management practices to efficiently manage the business [10]. The efficiency with which these management practices are adopted by the farmers depends on the quality of information they were able to access. When highly relevant information is accessed, it can likely trigger high productivity on the farm [6]. As shown by the result obtained in this study, there is a need for the respondents to access information across all aspects of managing the fish farm. According to [9], proper management of the fish farm using improved technologies can substantially boost production which has a bearing on the farmers' income earnings. One area that should be emphasised is the issue of value addition by the farmers. As opined by [25] fishers and fish farmers can increase their income by enhancing the quality of their output through proper post-harvest handling. Hence, there is a need for farmers to be encouraged to add value to their produce.

Table 5. Distribution of Respondents' Information Needs

Variable	Mean	St. Dev.
Enterprise Combination	2.65	0.65
Site selection for housing	2.39	0.61
Pond construction	2.52	0.50
Transportation of fingerlings	2.41	0.67
Stocking operations	2.68	0.47
Hormones identification	2.52	0.61
Selection of broodstocks	2.52	0.50
Fish breeding (Fertilization)	2.52	0.60
Disease control	1.42	0.67
Water treatment	2.41	0.67
Liming	1.41	0.66
Feed formulation	2.11	0.56
Preservation/processing techniques	2.35	0.67
Weeding	2.30	0.65
Environmental Sanitation	2.41	0.75
Keeping Records and Accounts	2.41	0.68
Sourcing of formal credit	2.35	0.74
Being a good member of the fish farmers association	2.11	0.65
Marketing of produce	2.65	0.74
Farm security	2.41	0.65

Source: Field survey, 2020.

Factors Influencing Information Needs

The result of the ordinary least square regression analysis used in identifying the factors influencing the information needs of the fish farmers is presented in Table 6. The model's coefficient of determination (R^2) was 0.67, implying that about 67% variability in the dependent variable was accounted for by the independent variables used in the model. Similarly, the model had a good fit on the overall considering the F-value (35.98) that was statistically significant at 1% (p-value =0.0000). Equally, in order to ensure that all the basic assumptions of Ordinary Least Square (OLS) regression were upheld, several diagnostic tests were conducted and the result showed that none of the assumptions were violated in any way, hence the model was used. Based on the result, fish farmers' need for information is negatively related to their age, marital status, household size, educational attainment, and access to credit. Similarly, gender, stock size, and farming experience positively influence the information needs of the respondents at various levels of significance. This result implies that the respondents' information needs declines with an increase in age and vice versa. Based on the finding, as the farmer becomes older, the need for information reduces. This may be attributed to a decline in economic productivity with a decline in age. In the same vein, an increase in household size reduces the information needs of the farmer and vice versa. This can be attributed to the fact that having a large number of people in the household (particularly adults) widens the social capital base, and increases access to information. The study further indicated that respondents having access to credit have limited information needs and vice versa. The likely explanation for this is the fact that the majority of the respondents rely on the internet for information, and having access to credit increases resources at the disposal of farmers to source for information, thereby reducing their deficiency in information access. This study also indicated that the information needs of the farmers are positively influenced by gender, stock size, and farming experience. This implies that the need for information increases with being a male compared to a female. Similarly, having a large stock size increases the need for information among the respondents. This is as expected since having a large stock size entails a huge investment that requires proper management. In the same vein, an increase in farming experience is also positively related to the information needs of the fish farmers. This implies that an increase in fish farming experience increases the need for information and vice versa.

Access to information generally depends on the person's socioeconomic status and location [4; 14; 26]. This study outlined that deficiency in information access concerning fish farming is directly linked with the farmers' age, household size, and the ability to access the credit facilities. This finding implies that respondents' information needs decline with an increase in these variables. Coversely also, gender, stock size, and farming experience positively influence the information needs of the respondents at various levels of significance. This result implies that the respondents' information needs declines with an increase in age and vice versa. This finding is supported by the submissions of [36] and [12] who also revealed that farmers' need for information can be influenced positively or negatively by farmers' socioeconomic characteristics, particularly education, age, and farming experience. They established a strong negative relationship between the level of education and information needs. They suggested that less educated farmers have a higher need for agricultural information than educated ones. This is probably because educated farmers can have the ability and the chance to search and consult different information sources compared to less educated and hence their information needs may differ in such aspects. Similarly, in conformity with the finding of this study age was negatively associated with farmer's information needs. The likely explanation for this was the likelihood that younger farmers can be less experienced in farming when compared to experienced adult farmers who may have limited information needs. The study further indicated that respondents having access to credit have limited information needs and vice versa. This is since the majority of the respondents rely on the internet for information, and having access to credit increases resources at the disposal of farmers to source for information, thereby reducing their deficiency in information access.

Table 6. Factors Influencing Information Needs of Fish Farmers

Variable	Coefficient	Std. Error	Z-statistic	Prob.
Age(X_1)	-0.008	0.003	-2.931 * *	0.004
Gender(X_2)	0.429	0.079	5.438 * * *	0.000
Marital Status (X_3)	-0.338	0.081	-4.200 * * *	0.000
Household size (X_4)	-0.042	0.007	-6.325 * * *	0.000
Educational Level (X_5)	-0.022	0.010	-2.196 * *	0.030
Stock Size (X_6)	0.227	0.031	7.420 * * *	0.000
Farming Experience (X_7)	0.022	0.006	3.874 * * *	0.000
Access to Credit (X_8)	-0.121	0.065	-1.861 *	0.065
Membership of Association (X_9)	-0.010	0.056	-0.177	0.860
Constant	2.288	0.173	13.256	0.000

Source: SPSS Output.

*, **, *** Significant at 10%, 5% and 1%, respectively.

Fishery Constraints

Fish farmers in the study are faced with a wide range of constraints as shown in Table 7, prominent among these constraints were; high-cost fish feed (100%), lack/inadequacy of capital (78.5%), lack of good/reliable market information (78.5%), and poor breeds of fish (73.1%). Other challenges include the incidence of disease/pest (67.7%), scarcity of good water/ poor quality in farm area (67.7%), poor policies and political will by the government (67.7%), and low demand leading to the low price of fish (64.5%). In the same vein, the respondents reported that inadequate extension or advisory services (64.5%high cost of drugs and vaccines (59.1%), lack of readily available market for fish (57%), high cost of processing (48.4%), insecurity due to theft (48.4%), and the high cost of electricity (46.2%). The interplay of these constraints limits the ability of farmers to maximise gains from the venture. Hence, the need to eliminate or minimise the effects of these constraints through the adoption measures that will enhance fish farmers' access to resources, especially capital and relevant agricultural information.

In this study, high-cost fish feed and lack/inadequacy of capital were the most prominent challenges of fish farmers in the study area. The inability of the farmers to generate reasonable capital can limit their ability to maximise gains from the enterprise. This can be attributed to the ineffectual implementation of the fishery policy over the years. These issues are also challenges in Benin Republic where the Fisheries and Aquaculture Department has been starved of funds leading to its overdependence on foreign aids to develop the sector [19]. Similarly, the farmers have limited availability and access to good quality feeds. In the Cameroun Republic, inadequate financing and inadequate quality of feed were prominent barriers to fish production in the country [35]. Therefore, improving aquaculture in Nigeria will contribute to improving the wellbeing of its immediate neigbouring countries. But, achieving this will require strong political will to implement the policies and programs designed to enhance the performance of fish farmers. In most countries, aquaculture developed because entrepreneurs were able to benefit from favourable policies of the government [27]. Therefore, the proper implementation of such policies will enable fish farmers to surmount the challenges of the sector [21]. According to [29] and [32], the implementation of relevant fishery policies has made South-East Asian countries be leading nations in both aquaculture and capture fisheries. Examples of such initiatives were the establishment of brood banks and seed certifications, and also the promotion of farm-made feeds using local ingredients to minimize costs of production in the region. In other instances, a reasonable number of aquaculture extension workers employed and stationed at district offices to disseminate information and send feedbacks to the Fisheries Departments for further actions. Such an initiative can substantially contribute to mitigating some of the challenges identified by fish farmers in this study and unleash the unexhausted potentials of the sector to the nation's economy. Studies in recent years have established that fish farming is the fastest-growing animal-based food production sector in Nigeria [41; 8; 15].

Table 7. Distribution of Fishery Constraints

Variable	Frequency	Percentage*
Lack of/inadequacy of capital	130	78.5
High-cost fish feed	166	100.0
Poor breeds of fish	121	73.1
Incidence of disease/pest	112	67.7
The high cost of electricity	77	46.2
Scarcity of good water/ poor quality in the farm area	112	67.7
Lack of readily available market for fish	95	57.0
Low demand leading to the low price of fish	107	64.5
The high cost of processing	80	48.4
Lack of good/reliable market information	130	78.5
The high cost of drugs and vaccines	98	59.1
Extreme weather condition	80	48.4
Inadequate extension or advisory services	107	64.5
Poor policy and political will by the government	112	67.7
Insecurity due to theft	80	48.4

Source: Field survey, 2020.
*Multiple Responses

CONCLUSIONS

This study has outlined the need to improve information access by fish farmers to adopt management practices that can enhance their productivity. Having a thorough understanding of the fish farmers' management practices and information sources/needs should be critical considerations in the planning and delivery of aquaculture extension services. Based on the findings of the study, it can be deduced that fish farmers in the study area do not rely on agricultural extension agents or the mass media for information. Rather, the internet and friends/acquaintances were prominent sources. Similarly, the study established that the majority of the respondents need information on most aspects of fish farming and that these information needs are influenced by the farmers' socio-economic characteristics. Furthermore, the high cost of fish feed, lack/inadequacy of capital, lack of good/reliable market information, and poor breeds of fish were identified as the leading constraints of the fish farmers in the study area. Based on the findings of the study, the following recommendations were made:

(i)Efforts should be made to avail fish farmers of relevant fish farming information on the internet and also receive feedback in good time. This will require upgrading facilities at agricultural extension departments by adequate budgetary provisions and ensuring implementation.

(ii)Similarly, dedicated aquaculture extension service agents should be employed and trained for each agricultural extension block to improve face-to-face contact between the agents and the farmers.

(iii)Fish farmers should be encouraged through agricultural extension agents to join farmers' associations to enhance their access to relevant agricultural information and resources. The associations would also be a means of fostering social relations among fish farmers and improve the current ad hoc and unplanned farmer-to-farmer extension.

(iv)The government and other actors in the agricultural sector should assist farmers by easing their access to credit facilities which can enable them to adopt a wide range of fish production technologies.

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INCOME DIVERSIFICATION AND DRIVERS OF RURAL SMALLHOLDER FARMERS' INCOME IN ENUGU STATE NIGERIA

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Abstract

Rural smallholder farmers in developing countries were faced with the challenge of low income which disposed them to malnutrition and high poverty rate. This affects their productivity, livelihood and wellbeing. Understanding the drivers of income and its patterns is very important to curtail these challenges. Therefore, this study analysed the level of income diversification, shares of different income sources and drivers of smallholder farmers income in Enugu State Nigeria. Primary data collected from 180 rural smallholder farmers were analysed using descriptive statistics and multiple regression. The study revealed that the majority (65.6%) of the smallholder farmers did not diversify their income, thus agriculture is their major source of income. Farm income, off-farm income and non-farm income contributed 72.3%, 16.3% and 11.4%, respectively to rural smallholder farmers' income. The identified contributing factors to smallholder farmers' income were education, farm size, access to agricultural extension services, income derived from off-farm and non-farm activities, and access to credit facilities. The only inhibiting factor to smallholder farmers' income was the age of the farmers. This study recommends increase in diversification level of smallholder farmers' income and increase in cultivated farm size to boost their economic status. Provision of accessible credit facilities at a low or no interest rate, quality education and more extension contacts by the governments and related agencies to the smallholder farmers were also needed to increase smallholder farmers' income which will improve their wellbeing.

Key words: *drivers, farm income, nonfarm income, smallholder farmers, rural households*

INTRODUCTION

Nigeria is an agrarian country with abundant arable land supporting the growth of several crops. Agriculture is an important sector in Nigeria and other developing countries. Despite a reduction in its contribution to Nigeria Gross Domestic Product from 58.5% in the 1960s to 22% in 2019. Over seventy per cent of Nigeria population depends on agriculture and allied activities for their sustenance and livelihood [11, 13], thereby serving as a source of income for many Nigerians especially the rural dwellers. Over 80 per cent of the farmers in Nigeria are smallholder farmers who produced more than 85 per cent of the food locally produced in the country [8].
These rural dwellers, who engaged in agriculture, are the most hit in terms of malnutrition and high poverty rate in the world, especially in developing nations [3]. Level of income, food security and poverty are among the major drivers of the extent of economic growth and development and welfare of people in a country. Diversification of income among rural households can boost their income in a bit to achieve rural economic growth and development. Investing in agriculture, especially in nations where agriculture serves as means of livelihood to the majority, is generally agreed by practitioners and economist to be an effective measure of poverty, hunger and inequality reduction [16].
Farm income determines farmers access to basic needs and quality of life. Reduction in farm income and productivity severely affects rural prosperity and economic growth [2]. Thus, low farm income among smallholder farmers is among the policy debates in developing countries. This is because farm income determines most farmers' wellbeing and economic status. A low farm income

earner is likely to have a poor wellbeing while a high-income earner is likely to have a better wellbeing. Thus, an increase in farmers' income is fundamental to social and economic development and determine farmers' level of investment. This is because income of the inhabitants of a nation is among the criteria for measuring the level of socio-economic development in a region [6].
Agricultural income and its determinants are frequently discussed problem [6]. The income derived from agriculture determined the purchasing power of millions of rural dwellers [12], their living standards and wellbeing. For effective policy formulation for rural farmers to improve their wellbeing and welfare, identification of driving factors of income is very important. The low income in the rural areas who are mostly smallholder farmers remains a serious challenge in Nigeria as it disposed them to severe poverty and hunger. This further affects their productivity, livelihood, wellbeing and deny them some basic needs. Despite government programmes such as National Accelerated Food Production Programme, Operation Feed the Nation, Back to Land Programme, Better Life Program, Family Support Program, Family Economic Advancement Program, National Poverty Eradication Program, National Economic Empowerment and Development Strategy programme targeted at boosting Nigeria rural people's economic status, they remain vulnerable to poor wellbeing and poverty which lowered the level of development in the rural areas.
In view of these, this study examined the degree of rural smallholder farmers income diversification, shares of different source of income to the farmers total annual income and identified the driving factors of income among rural smallholder farmers in Enugu State Nigeria in a bit to enhance their economic status, improve their wellbeing and reduced malnutrition which is highly pronounced among them. The identified contributing or inhibiting factors will be of importance to government and policymakers for proper intervention to boost the economic status of smallholder farmers and improve their livelihood, standard of living and wellbeing. This would also serve as a tool for rural development.

MATERIALS AND METHODS

This study was carried out in Enugu State, Nigeria. The state is one of the 36 states of the Federal Republic of Nigeria. It shares a national border with Abia and Imo State to the South, Ebonyi State to the East, Benue State to the Northeast, Kogi State to the Northwest and Anambra State to the West. The state has seventeen local government areas (LGAs) with Enugu as the capital. It is located between Latitudes $5^0$55'N and $7^0$08'N of the equator and longitudes $6^0$55' E and $7^0$08' E of the Greenwich meridian [4]. Enugu state has a population of 3,257,298 people and a landmass of 71,161 square kilometres. The larger proportion of the population lives in rural areas who are mostly farmers. The climatic condition in the state supports the growth of several crops and rearing of livestock. Multistage sampling technique was used to select smallholder farmers used in this study. Because most of the rural dwellers in the study area were engaged in agricultural and allied activities, a random selection was used. Six LGAs were randomly selected in the state in the first stage. The second stage also involved a random selection of three villages from each LGAs making a total of eighteen villages. The last stage involved a random selection of ten farmers in each village making a total of 180 farmers for the study.
Primary data were used in this study. The data were collected from the rural smallholder farmers through the use of a structured questionnaire and interview schedule. Data collected contained information on smallholder farmers demographic and institutional features, level of income diversification, contributions of each income source to total annual income and their total annual income. The data were collected between the month of August and September 2019. Data collected were analysed using descriptive statistics and multiple regression. Descriptive statistics such as mean, percentage and frequency were used to analyse the demographic and institutional

features of the smallholder farmers, level of income diversification and shares of different income sources to the smallholder farmers total income. Multiple regression is a predictive model used when the dependent variable is continuous. This was used to analyse the driving factors of income among smallholder farmers as it can perfectly account for continuous dependent variables. It is explicitly represented as:

$$Y = \beta_0 + \beta_1 Ag + \beta_2 Gen + \beta_3 ED + \beta_4 HS + \beta_5 FS + \beta_6 CM + \beta_7 EXT + \beta_8 EXP + \beta_9 NFinc + \beta_{10} AC + \varepsilon$$

where:
Y is the annual income measured in Naira,
β_0 is the constant,
Ag, Gen, ED, HS, FS, CM, EXT, EXP NFinc and AC are the explanatory variables,
β_{1-10} are the coefficient of regressors and
ε is the error term.

Table 1. Description of explanatory variables

Variable name		Description	Expected sign	Unit of measurement
Ag	Age	Age of household head	+/-	Years
Gen	Gender	Gender of the household head	+/-	Dummy (Male = 1, female = 0)
ED	Education	The educational level of the household head	+	Years
HS	Household size	Number of persons living in the same households contributing to or depending on the household income	+/-	Number of people
FS	Farm size	Hectares of farmland under cultivation	+	Hectare (10,000m^2)
CM	Cooperative membership	Membership of cooperative society by the farmers	+	Dummy (Member = 1, non-member = 0)
EXT	Access to extension	Access to agricultural extension services in the previous farming season	+	Number of contacts
EXP	Experience	Years of farming experience by the household heads	+	Years
Nfinc	Income from other sources	Income generated from nonfarm and off-farm activities by rural households	+	Naira
AC	Access to credit	Access to credit facilities from formal and informal sources	+	Dummy (Yes = 1, no = 0)

Source: Developed by authors.

RESULTS AND DISCUSSIONS

Demographic and institutional features of smallholder farmers

The demographic and institutional features of smallholder farmers were presented in Table 2. The larger proportion of the rural smallholder farmers were within the age of 41 to 50 years. They had an average age of forty-nine years. This implies that the smallholder farmers were advanced in age and still in their economic active age to carry out agricultural activities. Therefore, could maximize available scarce resources for increased production and outputs [14]. Considering the type and quality of farm labour available, age of the farmer is a vital factor due to the drudgery involved in peasant agriculture [9]. Therefore, younger farmers are likely to spend more hours on the farm than the elderly ones. Rural household heads were predominantly male while only 9.4% of the households were headed by females which was common among the widow. This implies that males dominated the rural households which might make them have a say in decision-making in the households. The majority (84.4%) of the smallholder farmers were married followed by the widow(er) and single. The majority (76.7%) had a household size between five and eight persons with an average household size of six persons. This suggests that they had a large household size who can assist them in farming. Family labour is the major source of labour used for farming activities among smallholder farmers, thus reduced the cost of production.

The level of education among the rural smallholder farmers was very low as the majority (49.4%) had only primary school education. Only 5% could be said to be well educated among the rural smallholder farmers in the study area. This could affect their decision-making process as the level of education is highly correlated with decision making on agricultural production and the use of agricultural inputs [1]. The majority had above ten years of farming experience with an average of seventeen years of experience. The skills acquired in an enterprise depends on time spent on it; thus, the longer a farmer spent in an enterprise the better his or her understanding of the business [10]. The number of years spent in farming activities plays a significant role regarding the performance of the farmers and good knowledge of farming. Thus, smallholder farmers in the study area can be described as well experienced who have good knowledge of farming.

The majority of the smallholder farmers had below three hectares of farmland under cultivation with an average of 1.8 hectares. This implies that the farmers were operating on a small scale which the revenue derived from it might not be enough to meet their household needs. Access to agricultural extension services (36.7%) was low among the rural smallholder farmers. This could lower their productivity as agricultural extension agents disseminate useful information about the innovations and agricultural best practises.

Table 2. Demographic and institutional features of smallholder farmers

Variables	Category	Frequency	Percentage	Mean
Age	≤ 30	2	1.1	49
	31 – 40	34	18.9	
	41 – 50	68	37.8	
	51 – 60	54	30	
	> 60	22	12.2	
Gender	Male	163	90.6	
	Female	17	9.4	
Marital status	Single	12	6.7	
	Married	152	84.4	
	Widow(er)	16	8.9	
Household size	1 – 4	23	12.8	6
	5 – 8	138	76.7	
	≥ 8	19	10.6	
Education	No formal education	27	15	
	Primary	89	49.4	
	Secondary	55	30.6	
	Tertiary	9	5	
Experience	< 10	30	16.7	
	11 – 20	88	48.9	
	> 20	62	34.4	
Farm size	< 1	32	17.8	1.8
	1 – 3	136	75.6	
	≥ 4	12	6.7	
Access to extension services	Yes	66	36.7	
	No	114	63.3	
Cooperative membership	Yes	38	21.1	
	No	142	78.9	
Access to credit	Yes	43	23.9	
	No	137	76.1	

Source: Field survey, 2019.

Membership of cooperative association was low among them, only 21.1 per cent were members of cooperative society in the study area. This could deny the majority of the smallholder farmers some benefits such as access to information, financial assistance and enjoyment of economies of scale from the association. The majority (76.1%) of the smallholder farmers did not have access to credit facilities.

This was basically due to lack of collateral required by commercial banks. It is worth noting that the few that could access credit got it from friends and family, money lenders and cooperative societies.

This could be one of the reasons for their low farm size under cultivation, that is operating on a small scale, as personal fund might not be enough for the farmers to operate on a large-scale farming.

Income distribution, diversification and shares of income sources among smallholder farmers.

Table 3 presents the income distribution of smallholder farmers, level of income diversification and shares of different income sources to the total annual income of the smallholder farmers. The larger proportion (28.3%) of the smallholder farmers had an annual income between ₦200,001 (USD 525.21) and ₦300,000 (USD 787.82) followed by those with ₦100,001 (USD 262.61) to ₦200,000 per annum. They had an average income of ₦239,778 (USD 629.75) and an average per capita income of ₦39,963 (USD 104.96) per annum. This suggests a very low level of income among the rural smallholder farmers and their households. This further implies that the smallholder farmers' household with an average of six-person were living on ₦656.93 (USD 1.73) daily. This shows that, on average, each member of the households was living on about ₦110 (USD 0.29) daily. This was far too low than the Nigeria poverty line of ₦376 (USD 0.99) per person per day which denotes level of wellbeing.

Further analyses revealed that the few rural households (10.6%) that had up to ₦376 per person per day were those with small household size (below four persons) who also earned above ₦350,000 (USD 919.24) per annum. This suggests that small household size reduce the financial burden on the farmers and could enhance household wellbeing and access to basic needs of life. This is because small household size increases the household per capita income and boost the economic status of the rural households. Whereas large household size lowers the per capita income in the household.

The level of income diversification among the smallholder farmers was low as only 24.4 per cent had other sources of income (off-farm and nonfarm). This could contribute to their low level of income as income derived from only farm may not be enough to meet up with their basic needs as they operate on a small scale which is usually characterised with low level of productivity.

Table 3. Income distribution, diversification and shares of income sources among smallholder farmers

Variables	Categories	Percentage	Mean
Annual income	≤ 100,000	17.8	239,778
	100,001 – 200,000	25	
	200,001 – 300,000	28.3	
	300,001 – 400,000	22.2	
	> 400,000	6.7	
Income diversification	Yes	34.4	
	No	65.6	
Income sources share	Farm income	72.3	
	Non-farm income	11.4	
	Off-farm	16.3	

Source: Field survey, 2019.

Farm income from crop and livestock production had the highest share (72.3%) of the rural farmers' income, thus was the major source of income among the rural smallholder farmers.

The share of off-farm income derived from marketing of agricultural produce and processing of crops such as palm fruits into palm oil was 16.3 per cent. Nonfarm income had a share of 11.4 per cent of the total annual income.

Non-farm income in this context is the income smallholder farmers derived from other sources (remittance and artisan) apart from crop or livestock production and other agricultural related activities in a farming season, usually one year. These results imply that diversification of income contributed to rural smallholder farmers' income.

Drivers of smallholder farmers' income

Table 4 presents the results of multiple regression estimates used to identify the factors influencing the smallholder farmers' income. The identified contributing factors to smallholder farmers' income were education, farm size, access to agricultural extension services, income derived from off-farm and non-farm activities, and access to credit facilities. The only inhibiting factor to smallholder farmers' income was the age of the farmers. The coefficient of determination (R-Squared) of 0.6281 shows that 62.81 per cent of the variation in smallholder farmers' income was explained by the independent variables included in the model. The model also had a good fit as indicated by the F-stat (27.52) which was, however, significant at 1%.

The coefficient of the age of smallholder farmers was negative and significant in relation to smallholder farmers income ($p < 0.01$). This implies that one-year increase in age will reduce the smallholder farmers' income by ₦928.44 per annum. This is because the energy possessed by farmers reduces as their age increases which may lower their agricultural productivity due to the nature of their production (use of crude implement). This agrees with the finding of [5] who reported that the rural farmers income declined as their age increases.

The coefficient of the level of education was positive and significant in relation to smallholder farmers income ($p < 0.1$). This implies that one-year increase in education level will increase farmers income by ₦759.48. This is because education paves ways for access to relevant information and adoption of innovation. Also, level of education increases the ability to make intelligent decisions in an enterprise [1]. A similar result was reported by [7, 15] who reported that the level of education increased the income of cowpea and shallot farmers, respectively.

The coefficient of farm size was positive and significant in relation to smallholder farmers income ($p < 0.05$). This implies that one hectare increase in cultivated land will increase smallholder farmers' annual income by ₦24,682.94. This is because more land under cultivation increases farmers output, *ceteris paribus*. This will, in turn, increase smallholder farmers revenue from agriculture. This is in tandem with the findings of [12, 5] who reported that farm size increased the income of farmers.

The coefficient of access to agricultural extension services was positive and significant in relation to smallholder farmers income ($p < 0.05$). This suggests that an increase in agricultural extension contacts will increase smallholder farmers income by ₦13,706.61. This is because extension agents disseminate useful information on best farming practises and introduce innovation to the farmers. Access to useful information and adoption of innovation will boost farmers productivity which will, in turn, enhance their income derived from agricultural activities. This result conforms with the findings of [7] that access to extension services increased the income of farmers.

The coefficient of nonfarm and off-farm income was positive and significant in relation to smallholder farmers income ($p < 0.01$). This implies that income derived from off-farm and nonfarm activities increased the smallholder farmer income by ₦3,431 per annum. This result is in coherent with the findings of [17] that nonfarm income increased the farmers' income. Considering the fact that the farmers were operating on a small-scale, diversification of income will increase the smallholder farmers income level. This is likely to improve the standard of living and wellbeing of rural households.

Access to credit facilities was positive and significant in relation to smallholder farmers income ($p < 0.01$). This implies that one per cent increase in credit access will increase farmers' income by ₦17,737.39. This is because the personal fund is not always enough in a farming enterprise, especially to operate on a large-scale farming, thus access to credit provides farmers with required capital for a better investment. A better investment will, in turn, yield a higher output, return to investment and income, *ceteris paribus*. This is in coherent with the findings of [15, 17] who reported that access to credit facilities increased the income of farmers.

Table 4. Drivers of smallholder farmers income

Independent variables	Coefficient	Standard error	t-value	P-value
Age	-928.4365***	261.8251	-3.55	0.001
Gender	12063.03	9515.068	1.27	0.207
Education	759.483*	440.3218	1.72	0.086
Household size	944.6857	3773.358	0.25	0.803
Farm size	24682.94**	4112.492	6.00	0.000
Cooperative membership	-11038.17	7368.679	-1.50	0.136
Access to extension	13706.61**	5325.271	2.57	0.011
Experience	56.2204	2790.916	0.02	0.984
Nonfarm/off farm income	3431.267***	316.7396	10.83	0.000
Access to credit	17737.39***	4488.05	3.95	0.000
Constant	-57050.51**	26263.64	-2.17	0.031
F-stat	27.52			
Prob > F	0.0000			
R-squared	0.6281			
Adjusted R-squared	0.6052			

*** significant at 1%, ** significant at 5% and * significant at 10%
Source: Field survey, 2019.

CONCLUSIONS

This study revealed that smallholder farmers were low-income earners who have not fully diversify their income, thus sourced their income majorly from agricultural and allied activities. The low income seriously disposed them to high poverty rate which could lower their purchasing power and wellbeing. Farm income had the highest share of rural smallholder farmers' income followed by off-farm income and nonfarm income. Income diversification contributed to rural smallholder farmers' income. Level of education, farm size, access to agricultural extension services, income derived from off-farm and non-farm activities, and access to credit facilities were the contributing factors to smallholder farmers' income. While age was the inhibiting factor to smallholder farmers' income. To boost their economic status, smallholder farmers need to diversify their income and increase their cultivated farm size. Policymakers, governments and other relevant agencies need to provide accessible credit facilities at an affordable interest rate, quality education and designate more agricultural extension agents to the rural areas to increase smallholder farmers' income. These would not only boost their economic status but also improve their productivity, purchasing power, food security status and their wellbeing. Increase in rural households' income would also enhance rural development in the long run. This is because level of income among people in an area determined the development level of such region.

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STRATEGIES ADOPTED BY YAM FARMERS IN COMBATING CLIMATE CHANGE IN KOGI STATE NIGERIA

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Abstract

Climate change has always been a thing of concern in agricultural production, especially in yam production. The study investigated farmer adaptation strategies to the effect of climate change on yam production in Kogi State with the specific objectives of assessing the socio-economic characteristics of farmers, farmers' climate related constraints, the adaptation strategies employed by farmers, and yam farmers' level of knowledge on climate change. A multistage sampling technique was used to select one hundred and twenty respondents from the different communities selected in the study area in year 2019. Data were collected through structured interview schedule. The data were analysed using frequency counts, percentages and Pearson Product Moment Correlation. Results obtained showed that farmers in the study area were mostly males with a mean age of 44.5 years. Most of the yam farmers in Kogi State got information on climate change from other farmers (77.3%) and (81.3%) of the respondents aware of climate change. Furthermore, the major effects of climate change as identified by the respondents were pest infestation (90.8%) and high rate weed growth (88.3%). Various strategies adopted by yam farmers include mulching (Mean=5.0), intercropping yam with other crops (Mean=4.5), use of weather-resistant variety (Mean=4.1) and use of early maturing crop varieties (Mean=3.8). Pearson product moment correlation shows that there is a significant relationship between estimated annual (r = 0.887), income farming experience (r = 0.274) and the farmers' level of awareness. Therefore, efforts should be made towards developing and making available, yam seeds and yam tubers that can adapt to the change in climate and weather elements like flood and drought. These findings suggest the need for more training on climate change, the adaptation methods, environmental education and sustainability of yam cropping.

Key words: *Adaptation strategies, climate change, pest infestation , mulching, sustainability*

INTRODUCTION

Climate change is one of the most challenging issues that need urgent attention especially in the recent time with widespread implications for the earth's ecosystems and human development in all sphere of life. [1] claim that impacts of climate change are extensive ranging from the aggravation of poverty, the collapse of infrastructure, to the loss of environmental, political, economic and social security. Climate change impacts on agriculture and ecosystems run through rising temperature and changes in rainfall variability and seasonality as well as through extreme heat, floods and droughts [6]. Also, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [6] indicated that warming of the climate system is now unequivocal clearly shown that global warming is mostly due to man-made emissions of greenhouse gases (mostly CO_2). Climate change has serious implication on smallholder and subsistence farmers production at a landscape, watershed, or community level and also compounded by environmental and physical processes. Moreso, agricultural production severely affected due to loss of land, shorter growing seasons, more uncertainty about what and when to plant crops which in turn worsening of food insecurity and increase in the number of people at risk from hunger. West Africa is one of the most vulnerable to the vagaries of the climate, as the scope of the impacts of climate variability over the last three or four decades [8]. Climate change have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones [14].

Adaptation to Climate Change refers to a set of strategies put in place to reduce climate change effects with respect to agricultural and economic system [2, 5]. According to [13], adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It further refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Climate change adaptation methods according to [10] are those strategies that enable the individual or community to adjust to the impact of the change in climate. Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts.

Climate variation already poses significant impacts on the agricultural sector and there has been little commitment to make adaptation a national priority in the country. Conspicuously, the associated impacts of climate variation are predominantly negative, with the most severe impacts being experienced in vulnerable communities made up of the bulk of Nigerian farmers practicing farming at subsistent levels, where capacity to adapt is very weak [14].

It is known fact that most of the rural people have little or no technology and also might encounter greater problems caused by the change in climate or adverse change in the climatic condition of an area. In Africa rural farmers have been practicing a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events. These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes [14].

Despite the fact the rural farmers have inadequate technologies to cope with climate change, fortunately, there are many practices that farmers can improved on in adopt and changes that can be made to our agricultural production system to make the system more resilient to our changing climate. Thus, the study assesses yam farmers strategies adopted in combating climatic change.

The specific objectives are to:

(i)describe socio- economic characteristics of yam farmers in the study area.

(ii)assess the level of knowledge of yam farmers in adaptation to climate change.

(iii)determines yam farmers' perceptions of climate change

(iv)examine the constraints of adaptation to climate change.

(v)identify different adaptation measures used by yam farmers to mitigate the effects of climate change.

Hypothesis:

(i)There is no significant relationship between the socio-economic characteristics of the farmers and adaptation strategy methods adopted to combat climate change.

MATERIALS AND METHODS

The study was conducted in Kogi State which is located in the North-central geo-political zones of Nigeria. Extends from latitude 6.33° N to 8.44° N and latitude 5.40° E to 7.49° E. It shares boundaries with 10 other states having Federal Capital Territory (Nigeria) to the north, Nasarawa State to the north east, Benue State to the east, Enugu State to the south east, Anambra State to the south, Edo State to the south west, Ondo State to the west, Ekiti State to the west, Kwara State to the west, Niger State to the north and also the two major rivers in Nigeria, River Niger and River Benue form a confluence with the state. The temperature ranges from 21°C to 35°C with high humidity. The vegetation consists of rainforest in the southern part of the state and the woody derived savannah and Guinea savannah in the northern extreme. Generally, the land mass is flat or gently undulating and lies at 50m to 700m above sea level.

Agriculture is the central component of the economy. There are many farm produces from the state notably yam, coffee, cocoa, palm oil, cashews, groundnuts, maize, cassava, rice and melon.

A multi stage sampling procedure was used to select respondents in the study area. At first stage, 5 local governments (Ankpa, Dekiha, Omala, Idah, and Ofu) were purposefully selected being the major yam producing community in the study area.

Second stage involved selection of two communities in each of the local government making a total of 10 communities in the 5 local government areas. The third stage involve selection of 12 farmers from each community making a total of 120 yam farmers Data for the study was obtained through the use of interview schedule. Data was collected on the following socio-economic characteristics of farmers such as household size, sex, age, years spent in acquiring education, access to credit, extension services, personal income and farm size in hectares. Others were effect of climatic change such as temperature and precipitation; awareness and knowledge level, adaptation measures adopted by farmers in the study area such as change in planting dates, crop diversification, soil conservation and changing tillage operations.

The data was analysed using descriptive statistical tools such as frequency, percentage, mean and standard deviation to describe parameters such as age, sex, household size, year of schooling and extension contacts, Inferential statistics such as Pearson correlation, chi square, were used to analyse the data.

To examine their knowledge of climate change causes and effects, respondents were asked to tick "yes" or "no" if they were aware of climate change. They were also required to tick against a list of options on the perceived causes and effects of climate change. Options provided in the list for the causes of climate change included: bush burning, deforestation, use of excess chemicals such as pesticides on farms, high rate of weed growth, prolong rainfall, delayed onset of rain etc. based on correctness of responses on the twenty-one questions measuring knowledge.

To assess the effect, total scores for each respondent for extent to which the factors causing climate change affects farming and the constraints of climate change, they were grouped into 4 categories "To a very great extent"," To a great extent", "To a little extent" and "To no extent at all".

RESULTS AND DISCUSSIONS

Analysis on the socio-economic characteristics of yam farmers

From the data presented in Table 1, it is observed that preponderance of the yam farmers in Kogi state are males (63.3%). Above average 59.2% of the respondents are married persons and within the age range of 30-60 years (59.1%). This indicated that majority were responsible were at a productive age.

Table 1. Socio-economic characteristics of the respondents

Characteristics	Frequency	%	Mean
Sex			
Male	76	63.3	
Female	44	36.7	
Marital status			
Single	25	20.8	
Married	71	59.2	
Divorced	9	7.5	
Widowed	15	12.5	
Age (years)			
≤30	28	23.3	
31-60	71	59.1	48 ± 9.7
≥ 61	21	17.6	
Farming experience (years)			
≤ 10	20	16.7	
11-20	33	27.5	22.4 ± 11.2
≥ 21	67	55.8	
Years spent in acquiring formal education			
Never	24	20.0	
≤6	50	41.6	8.1 ± 3.2
≤12	32	26.7	
≥13	14	11.7	
Household size			
≤ 5	21	17.5	
6 -10	77	64.3	6.22 ± 1.7
≥10	22	18.3	
Farm size (hectares)			
≤ 5	64	53.3	
6 -10	36	30.0	4.5 ± 1.6
≥10	20	16.7	
Annual income (₦)			
≤ 500,000	77	64.0	
500, 000 -1000,000	41	34.2	571,500 ± 169, 511
≥1000,000	41	43.2	

Source: Field survey, 2019.

Furthermore, 81.3% of the respondents had farming experience of over 10 years, Data retrieved from the study also revealed that preponderance (64.3%) of the farmers in Kogi state have a household size of 5-10 persons per house, The implication of the household size is that there will be enough labour to work on the farm lands.

Above average (53.3%) of the farmers indicated that they had 3 hectares of farm

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land. Furthermore, 64.0% of the yam farmers in Kogi state had an annual income between ₦500,000-1,000,000 ($1,041 –2,082). This an indication that majority of the farmers ought to be able to practice climate adaptation strategies.

Source of information of respondents on climate change

Further analysis on their source of information on climate change revealed that most of the yam farmers in Kogi state got their information from other farmers (77.3%) while (70%) rely on radio broadcast for information. However, low percentage (38.6%) engage the television as a source of information, extension agents (38.6%) resp3ectively. Furthermore (33.0%) choose the newspaper as a source of information about climate change. This implies that other farmers and radio were the major source of information in Kogi. State Agricultural Development Programmes (ADPs)) that were in charge of disseminating information to farmers were not always on ground to give reliable information to farmers on the technical skill they required to assist the farmers on different methods of adaptation to climate change (Table 2).

Table 1. Sources of information on climate change

Variable	Frequency	Percentage	Rank
Other farmers	92	76.7	1st
Radio	84	70.0	2nd
Television	46	38.3	3rd
NGOs	44	36.7	4th
Internet	42	35.0	5th
Newspaper	40	33.3	6th
Extension Agents	38	31.7	7th

Source: Source: Field survey, 2019.

Yam Farmers awareness on climate change

The data presented in Figure 1 reveals that a large proportion (81.3%) of the respondents aware of climate change. However, 18.7% of the respondents indicated that they are not aware of climate change. This implies that majority of the farmers are aware of climate change which has a possible influence of the production of yam. This study is in line with the findings of [12] who reported that majority of the farmers in Oyo state are aware of climate change (Figure 1).

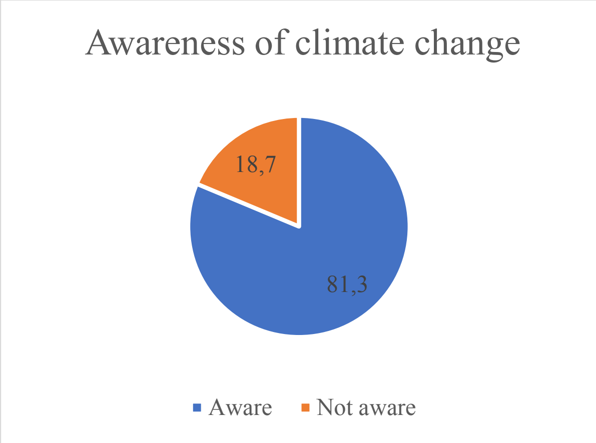

Fig. 1. Awareness on climate change
Source: Own design based on field survey.

Farmer's knowledge about perceived causes of climate change

The majority of respondents showed a good knowledge on the causes of climate change such as deforestation (81.3%), use of excess chemicals such as pesticide (81.3%), the high intensity rainfall (81.0%), increase in the size of the sun (78.0%), and bushing burning (72.0%).

Table 3. Yam farmers' knowledge of the causes of climate change

Causes of climate change	Yes (%)	No (%)
Deforestation/cutting down of trees	81.3	18.7
Use of excess chemicals in farming like pesticide	81.3	18.7
Bush burning	72.0	28.0
High rainfall intensity	81.7	18.3
Use of generator to generate electricity by many households	67.3	32.7
Increase in size on the sun	70.0	30.0
Gases released from industries	65.3	34.7
Cooking with firewood	35.3	64.7
Late onset of rainfall	33.3	66.7
Abandoned deities	29.3	70.7
Gas flaring from oil companies	23.7	65.3

Source: Field survey, 2019.

A large proportion of the respondents also believed that use of generators (67.3%), and gas releases from industries (65.3.0%) are amongst the causes of climate change. However, preponderance of the respondents (64.7%) had no knowledge of the use of firewood as a major contributor to climate change. Bush burning and deforestation have been found in other studies to contribute to climate change [3, 11].

This finding is also in consonant with the Fifth Assessment report of [7] which provides scientific evidence that human impacts, especially greenhouse gas emissions, are the primary factor in global warming (Table 3).

Perceived effect of climate change on yam production

The effects of climate change as identified by the respondents include pest infestation (90.8%) and high rate weed growth (88.3%). yam spoilage in the soil (87.5%) respectively Moreover, majority (85.0%) of respondents were of opinion that climate change causes destruction of field crop by heavy wind. Others include increase erosion (82.5%), low crop yield (80.8%), premature ripening of crops (70.8%), reduction of soil nutrients (70.8%) and excessive soil moisture (68.3%), This result is an indication that climate change had serious effects on yam production which might resulted into economics loss for the farmer and in long run affect food sufficiency in the country. Hence the need for the adaptive measures to climate change to be put in place to ensure proper management of yam production (Table 4).

Table 4. The effects of climate change on yam production N=120

Variables	Yes (%)	No (%)
Disease and pest infestations	109 (90.8)	11 (9.2)
High rate of weed growth	106 (88.3)	14 (11.7)
Yam spoilage in the soil	(105) 87.5	15 (12.5)
Destruction of field crop by heavy wind	102 (85.0)	18 (15.0)
Increase erosion	99 (82.5)	21 (17.5)
Low crop yield	97 (80.8)	23 (19.2)
Premature ripening of crops	85 (70.8)	35 (29.2)
Reduction in soil nutrients	85 (70.8)	35 (29.2)
Excessive soil moisture	82 (68.3)	38 (31.7)

Source: Field survey, 2019.

Strategies adopted in order to adapt to climate change

The finding presented in Table 4 below outlines various strategies adopted by yam farmers to coped with climate change in descending order adoption in the study area. All the yam farmers interviewed used mulching (Mean=5.0) which was followed by intercropping yam with other crops (Mean=4.5), Other strategies include use of weather-resistant variety (Mean=4.1), use of early maturing crop varieties (Mean=3.8), planting of crop with early rainfall (Mean=3.6), change of planting dates (Mean=3.5), migration to a different farming location (Mean=3.4), using of irrigation systems (Mean=3.2), diversification into planting of other crops (Mean=3.2) and Listening to information about climate change (Mean=3.0) respectively. However, harvesting of rain water for use during the dry period and purchase of agricultural insurance had low level of adoption (1.8) which mighty be as a result of inadequate technical knowledge of rain harvest and storage by yam farmer and usefulness of insurance in mitigating against climate change.The implication of the finding is that most of the farmer practiced various strategies to mitigate climate change in yam production except rain harvest which might aid in water supply for yam production and purchase of agricultural insurance which mighty serve as buffer during the crop loss due to drought or flooding. This finding corroborates the findings of the study conducted by [4] that farmers used adaptation measures such as multiple/intercropping, agroforestry, expansion of cultivated land area, use of herbicides and pesticides and purchase/harvesting of water for irrigation were identified to mitigate climate change. [3] in another study, reported that the following adaptation measures were in use in the Niger Delta area of the country: use of improved crop varieties, use of early maturing crop varieties, and change of planting dates which is in line with the strategies put in place and used for this study. According to [9], adaptation helps farmers achieve and get food, income and livelihood security objectives in the face of changing climatic and socio-economic conditions including climatic change, extreme weather conditions such as drought, flood, volatile short-term changes in local send large scale markets (Table 5).

Table 5. Distribution of respondents' adaptation strategies on climate variation

Adaptation strategies	Mean	Rank
Mulching	**5.0**	**1st**
Intercropping yam with other crops	4.5	2nd
Use of weather-resistant variety	4.1	3rd
Use of early maturing crop varieties	3.8	4th
Planting of crop with early rainfall	3.6	5th
Change of planting dates	3.5	6th
Migration to other location	3.4	7th
Use of irrigation system	3.2	8th
Diversification into other activities	3.2	8th
Listening to information about climate change	3.0	10th
Harvesting of rain water for use during the dry period	2.0	11th
Purchase of agricultural insurance	1.8	12th

Source: Field survey, 2019.

Testing of Hypothesis

Pearson product moment correlation (PPMC) analysis showing correlation between age, estimated annual income, farming experience and adaptation strategy methods adopted to combat climate change shows that there is a significant relationship between annual income ($r = 0.887$), farming experience ($r = 0.274$) and adaptation strategy methods adopted to combat climate change.

This implies that adaptation strategy methods adopted to combat climate change increase with increase in estimated annual income and their farming experience (Table 6).

Table 6. Pearson product moment correlation

Variables	r-value	p-value	Decision
Age	-0.066	0.570	Not significant
Estimated annual income	0.887	0.000	Significant
Farming experience	0.274	0.006	Significant
Farm size	0.354		Significant

Source: Field survey, 2019.

CONCLUSIONS

Majority of the farmers had high knowledge of climate change issues. The effects of climate change were manifest in the study and these include: low crop yield and increase in pest and disease outbreak. These situations are being increasingly linked to decrease in farmers' income and hence, increase in vulnerability.

There were conscious efforts made by yam farmers to adapt to climate change. For example, farmers are already practicing changes in planting dates and processing of farm produce to minimize post-harvest loss, etc. Constraints that limited farmers' ability to adapt to climate change include inadequate access to information and training. Despite the constraints that farmers experienced in accessing information, they made efforts to access information on climate change issues from other farmers and radio. It was also noted that information on causes, effects and adaptation to climate change are necessary to aid them in adapting to the negative consequences of climate change.

Based on the findings of this study, it was recommended that:

-There is need for government and non-governmental bodies to provide necessary technologies to help rural farmers become better in their adaptation to climate change.

-There is need to train on the issues of climate change, especially in the rural areas by Extension personnel and non-governmental organizations

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DIVERSITY OF YAM-BASED PRODUCTION SYSTEMS AND SUSTAINABLE SOIL MANAGEMENT: THE CASE OF TIÉNINGBOUÉ IN IVORY COAST

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Abstract

Yams are cultivated by almost every household in Tiéningboué in the northern center of Ivory Coast. The steady increase in production by increasing the areas of cultivation leads to a scarcity of land, which commands for more sustainable management practices regarding soil fertility. This study establishes the baseline for more effective interventions of a research for development project 'YAMSYS', aiming to develop more sustainable yams production systems. To assess the accumulation of natural and social capital that are essential factors in sustainable production systems, a typology combining qualitative and quantitative approach is developed. Then, stakeholder analysis is carried out for soil fertility management. Six yam-based production systems are identified: 'yam specialists' (1%), 'cotton growers' (15%), 'smallholders' (47%), 'very large indigenous farms' (3%), 'large indigenous farms' (27%), 'large allochthonous and allogeneic non-cotton farms' (7%). Results show both similarities and differences in production system, as well as predictions of reaction of the groups to Integrated Soil Fertility Management (ISFM) technologies developed by YAMSYS. For 'Smallholders', facing low resource endowments, the potential for ISFM techniques adoption is the highest when their cropping system become permanent. Ultimately, the study highlights the stakeholders making up an innovation platform whose objective is to have "champions" along the yam value chains acting as "agents of change" allowing farmers to adapt new technologies for better management of soil fertility.

Key words: *crop production systems, soil fertility management, family farm, innovation platform, yam*

INTRODUCTION

Yam, consumed as staple food by about 155 million people, is cultivated as cash crop and medicinal plant, mainly in Africa [42]. In addition, it has an important cultural value for producing communities [10]. The most important species are *Dioscorea alata, Dioscorea rotundata, Dioscorea cayenensis* and *Dioscorea esculenta* [1]. The yam belt, formed mainly by West African countries, extends from the humid forest, where yam is grown for food security, to the Sudanian savannah, where yam is also grown as cash crop [2]. In fact, West Africa produces 92% of the world's supply of yam tubers [19]. Consumed in daily diets in both cities and rural areas, the cultivation of yam has expanded drastically over the last three decades. The cultivated area increased from 2.1 million hectares in 1994 to 8.1 million hectares in 2018, and led to an increase in production of 36.5 million tonnes in these 24 years. During this period, the average tuber yield fell from 11.9 tha^{-1} to 8.25 tha^{-1} [19]. Thus, farmers' yields are far below yield potentials of 50 and 40 tha^{-1} that have been reported by research for *D. alata* and *D. rotundata*, respectively [13, 3].

Ivory Coast, located on the yam belt, is the third largest yam producer in the world with 7.2 million tonnes of tubers harvested from 1.3 million hectares. Yield average is even lower, with 5.5 tha^{-1} in 2018 [19]. Several factors were reported to explain this gap, such as: inadequate crop fertilisation, poor seed quality, high pest pressure, and limited production potential of traditional varieties [43]. [15] identified quality seed being the main constraining factor, in terms of availability and its cost. For [44], increased land pressure reduces the availability of 'virgin' land sought by yam farmers, making them grow yam on less fertile soils. For [25], the lower yam yields result from production practices that relate to a steadily declining soil fertility.

In fact, the common practice of farmers to use newly deforested land, i.e. soils rich in organic matter, and to grow yam at the head of a crop rotation based has become rare. Therefore, the concern of various rural development and research actors is to develop and disseminate appropriate intensification methods that aim to ensure both a certain degree of food security and the conservation of natural resources. This involves providing farmers with technologies adapted to their constraints and priorities. To address the constraint of decline in soil fertility, the project "Biophysical, institutional and economic determinants of sustainable land use in yam production systems (YAMSYS)" was set up. The main objective of the project is to develop innovations for sustainable soil management in yam production systems in West Africa to sustainably improve food security, farmer income and environmental quality. The project is conducted on two pilot sites in Burkina Faso and two pilot sites in Ivory Coast. Tiéningboué is one of the sites in Ivory Coast. This study aims to develop a typology for different yam-based or –related production systems in Ivory Coast, as the basis to analyse the potential and pathways to make yam production more sustainable in varying production systems. Thereby, its analysis will make it possible to identify the constraints and priorities that influence the adoption or rejection of a change in agricultural practices. In order to develop adapted technologies, the characterisation of farms is necessary and refers to farms typology establishment. A "typology" divides entities into groups according to interest subject and makes it possible to characterise each group according to observed criteria that present variability [34]. It makes it possible to define target groups for more effective interventions. It can improve knowledge of the dynamics change in regional agriculture [14] and serve as a basis for local policies technical support. The study of yam-based peasant production systems was therefore a necessary step in the YAMSYS technology improvement project.

Integrated soil fertility management as part of sustainable land use

In Sub-Saharan Africa, the severity of land degradation is well documented, ranging from physical degradation due to wind and water erosion, compaction and formation of impermeable layers, soil compaction, waterlogging and reduced infiltration, to chemical degradation resulting from acidification, nutrient depletion, pollution due to the pesticides or fertilisers misuse, or biological degradation produced by organic matter levels reduction in the soil, the burning of biomass and the depletion of plant cover and soil fauna [17]. In the case of yam-based production systems, researchers have mainly emphasised the chemical and biological impoverishment of the soil caused by crop succession without appropriate organo-mineral restitutions, the consequences of opening up new land through deforestation [29]. The degradation also relates to the loss of traditional yam varieties, as wild yam domestication practices disappear and the cultivation of improved varieties expand [20]. Faced with the risks of land degradation and gaps between actual and potential yields, the YAMSYS project has developed technology packages that need to be analysed for their relevance and effectiveness for the different production systems in important yam production areas. These technological packages consist of a combination of innovations, relating to the use of improved varieties, healthy seed, low disturbance tillage techniques, organo-mineral fertilisation, improved crop rotation and improved staking in yam production [23]. All these aspects are part of an integrated soil fertility management (ISFM) approach that build on a combined use of organic and inorganic nutrient sources to ensure an adequate fertilization in agricultural production. ISFM combines different methods of soil and water amendment and conservation and is based on the following three (3) principles: maximising the use of different sources of organic matter; minimising nutrient losses; and using mineral fertilisers judiciously according to economic needs and availability [18]. In practice, the endorsement of ISFM translates into a wide variety of techniques depending on production systems and regions [18].

From a sustainability point of view, a farm is only sustainable when it at least maintains the productive natural capital of its land over time. According to the model of sustainable agriculture developed by [39], sustainable systems are those that ensure renewal and promote the accumulation of a stock of both natural and socio-economic capital. Yam being a nutrient-demanding crop of great cultural relevance, it is indeed essential to broaden the analysis by considering also environment-related and social capital, i.e. assessing under what circumstances stocks of these capitals are accumulated or eroded in yam-based production systems, respectively to study possible substitution effects between one and the other. Natural capital corresponds to the stock of goods (plants, animals, minerals, etc.) and services provided (e.g. waste absorption cycle) by ecosystems to satisfy human needs. [16] propose a framework for analysing natural capital, structured by four environmental elements: air, water, soil and habitats. Social capital is "the sum of the actual and potential integrated resources available through or arising from the network of relations that an individual or social unit possesses" [35].

We hypothesize that according to [39] model, current production systems based on yam do not ensure an accumulation of at least one natural capital (i.e. soil fertility) and one social capital (i.e. farmers' organization).

This article aims to assess how the use of the technological packages developed by YAMSYS affect the renewal and accumulation of natural capital and social capital in Ivory Coast central northern. Firstly, the article characterises current yam-based production systems and identifies some principles of their functioning. Secondly, it analyses which ISFM practices are already at least partially integrated into these systems and compares them with the technologies developed by YAMSYS. Finally, the limits to the adoption of widespread ISFM practices are discussed and ways to overcome them.

MATERIALS AND METHODS

Favourable characteristics for yam cropping

The region selected for the study is the sub-prefecture of Tiéningboué in north-central Ivory Coast. Tiéningboué (Fig.1) is a yam production area that supplies not only Bouaké (the city where the wholesale yam market is located) at about 101 km, but also Abidjan (the economic capital, the largest consumer city in the country) at 343 km. According to the latest general population and housing census of 2014, the population of Tiéningboué, which is predominantly agricultural, is estimated at 40,000 inhabitants. It is made up of indigenous people (Koro), allochthonous people (Sénoufo, Lobi, Baoulé) and allogeneic people (Economic Community of West African States 'ECOWAS' nationals, particularly Malians, Burkinabes, Guineans). Koro and Baoulé have yam as their staple food. The other communities mainly produce yam as a cash crop. It was expected that this ethnic diversity would result in a diversity of yam-based production systems. The natural characteristics of Tiéningboué are favourable to yam. The tropical climate at the edge of the southern forest zone and the savannah region are suitable to yam, and the vegetation found in the area is of the "forest meadow" type; it is made up of forests and savannah which give way to numerous fallow lands, and cashew tree. Tiéningboué was also selected because of the presence of the YAMSYS project. It has set up an experimentation site under the management of researchers and disseminated the innovative techniques of the technological packages tested through "baby trials" managed by interested farmers. Also, a multi-stakeholder platform was set in place to facilitate exchanges between farmers, traders and service providers in the yam sector, and this lead to analyse it.

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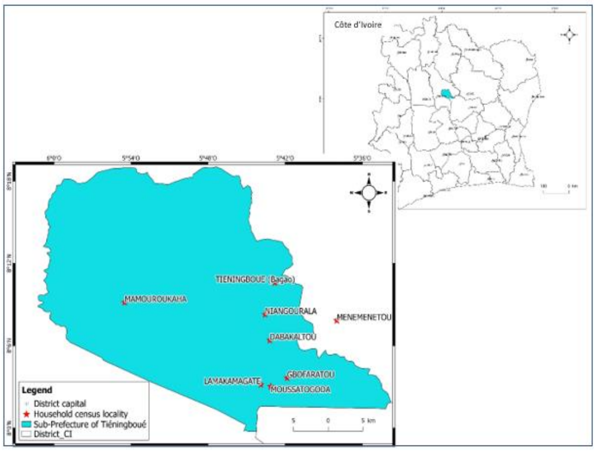

Fig. 2. Map of Ivory Coast highlighting the Tiéningboué sub-prefecture (the study area)
Source: Authors, 2020.

Iterative approach for data collection and analysis

The study was conducted in two phases. The holistic approach combines exploratory studies and surveys of a sample of farm households. A rapid diagnosis was carried out in July 2015 in the sub-prefecture of Tiéningboué and in March 2017, a socio-economic monograph was conducted on 3 villages in the sub-prefecture, which differ in their population density and ethnic structure, factors that influence yam-based production systems and yam marketing. Following a household census from December 2017 to February 2018, a survey of a sample of households was conducted between April and May 2018.

Then, according to the formula of [24], the formula for calculating an exhaustive sample:

$$n^2 = \frac{t^2 p(1-p)}{e^2} * \frac{N-n}{N-1}$$

with t= 1.96; p= 0.898; e= 5%; N= 410;

$n = \frac{t^2\, p\,(1-p)}{e^2}$; n= 140.75, so n^2= 92.66.

where:

N: mother population size;

n: sample size for a very large (infinite) parent population;

n^2:sample size for a limited parent population;

s: Confidence threshold ;

t: Margin coefficient deduced from the Confidence rate "s";

e: Margin of error ;

p: Proportion of the elements of the mother population that have a given property. (When p is unknown, we use p = 0.5);

q = 1-p: Probability of failure.

We also define: The sampling rate R = n/N; The Uncertainty Range I = 2e).

Thus, the minimum sample size for the survey is 93 farm households. However, the questionnaire was administered to 230 households that constituted the sample for the statistical typology.

The actor-oriented approach starts with the assumption that different farmers define and operationalize their objectives and farm management practices based on different criteria, interests, experiences, and perspectives [11]. The approach was intended to be iterative, with each step making it possible to identify relevant factors differentiating operating systems and to verify or refine them during the next step based on assumptions [8]. The diagnosis in the exploratory phase used interactive tools of the Accelerated Method of Participative Research (MARP) documented by [7].

On the one hand, the monographs allowed the typologies built by farmers to identify discriminating criteria and explanatory factors and to question representatives of each type about their practices. Based on this, a standardised questionnaire was developed for household survey to establish the statistical typology.

The statistical typology was constructed based on structural (resource endowment) and functional (production objectives) characteristics [30].

Six groups of variables (Table 1) were identified during the exploratory phase and validated by the bibliographical analysis: yam production experience, socio economic variables (autochthony), marketing (or consumption) objectives pursued, yam species cultivated, land allocation and cropping system features, and the level of mechanization.

Multiple variables required a multidimensional analysis. Depending on the nature of quantitative or qualitative variables, multiple factor analysis (MFA) reduces the complexity of the variables before grouping the individuals into classes using a hierarchical bottom-up classification (HLC) method. For the characterisation of the classes obtained, a chi 2 significance test was carried out. The significance of the test was evaluated at the 5% threshold. Thus, the chi2 test makes it possible to know if the class variable is related to the qualitative variables [27].

Multiple Factor Analysis (MFA) first plan explains more than 50% of the variability. Hierarchical bottom-up classification (HLC) carried out with 5 dimensions of MFA, i.e. at least 90% of the inertia, has led to the formation of six (6) classes.

The multivariate analyses were carried out with the FactoMineR package of software R version 3.5.3.

Stakeholder analysis

On the other hand, stakeholder analysis has been seen in policy research as a way of generating information on the ‘‘relevant actors’’ to understand their behaviour, interests, agendas, and influence on decision-making processes [5]. Many definitions of stakeholders build on [21] seminal work on stakeholder theory that distinguished between those who affect or are affected by a decision or action. Indeed, stakeholder analysis is used in development and the natural resources management. By understanding who has a stake in an initiative, and through understanding the nature of their claims and inter-relationships with each other, can the appropriate stakeholders be effectively involved in environmental decision-making [41]. Therefore, the monographs identified stakeholders for soil fertility management issue. Then, a focus is put on the innovation platform (IP) set up by YAMSYS as a tool to develop collaboration between stakeholders [22]. Indeed, "Innovation platforms (IPs) are a way of organizing multi-stakeholder interactions, marshalling ideas, people and resources to address challenges and opportunities embedded in complex settings" (Davies et al., in press). Often, IPs are organized around a farm product, such as, yam [4]. Therefore, it is a question of identifying the axes of IP analysis to improve its actions.

RESULTS AND DISCUSSIONS

Yam cropping as a farm household activity

The census of households and their agricultural production units took place in eight (8) localities of Tiéningboué. Out of 410 households surveyed, 397 are agricultural households and 368 consist of at least one yam-producing unit, representing 89.8% of the total number of households.

The heads of yam production units (PUs) also engage in non-agricultural or para-agricultural activities (trade in agricultural and other products, crafts). 92.3% of the heads of PUs who cultivate yams are also heads of households and all are men. Women are heads of production units when the head of household is very old and has no sons, or when they are widows. Yam cultivation is practised by men.

Common characteristics of production systems in the Tiéningboué region

The quantitative typology differentiates six clusters relating to different classes. Although they have different characteristics, it is worth noting the common elements that they share.

Cropping and production systems

Most farms in the study site involve 10 to 30 ha of UAA (Utilized Agricultural Area) and grow mainly cashew, rice and yam (Table 1). International demand has made cashew cropping become a major source of income in the zone. New plantations are established every year, sometimes as soon as land is cleared and new fallow land is developed, and sometimes after a few years of production when the plots run out. Only 37% of the area in cropping relates to annual crops, including yams, which is not planted within cashew plantations. It is possible to combine annual crops with young cashew trees for 2 to 3 years, but then the plantations have a high coverage rate.

In the cropping systems, yam is head of rotation for 97.8% of all farms. According to farmers, this crop is demanding in terms of soil fertility and new clearings meet this demand. The other 2.2% of the farms put rice at the head of the crop rotation. In this case, farmers argue that rice helps to increase soil fertility before cropping yam the coming year.

Table 1. Retained variables for statistical typology

	Quantitative variables Mean +/- standard deviation								
	Name	Unit	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**	**Total sample**
1	*D.alata*	ha	0.79± 0.36 *	0.74± 0.33 *	2.0± 0.71 *	0.66± 0.67*	2.35± 0.78*	5± 1*	1.18± 0.9
	D.rotundata	ha	0.19 ± 0.30 *	0.43 ± 0.55	0.21 ± 0.33 *	2 ± 0.8 *	0.72± 0.63	5 ± 1 *	0.41 ± 0.8
2	Cotton	ha	0.32 ± 0.93 *	6.69 ± 2.16 *	0.12 ± 0.63 *	1.25± 2.01	0.43± 1.05	3 ± 3	1.33 ± 2.6
	Fallow land	ha	1.19 ± 1.96 *	2.73 ± 3.48	3.88 ± 3.28	2.94± 2.84	20± 9.63*	2.5 ± 2.5	2.78 ± 4.5
	Cashew tree	ha	3.81 ± 3.09 *	12.06± 7.18*	7.42 ± 4.45	6.62± 5.08	20.29± 13.38*	7.5± 7.5	6.99± 6.3
3	Farmers'age	years	46.95± 13.61	50.17 ± 9.85	47.23± 11.57	43 ± 10.37	46 ± 12.92	45 ± 13	47.3 ± 12.5
	Experience in Yam	years	15.33± 11.07*	19.71± 10.72	19.93± 9.49	19.5± 8.28	23 ± 11.35	23 ± 11	17.81 ± 10.7
	Qualitative variables Proportion (%)								
	Variables	**Modality**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**	Global (%)
	Rotation head	Yam	97	100	95.1	100	100	100	97.8
		Rice	3	0	4.9	0	0	0	2.2
	Rotation with Cotton	No	98.17	80	100 *	100	100	50	95.7
		Yes	1.83	20 *	0	0	0	50	4.3
	Rotation with return to fallow land	With fallow land	6.42	8.57	6.56	18.75	0	0	7.4
4		Continuous in annual crop	33.03	51.43 *	14.75	18.75	14.29	50	29.6
		Non	60.55	40	78.69 *	62.5	85.71	50	63.0
	First Year of Cashew tree Association	Year1 after fallow	52.3	37.14	70.49 *	50	71.43	0	54.8
		2 years of annual crop rotation.	8.25	2.86	8.2	12.5	14.28	50	8.2
		Without Cashew	39.45	60 *	21.31	37.5	14.29	50	37.0
	*D.alata_* majority destination	own consumption	47.71 *	42.86	27.87	37.5	14.29	50	38.7
		no production	15.59	0	0	37.5	0	0	14.8
		sale	36.7	57.14	72.13 *	25	85.71 *	50	46.5
	*D.rotundata_* majority destination	own consumption	10.1	25.71 *	19.67	12.5	14.29	0	11.7
		no production	69.72 *	40	62.3	0	14.29	0	60.4
		sale	20.18	38.28	18.03	87.5 *	71.42	100	27.8
5	Autochthony	No	39.45	100 *	11.48	68.75	28.57	100	43.5
		Yes	60.55	0	88.52 *	31.25	71.43	0	56.5
	Yam species	*D.alata(a)*	62.38 *	40	62.3	0	14.29	0	52.6
		a&r	33.03	60 *	37.7	62.5	85.71 *	100	42.6
		D.rotundata (r)	4.59	0	0	37.5 *	0	0	4.8
	Utilized Agricultural Area (UAA or in French SAU) (ha)	S1(0,5≤UAA<5)	20.94 *	0	0	6.25	0	0	11.3
		S2 (5 ≤ UAA <10)	50.46 *	0	8.2	6.25	0	0	26.5
6		S3(10≤ UAA <30)	26.6	60	91.8 *	87.5*	0	50	52.6
		S4(30≤ UAA <70)	0	40 *	0	0	100 *	50	9.6
	Mechani-zation of ploughing	No	97.25*	74.29	93.44	85.7	85.71	0	90.9
		yes	2.75	25.71*	6.56	14.3	14.29	100 *	9.1

*significant variable at 5% threshold

Variables groups: **1.**Species of yam; **2.**Other Allocation of land; **3.**Experience; **4.**Cropping system; **5.**Socio-economic; **6.** Mechanization

Source: Authors' results, 2020.

According to the agricultural seasons and considering their food availability and need, all farms grow rice, maize, groundnuts and cowpeas, being part of the yam-based crop rotation. In terms of biomass management, most of the crop residues are exported from the plot, except for the roots. Thus, the tubers for yam, the ears for maize and other plant parts are taken out of the plot when the time comes to prepare the land for the next crop. On the other hand, for rice, except for the panicles which are exported, all the other organs are left on the plot and will be incorporated into the yam mounds. Farmers never grow yam after yam.

Mechanization and fertilisation

Cropping yam is essentially done manually. Even those farms with cattle, being in the position to do semi-mechanized soil work, do not systematically practice mechanised ploughing before making the mounds. To prepare the mounds for yam copping, plots are mostly cleaned by burning, or more rarely with total herbicides. Commonly, both yam species, i.e. *D. alata* and *D. rotundata,* undergo herbicide treatments after planting. No mineral or organic fertiliser is applied. Even cotton growers, who have the greatest experience with mineral fertilisers application, believe that all type of fertilisation is detrimental to the quality of the tubers and their preservation.

Yam species and seed management

Overall, cropping *D. alata* dominates. A comparison of the technical itineraries of these two species shows that *D. alata*, reputed to be hardier, is more often associated with perennials (mainly cashew trees) and receives less care than *D. rotundata*, whose mounds are more often protected from sunlight by straw pads and stakes. Seeds of *D. rotundata*, which account for a considerable part of the harvest, are expensive and are therefore more often treated before planting with insecticides and acaricides (used for cotton). Farmers commonly produce their own seed. One (1) cultivar is mainly found for the species *D.rotundata* in the zone, the "krènglè", whereas for the species *D.alata*, four (4) cultivars: Bètè-bètè, Cameroun (C18), woroba, Florido.

Place of animal husbandry

The traditional goats, sheep and poultry breeding is practiced, but in relatively small numbers (2 cattle, 1 sheep, 1 goat, 7 poultry on average) and essentially for self-consumption. The farms are managed by leaving the animals free to roam freely. This makes it difficult to collect manure or compost. There are also a few cattle farms managed by Peulhs, but their natural pastures in savannah areas are increasingly bordering farmers' fields, resulting in recurrent farmer-herder conflicts. Thus, the availability of organic manure, whether from traditional livestock farming or rare night pens for cattle, is low and rarely used for crop production.

Link with ethnicity

An important diversification factor identified is linked to farmers' ethnic origin. Cotton is only produced by non-native Senoufo people, who mainly grow the species *D. rotundata* for the market. They have migrated decades ago from areas where these two practices are common, also using cattle for soil work and mineral fertilisation in cotton. Their relatively old migration has enabled them to develop and thus appropriate areas at least as large as their indigenous Koro neighbours. The more recent migrants have no own land and cultivate the land of indigenous people; after some time, they tend to obtain plots from their landowners, but their land rights are limited and precarious, especially their cashew tree planting rights.

Diversity of yam-based production systems

The farming system typology shows that there are few farms that involve large areas in cropping yam. Only 1% of the farms (Class 6 in Fig. 2) produce yam on 10 ha or more, half of which are in *D. rotundata*. The vast majority of grow little yam, partly for own consumption, mainly *D. alata*. This is the case of Class 1, which includes 47% farmers, and Class 2, which includes 15%. These two large groups are essentially distinguished by the fact that Class 1 is made up of natives following cashew settlement pattern and Class 2 is made up of non-natives who grow cotton. Classes 4 and 5 are distinguished from the others by their larger size, which allows them to both establish large cashew plantations and clear fallow land to grow yam on areas smaller than those implemented by Class 6, but larger than the other classes. These two classes are distinguished by the relative importance of *D.rotundata*.

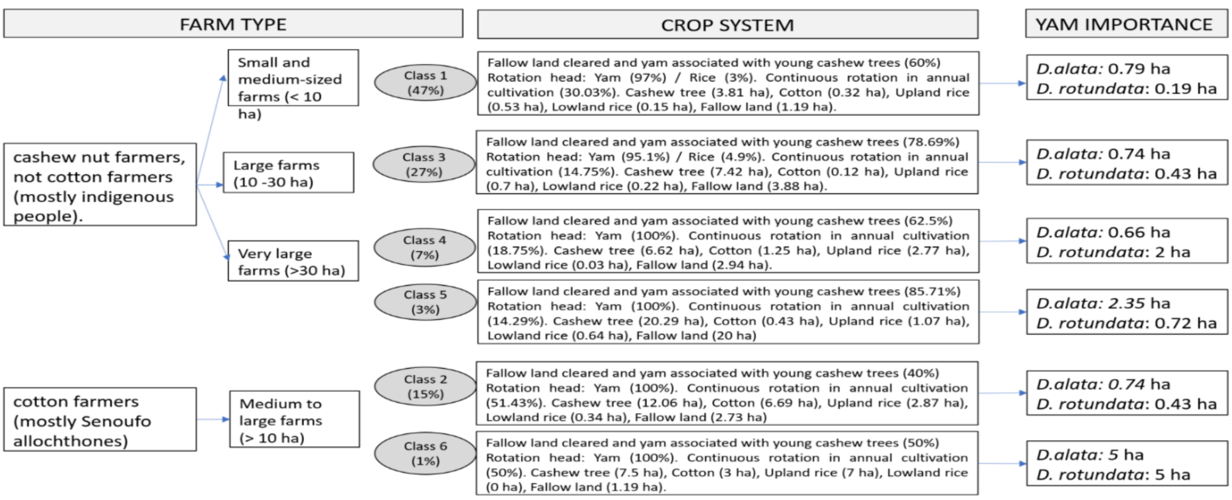

Fig. 3. Characteristics of the six (6) types of production systems
Source: Authors' results, 2020.

Differences in fertility soil management

Three types of yam cropping systems can be counted and classified in descending order of importance: (1) yam at the head of rotation in permanent crop rotations that often include cotton; (2) yam at the head of the rotation after clearing and more or less rapid transformation of the plots into cashew groves and (3) yam at the head of rotation after clearing in a system that allows return of overexploited land to fallow after a few years. This last system has become residual (8.57% of farmers). Despite this, only specialised farmers in yam cropping, being part of Class 6, consider limited by the fertility of their land. The land under yam crop appreciation (Table 2) shows that more than 57% of each Classes 1, 2, 3 and 5 consider their land to be fertile; 44% of Class 4 as well as 100% of Class 6 consider the land to be not very fertile. Based on this farmers' perception about soil fertility, how relevant is for them fertilization? In fact, farmers consider fertilisation only of marginal importance in yam production. Organic fertilisation is only very important for about 1% of the farms in each of Classes 1 and 3. Mineral fertilisation is only very important for about 2% and 3% of Class 1 and Class 2 respectively (Table 2).

In farmers' opinion (Table 2), when yam is not grown on forest or fallow land cleared, the best precedent is rice. Yam specialists from Class 6 grow 100% of their yam after rice. In the other classes, the best precedent with an improving effect is groundnuts in 69% of Class 1, cotton in 62.5% of Class 2, and rice or maize in Classes 3 and 4 in almost identical proportions. It can be deduced that by playing on the previous ones, farmers are satisfied with their fertility management methods. They also do not attach importance to production sites choice; for example, they have no preference for cattle pens or lowlands, although 28-37% of farmers in each class feel that the length of the drought period is increasing. In fact, they attribute more importance to other constraints than the fertility of their land. For instance, between 42 and 56% farmers, depending on the class, consider seed size and more than 50% of the farms in each class, the health of the seed, for being important. Finally, certain farming practices that *a priori* allow for improved yields are not considered important. This is the case of the use of straw pads on the top of the mounds, which is only considered relevant by a very small minority. Some farmers rely on crop associations to improve the productivity of their plots. Overall, the last five years, farmers feel that there has been no change in cropping practices, except for weed control through herbicides use. This change is seen as positive because the tedious task of weed control is reduced. It is particularly relevant for Class 2 cotton growers, who have easier access to herbicide supplies from the cotton purchasing companies.

As yam is a cultural crop, 20 to 44% farmers (depending on the class) give a very important place to spiritual forces to obtain good production. Only the few specialised producers in Class 6 do not refer to these as being important.

Table 2. Assessment of the fertility of yam crops and farmers' perceptions

		Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Appreciation of the land sown to yams	Fertile	70.64	71.43	73.77	50	57.14	
	Poor	1.83		1.64	6.25		
	Not very fertile	27.52	28.57	22.95	43.75	28.57	100
	Very fertile			1.64		14.29	
Perception of organic manure	Quite important	0.92	2.86	1.64			
	Not used so no opinion	98.17	97.14	96.72	100	85.71	100
	Very important	0.92		1.64			
	not important					14.29	
Perception of mineral fertilisation	Quite important	0.92	2.86	1.64			
	Not used so no opinion	97.25	97.14	93.44	100	85.71	100
	Very important	1.83		3.28			
	not important			1.64		14.29	
Good cropping precedent for yam	Groundnut	68.75	12.5	15.38			
	Cotton	12.5	62.5				100
	Maize		12.5	30.77	50		
	Maize & Rice			7.69			
	Rice	18.75	12.5	46.15	50		

Source: Authors' results, 2020.

Adequacy of agronomists' proposals to fertility management problems

Importance of marketing and credit

Most farmers state that the interest in producing yams for the market has become an important incentive to increase production. Yet, non-cotton farmers, i.e. farmers with less land and financial resources, are often limited by their cash flow. 41% of all farmers use loans from buyers (pre-harvest sales) to finance their campaign. In fact, these loans also often cover other expenses, such as children's schooling, being of greatest importance for farmers with limited resources. Between 75% and 100% of the farmers in Classes 1,3,5 and 6 obtain loans from a yam buyer. The use of a loan from a yam buyer implies an agreement on a unit price for yam set by the buyer before harvest, which is lower than the current market price at harvest. Other growers restrict their yam area to what they can financially afford. Only cotton farmers have facilities to obtain input credits from their marketing companies, and 50% use them.

Requirements of ISFM

The ISFM technology package offered by YAMSYS targets the decline in soil productivity quite specifically without paying too much attention to increased demand for labour and cash. It consists of integrated practices set. These technologies include different crop rotations, fertilizer inputs and fallow management and use crop cultivars requested by farmers, clean yam planting material and a planting density of one plant m^2. Mineral fertiliser has a specific composition suitable for tuber exports. The recommended organic manure is in the form of manure or compost.

Probable reaction to ISFM

Small indigenous class 1 farms with low resource endowment are a priori ideal candidates for the adoption of ISFM techniques to be proposed by the Yamsys project, as this class needs to intensify its cultivation system that has become permanent. But their cash flow could limit them because they sell their yams to traders via unloyalized relationships (buyers are numerous and change from one transaction to another for 44% of farmers and the relationship is loyal with only one buyer for only 14%); they have little chance of receiving credit from their buyers to obtain inputs. Often the family workforce is also small and they will prefer techniques that reduce the demand for labour.

Medium-sized cotton farms in Class 2 have long experience with mineral fertilisation. Thus, these farmers might be inclined to experiment with mineral fertilisation on yam, especially since they can easily obtain inputs from their cotton buying company, provided they are convinced that a direct effect of this fertilisation is superior to an indirect effect of fertilisation on yam. This has not been studied. They might also be able to switch to semi-mechanised yam cropping on slight raising of earth bounded by furrows with the help of a plough, since they use cattle for tillage. Nevertheless, there is very little interest in this technique because for the same yield, the tubers are more numerous and smaller. However, the large size of the tubers is still perceived as a local indicator of productivity. However, it should be remembered that yam is not an essential crop for them and that the adoption of new practices will rather interest those who will develop a market-oriented activity, such as the yam farmers currently in the minority in class 6.

Class 6 large farms specialising produce for the market and have sufficient labour and expertise to produce as much *D. rotundata* as the hardier *D. alata*. These growers will be interested in testing new techniques and will only keep those techniques for which the differences in performance are highly significant. In other words, they will only adopt techniques if and only if their financial and labour investment can be profitable. Cotton farmers in classes 2 and 6 would deserve special targeting and school fields.

Farmers in classes 3, 4 and 5 still have fallow land and are oriented towards processing them into cashew trees. In this process, they grow yams. They may be interested in techniques that improve labour productivity and the return on their investment in yam. The need to adopt ISFM techniques will become apparent in the longer term for the descendants of these farmers, when a large part of these large farms will be occupied by cashew tree and will have been broken up between heirs.

Stakeholders for soil fertility management

To understand the issue of integrated soil fertility management, it is first necessary to identify the actors involved or to be involved (Fig. 3) to determine the actions to be taken.

The implementation of YAMSYS' ISFM techniques will depend on producers' access to recommended inputs and technical information. Certainly, cotton buying companies in some way contribute partially to ISFM as cotton farmers are supplied with fertiliser to be paid back at harvest time and are assisted in the acquisition of production equipment such as cattle plough. Yam traders are not opposed to techniques that increase agricultural production. However, they believe that mineral fertilisation in yam cropping accelerates yam tubers rotting speed during storage and consumers complain of organoleptic properties of yam degradation when it is fertilised. Consequently, it is unlikely that traders will mobilise for loans to farmers for yam fertilisation, and even less likely to organise a supply of specific inputs as long as they are not convinced that it is in their interest to do so. The question of the combination of mineral and organic fertilisation has not been resolved. Recurrent conflicts between farmers and cattle breeders have dissolved traditional exchange links and the use of cattle dung to produce manure or, failing that, to grow on cattle pens has become minimal.

Agricultural extension in the zone is mainly focused on export crops. And there is an insufficient agent’s number, with only one agent from the Agence Nationale d'Appui au Développement Agricole (ANADER) for the entire sub-prefecture of Tiéningboué. This agent directs his advice mainly towards cashew tree. The cotton buying companies have agents who follow their farmers. Overall, the agricultural advisers in the zone do not carry out activities oriented towards ISFM or other crops, especially yam. Faced with this situation, the project YAMSYS has attempted to initiate a melting pot of exchanges in the form of an innovation platform bringing together the various stakeholders in the sector and agricultural support organisations.YAMSYS' technologies need champions, both at the level of farmers and other stakeholders in the system.

Indeed, the innovation platform (IP) in Tiéningboué, “Djiguissême”, is composed of direct and indirect value chains actors. The composition of the IP board describes its structure. On the one hand, six (6) producers, one (1) wholesale trader, one (1) supplier of phytosanitary products, who constitute the representatives of the direct actors. On the other hand, one (1) extension agent, one (1) researcher, one (1) modern administration authority, one (1) advisory service agent (social centre), one (1) agent of a microfinance institution (COOPEC), one (1) agent of the Water and Forestry Department, one (1) customary authority constitute the representatives of indirect actors. In addition, there is a facilitator for activities coordination.

The functioning of the IP can be described by the conduct activities, the decision-making process, monitoring and evaluation of the activities. First, the activities carried out are the frameworks for stakeholder consultation, workshops for planning and reporting on activities, training sessions, guided visits, farmer exchange trips, promotional and/or agricultural days, radio and television programmes. Then, IP decisions are taken by the board members during meetings. Finally, the project coordination ensures the monitoring and evaluation of activities by monitoring indicators such as the rates of implementation of activities and participation in activities. Ad hoc consultations are held during the year to diagnose the reasons in the event of a drop in these indicators.

IP will need to be analysed as a key institution for this process of agricultural technical innovation.

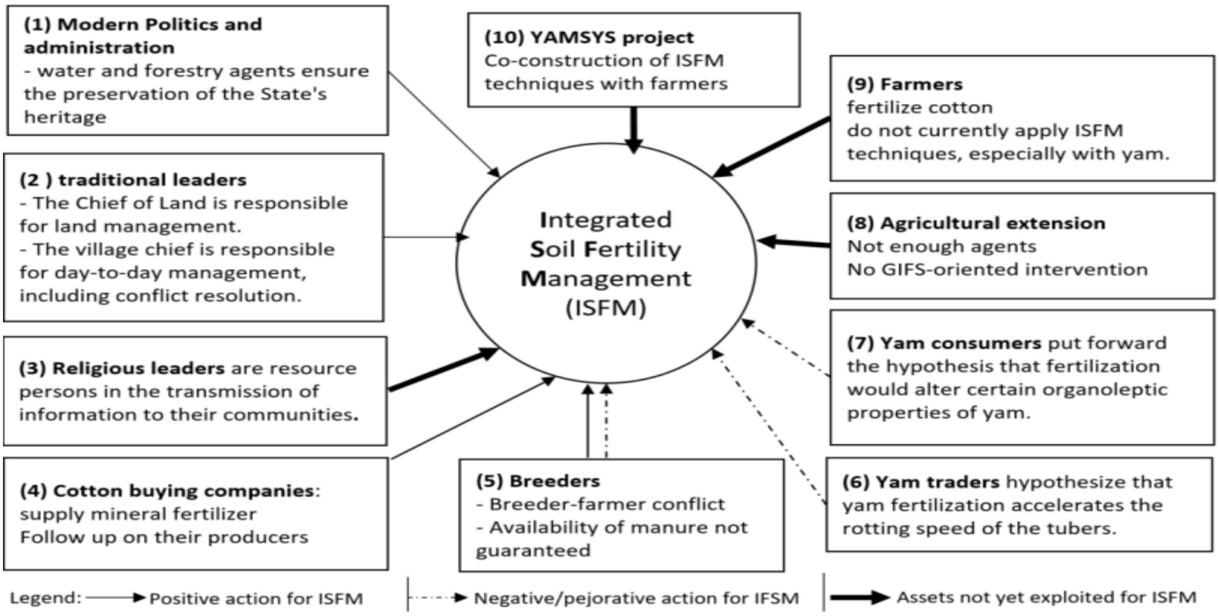

Fig. 4. Stakeholders for integrated soil fertility management
Source: Author's results, 2020.

Discrepancy between the perceptions of farmers and experts

According to the model of sustainable agriculture developed by [39], sustainable systems are those that ensure renewal and promote the accumulation of a stock of capital (natural and social). In traditional long fallow cropping systems, yam was traditionally planted as a first crop because it is considered demanding in terms of soil fertility [6]. In subsequent years, the field was sown with other crops and after one or more cycles, when yields declined or weeds required too much work, the field was returned to fallow.

Yam is usually grown without any external inputs using its own tubers as planting material. In areas where land is scarce, farmers produce yam after only one year of fallow or no fallow [32]. [31] reports that farmers perceive declining soil fertility as a key constraint to yam production in areas with low agricultural intensification. In current contexts, in the opinion of experts, yam-based production systems do not ensure the renewal of natural capital (soil fertility) and these ecosystems will be less and less able to satisfy human needs [16]. In fact, the export of macronutrients by yam crop is high and, regarding technical itineraries without the use of fertilisers, the mineral balance of the rotation is unbalanced [22]. Consequently, the natural capital 'soil fertility' is not renewed.

As for social capital, it is "the sum of actual and potential integrated resources, available through or resulting from the network of relations that an individual or a social unit possesses" [35]. Social capital mainly has two dimensions: a structural dimension, which refers to the structure of the network of relations between actors, and a relational dimension, corresponding to the content of relations in terms of norms and trust that result from the network of relations. Two types of links are identified as important in networks of relationships: strong links within the group of actors (bonding, according to [40]) and weak links with actors outside the group (bridging). However, ISFM does not mobilise the actors to any great extent. Membership in a cooperative and access to credit facilitate yam marketing [37]. However, these conditions are not yet a reality for the farmers of Tiéningboué. The potential for the creation of social capital exists, but its exploitation remains sub-optimal. Neither farmers nor the other yam actors seem to be able to dialogue with the researchers to readjust the technical proposals to their constraints and improve their relevance, efficiency and feasibility.

Why this discrepancy between the perceptions of experts and farmers?

In fact, the majority of Tiéningboué yam farmers no longer have large areas of fallow land, but most of them still have some that they are clearing and transforming into cashew fields. The effects of these processes on available area reduction for seasonal crops and on yield of fields cropping of continuously cultivated, are only gradually emerging. Most farmers continue to depend only on forest fallow or on *Chromolaena odorata*, a pioneer plant, as yam crop precedent, and are not yet under pressure to develop other strategies. "Cotton can be produced for a long time with fertiliser-medicine; however, no fertiliser-medicine for yam is known, so we only depend on fallow land", said one non-native famer during the exploratory phase. *Chromolanea* is recognised as a species with a high capacity for rapid biomass production and capable of slowing the decrease in soil organic matter [28]. When the alternative to natural fallow is no longer available and farmers switch to continuous cropping systems, rice cultivation has a moderating effect. Most of this crop biomass is reincorporated into the plot. We should also mention the effects of the increasingly frequent use of herbicides, which certainly disrupts the development of spontaneous flora and fauna, but also makes it less necessary to use burns to prepare a new plot of land. Thus, the rotations of the indigenous non-cotton farmers are lengthened with yam alternating with rice and sometimes groundnuts before installing cashew trees that will take over the plot when it becomes exhausted. Then some deforestation negative effects are counterbalanced by the plant cover provided by the cashew trees. The negative effects of unbalanced mineral balances will eventually make themselves felt, but not as quickly as researchers anticipate. Finally, land scarcity is only felt by a minority in this region, which still receives flows of migrants to compensate for the labour shortages of agriculture mainly manual, even if the land rights of these new arrivals are increasingly precarious or their obligations regarding monitoring and maintenance their landowner's cashew crop are becoming stricter.

Land scarcity is felt when agricultural intensity and population density are higher [33]. In such situations, local farming practices develop to grow yam in permanent crop rotations or short fallow. Common rotations with legumes (soybean, groundnut, cowpea, etc.) or cereals (rice, maize and sorghum) or fertilised cotton are part of ISFM farming strategies in the yam zone. Thus, for yam production systems in the Sudano-Guinean zone of Benin, [20] point out that in areas where there is little or no forest fallow, yam production has been sharply reduced but has not disappeared, and that some of these crops are planted in rotations after cereals whose stalks serve as yam stakes, after improving crop or after cattle have been parked on an area. This sedentarisation is accompanied by an evolution of cultivars for greater hardiness and production of small tubers that will be largely transformed into cossettes [47]. Another strategy observed is to concentrate *D. rotundata* fields in lowland areas where the plots benefit from the nutrient concentrations caused by runoff and where farmers grow early yams with high market value. In Nigeria and Benin, researchers then proposed fallows planted with fast-growing shrub species, to be managed in rotation or in association in yam rotations, but their management requires a lot of additional work. Easier to set up, various cover leguminous plants were tested as a precedent for yam. These promising systems are particularly suitable for use in permanent agriculture with minimum tillage [9]. However, these systems have not been widely adopted, having been promoted only by small research teams.

The transition towards permanent farming systems requires a major change in the logic of farmers' actions: from logic focused solely on enhancement of soil fertility naturally recreated, they are moving towards a recursive dynamic of enhancement, preservation and active creation of resources. The current yam-based systems of farms compared to the model of sustainable agriculture developed by [39] are not sustainable. In this model, capital (natural and social) has an important collective dimension, and its accumulation and use are based on forms of cooperation and coordination of actors [38] that contribute to sustainable management. The other capitals (physical, financial, commercial and human capital) are specific to an individual and are mainly the subject of individual strategies. For this reason, the YAMSYS team promote innovation platforms as a tool to develop collaboration between stakeholders [22]: they are called upon to design innovations and strengthen sustainable soil management in their yam-based production systems based on capital (natural and social). Despite the associated difficulties that must be overcome, researchers are aware of the need for improved collaboration, and with farmers and their organisations and between farmers and their organisations [46]. The levels adopting by YAMSYS include : the field where the actual crop management is implemented, the household where the decision for a given crop management technique will be taken, the yam value chain that provides the incentive for production, and the surrounding environment that also strongly affects the decision-making at the household level [23]. In fact, the innovation platforms function is to induce institutional changes that allow farmers who are under strong pressure to adopt innovations that are relevant to them (and therefore also relevant to downstream actors in the value chains).Currently, Tiéningboué IP vision is to develop cropping systems that preserve the environment and increase yam yields. Therefore, the IP members discussed the technologies that are developed by researchers and made available to farmers. Crop rotations and associations and increased planting density of 10,000 plants/ha are considered as a solution to land scarcity. The application of mineral and/or organic fertilizers is as a solution to soil fertility decline. For the importance of healthy seed, researchers proposed to select plants tubers with no visible disease symptoms as seeds for the next cropping season, to use a mixture of a fungicide and an insecticide to treat seeds just before planting and to improve tuber storage in order to keep the tubers healthy until the next cropping season [29]. One remark is that IP focused on production should be part of a dynamic that allows expression and consideration from other stakeholder groups expectations. Thus, actors in each field develop a common vision and are led to initiate major institutional and systemic changes that promote technical changes to which they adhere. A change of scale from niche to socio-technological regime is targeted in the long term [26]. The IP is an appropriate tool for stimulating dialogue among local stakeholders allowing co-development of technologies, but it has shown weaknesses when not appropriately managed [29]. Indeed, there is a risk of discrepancies between decisions and actions of IP and the real needs of stakeholder groups. A major risk is that, as stakeholders in the IPs, researchers often dominate discussions and influence the decision [29]. Concerning IP board, there was no guarantee that the representatives were the right persons who would work primarily for the interest of the group and not their own [12].

Nevertheless, the Tiéningboué platform does not yet have its champions among the actors of the yam sector, and the technologies only generate interest when they are accompanied by donations of inputs. Shouldn't we then return to basic principles such as "areas of recommendation" where technologies are knitted for particular types of farmers, in good knowledge of their internal constraints [36], but taking into account the requirements of their marketing? Such design of technical options requires strong interaction of researchers with farmers, their buyers and other stakeholders. Indeed, inevitably, behaviour will be linked to structural features of the economy within which any given farmer operates, especially agricultural policy, market configurations, and technology design [11]. Therefore, the transdisciplinary approach requires time and patience to make a relevant diagnostic and to co-develop solutions [29]. In such processes, failures in technology adoption are as important as successes if lessons are learned. Starting from local innovations to improve them is also an often-attractive entry point for stakeholders to articulate technical and socio-institutional innovations as well [45].

CONCLUSIONS

The choice of yam by the YAMSYS project is confirmed as this activity is practiced by 89.9% of households in the Tiéningboué area. Thus, six (6) yam-based production systems (PS) and their proportion in the sample are identified: yam specialists in class 6 (1%), cotton farmers in class 2 (15%), smallholders in class 1 (47%), very large autochthonous farms in class 5 (3%), large autochthonous farms in class 3 (27%), and large allochthonous and allogeneic non-cotton farms in class 4 (7%).

As a similarity, current soil fertility management strategies are based not only on rotations (with yam leading in 97.8% of the farms) although the best precedent for yam is not yet stabilised, but also on natural fallows which are only available in large areas for class 5, i.e. 3% of the sample. Current yam production is carried out without any external input of organic or mineral fertilisers, because traditional livestock farming makes it difficult to collect manure, and recurrent farmer-breeder conflicts reduce the chances of collaboration in the valorisation of cattle manure from the Peulh-managed farms.

In addition, the typology of yam-based SP assumes that the specific characteristics of the groups will affect the interest that each type would give to the different technical packages on soil fertility management proposed by the "Yamsys". Indeed, the producers' perception of fertilisation reveals a discrepancy with that of the researcher. This therefore raises the problem of the adequacy of agronomists' proposals to the problems of fertility management of yam farmers. In fact, the YAMSYS technology package targets quite specifically the decline in soil productivity without much concern for the additional demand for labour and cash. Small indigenous class 1 farms with low resource endowment are a priori ideal candidates for the adoption of ISFM techniques proposed by the Yamsys, as this class needs to intensify its production's system that has become permanent. But their cash flow could limit them because they sell yams to traders through non-loyalty relationships.

Finally, this study highlighted not only a segmentation of the target of the Yamsys project, but also pointed out the key factors to be exploited to have "champions" at the level of the actors of the yam sector in order to boost a change in farmers adaptive behaviour for the sustainable management of soil fertility by taking into account in particular the natural and social capital and to avoid the occurrence of critical levels of degradation.

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CHALLENGES TO TEA PRODUCTION AND TEA MARKETING IN TARABA STATE OF NIGERIA

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Abstract

Tea Camellia Sinensis (L) Kuntze is from the family of Theaceae. Tea plant encompasses some 200 woody plants species in the warmer regions of Asia and South America. Tea in its natural habitat develops to a small plant producing flower at six years or less or more based on type of variety and means of propagation. Total area of land under tea cultivation in the world is about 2,600,000 hectares with 86% in Asia, 85% in Africa and the remainder across South America, Russia and Oceania. The highest producer of tea in the world is Asia (60%), followed by Africa(12%). The countries in Africa which are large tea producers are Kenya, Malawi, Burundi and Cameroon. Nigeria still produces tea in small quantities as compared to Kenya. This study therefore examined the challenges to tea production and tea marketing in Taraba State of Nigeria. When these challenges are met tea production will be boosted and probably exported to improve the country's economy. The study was carried out in Taraba state in Nigeria. Data was collected through the administration of well-structured questionnaire among tea producers and marketers (272). Proportion to size sampling technique was used. In Taraba state, three communities were selected namely Mayo-Kusuku, Kakara and Kasalasah. Based on the population of tea farmers 90, 90, 92 were selected respectively from the communities. The result revealed that, thirty six percent of tea producers were between 17-30 years old, 50% of the producers were between 31-60years while 15% were above 60years. Majority of the producers are male(92.7%) while 7.3% were female. Twenty four percent of the producers have no formal education while seventy six percent have either primary, secondary or tertiary education. The challenges faced include poor soil fertility, low yield, pest infestation, labour shortage, lack of finance and lack of fertilizer/pesticide. Eighty six percent of tea producers lacked finance while 83.8% lacked fertilizer/pesticide. The problems faced by tea marketers in Taraba State are low market demand, low price, lack of access to market and high cost of transportation. Seventy five percent of tea marketers faced the problem of low market demand. Tea producers and marketers in Taraba State have great potential for development. Tea business can bring about economic development in Taraba State and Nigeria as a whole if government at various levels can put in place intervention programmes to overcome these challenges.

Key words: *challenges, tea marketers, tea producers, Taraba State, Nigeria*

INTRODUCTION

Nigeria's agriculture development is deeply conditioned by a large range of factors such as: geography, farm size and profile, labour force education, technical endowment, basic inputs, genetic engineering, and climate change [10].
Agricultural development in Nigeria is characterized by abundant land, a heterogeneous distribution of rural population, which creates a localized land pressure experienced by many farmers.
For avoiding the risk of failure, many farmers have adopted mixed cropping as a viable strategy [4].
The expansion of land area for cropping and the improvement of yield per ha are the basic tools for increasing agricultural production to meet population demand [12].
Among the main crops cultivated Nigeria there are: sesame, beans, nuts, cashew, beans, groundnut, cassava, cocoa, gum Arabic, millet, melon, rice, palm kernels, rubber sorghum, banana, plantain, beans and yams. However, tea is another important crop plant whose production is influenced and restrained by soil and climate conditions in Nigeria.
Since its introduction in Nigeria in 1952 and its commercial planting in 1982, and tea crop has been improved grace to the efforts and

research results of the Cocoa Research Institute of Nigeria [8].

Tea *Camellia Sinensis* (L) Kuntze is from the family of *Theaceae*. Tea plant encompasses some 200 woody plants species in the warmer regions of Asia and South America. Camellia genus has about eighty-two species and tea plant is the most important economically. There are also two main types, China and Assam teas. China teas are slow growing dwarf trees which has a good tolerance of cold weather and other tough conditions. On the other hand Assam teas are fast growing and adapted to warmer conditions [3].

There are two main ecological factors to be considered in the production of tea: climate and soil characteristics. Production of tea plant is restricted to subtropical regions and mountainous areas of the tropics, where altitudes are in the range of 1,200m to 1,800m above sea level with temperature regimes of 10^{o}C to 27^{o}C without frost. This is major reason why tea grows in few locations in West Africa [3]. For instance it grows only on the Mabilla Plateau in Taraba State in Nigeria because of the high altitude (coldness) in the region. The accepted optimum annual temperature is around 3,000mm while some tea-growing areas have 4,000mm and above. On the average 130-150mm is the best for optimal production. Tea requires a uniform mild temperature of between 18^{o}C- 20^{o}C. Sunshine is also very important to tea growth. An average of five hours of sunshine per day is required for optimal production [11].

Tea in its natural habitat develops to a small plant producing flower at six years or less or more based on type of variety and means of propagation. Total area of land under tea cultivation in the world is about 2,600,000 hectares with 86% in Asia, 85% in Africa and the remainder across South America, Russia and Oceania. China has approximately one million hectares compared with 400,000 in Indonesia and 85,000 hectares in Kenya. The highest producer of tea in the world is Asia(60%), followed by Africa(12%). The main producing countries are India (670,000 metric tonnes, China (500,000 metric tonnes), Sri Lanka (210,000 metric tonnes) and Kenya (150,000 metric tonnes).

The countries in Africa which are large tea producers are Kenya, Malawi, Burundi and Cameroon. Nigeria still produces tea in small quantities as compared to Kenya.

This study therefore examined the challenges to tea production and tea marketing in Taraba State of Nigeria. When these challenges are met tea production will be boosted and probably exported to improve the country's economy.

[6] carried out a study on the factors influencing tea marketing channel choice and sales intensity among smallholder farmers in Kenya. Information was obtained using questionnaires from smallholder tea farmers. one hundred and fifty five respondents were interviewed. The analytical techniques used were descriptive statistics and Heckman two stage model. In the study years of education, years of farming, age, gender, second payments had effect on the participation in marketing channel. The intensity of participation was significantly affected by tea production, age, farming years and second payment. This study therefore provided an insight to policy makers on the need to advance farmer-market linkages thus enhance farmers' incomes from their activities.

[1] examined processing of green tea in Nigeria. This study attempted to process green tea locally using Chinese method. Fresh tea leaves were plucked, fixed, rolled and dried under the sun. Physical and Chemical analysis were done using standardized methods. Investment Decision model comprising Net Present Value (NPV), Benefit-Cost Ratio (BCR) and internal Rate of Return (IRR) were used for economic analysis of green tea . In the study green tea produced conformed to international Organisation for Standardization (ISO) model for high-quality green tea. The scope of crude fibre (4.37-20%), water extracts (21.7-43.6%) moisture content was 4.11-7.00% and the caffeine in the range of 1.00 - 1.29%. The NPV, IRR, and BCR values were N13,928,856.02, 27.19% and 2.25% respectively. The authors recommended that diversification into green tea processing will create new opportunities for tea farmers who have depended on expensive black tea processing with less gains.

[5] examined the problems confronting sustainable tea production along the value chain in Nigeria. Eighty six tea farmers were selected. Structured questionnaires were used to collect information from tea farmers. Seventy one percent of the farmers conformed to standard two leaves + bud harvest at two-week harvesting interval. About fifty two percent of the farmers used herbicide while twelve percent of the farmers weeded manually. The authors reported that about 87.0% of the farmers used fertilizers of which seventy nine percent were organic-based. Seventy seven percent of the farmers implemented unsystematic chemical control. The authors recommended that treatment of old tea farms, standard practices and implementation of frequent soil testing should be done as a lead for fertilizer application for sustainable tea production.
In this context, the purpose of the paper is to examine the challenges to tea production and tea marketing in Taraba State of Nigeria.

MATERIALS AND METHODS

The study was carried out in Taraba state in Nigeria. It is a state in the North East geopolitical zone (Fig. 1).

Fig. 1. Map of Taraba State
Source: Nigeria Galleria maps, www.nigeriagalleria.com, Accessed on April 10th, 2021 [7].

Taraba State is known majorly as tea state because it is the only state where tea is produced in substantial quantity in the country (Oluyole *et al.*2017) [9].

Data Collection
Data was collected through the administration of well-structured questionnaire among tea producers and marketers (272). Proportion to size sampling technique was used.
In Taraba state, three communities were selected namely Mayo-Kusuku, Kakara and Kasalasah. Based on the population of tea farmers 90, 90, 92 were selected respectively from the communities. A total of two hundred and seventy two tea producers and marketers were interviewed in Taraba State.

$$\text{Proportion to size} = \frac{\text{No Re x T No Te Fa}}{\text{No In Re}}$$

where:
No Re = Number of Respondents
T No Te Fa = Total Number of Tea producers and marketers in the area
No In Re = Number of Interviewed Respondents.
The data have been processed using descriptive statistics such as frequency, percentages, the construction of simple frequency distribution, and the measure of central tendency such as mean.

RESULTS AND DISCUSSIONS

Table 1 presented the socio-economic characteristics of tea producers in Taraba State, Nigeria. Tea producers examined were from Mayo-Kusuku, Kakara and Kasalasah towns. Thirty six percent of tea producers were between 17-30 years old, 50% of the producers were between 31-60years while 15% were above 60years.
This revealed that one out of five of the tea producers are middle aged. Majority of the producers are male (92.7%) while 7.3% were female. Crop producers in Nigeria are majorly male dominated [2].
Twenty four percent of the producers have no formal education while seventy six percent have either primary, secondary or tertiary education. Education would help to play a key role in their producer business.

Sixteen percent were single and 0.7% were widowed. Majority of the producers are married (83%) and since they are mostly male.

Table 1. Socioeconomic characteristics of Tea Producers

Variable	Frequency	Percentage
Town/village		
Mayo-kusuku	70	25.7
Kakara	38	14.0
Kasalasah	164	60.3
Age (years)		
≤30	94	34.6
31-60	136	50.0
≥61	42	15.4
Mean age	40	
Sex of farmers		
Male	252	92.7
Female	20	7.3
Educational Status		
No formal education	66	24.2
Primary education	68	25.0
Secondary education	88	32.4
Tertiary education	50	18.4
Marital status		
Single	44	16.2
Married	226	83.1
Widowed	2	0.7
Occupation		
Farming	244	89.7
Trading	6	2.2
Technical	4	1.5
Craftmanship	18	6.6
Member of cooperative society		
Yes	224	82.4
No	48	17.7
Farm size(acres)		
1-12.5	192	70.6
≥ 12.6	80	29.4
Mean	12.2	
Age of the farm (years)		
1-10	50	18.4
11-20	84	30.9
21-30	64	23.5
31-40	64	23.5
41-50	10	3.7
Mean	24	
Nature of land ownership		
Inheritance	88	32.4
Self established	166	61.0
Purchased	18	6.6
N=272		

Source: Field survey, 2019.

Marriage could be a plus for men as they are not burdened with taking care of children and older family members.

As the head of the family their wives and children could support them in their business.

Ninety percent of the producers are farmers this means that majority of them sell what they plant. Other occupations that tea producers were involved in are trading, craftsmanship and technical.

Majority (82.4%) of the tea producers in Taraba State belong to a cooperative society. Being members of a cooperative society could help the producers in their business as they have access to information needed for their business. Seventy one percent of tea producers have a farm size of between 1and 12.5 acres. The mean farm size is 12.2 acres. Thirty one percent of tea producers have farmland aged 11-20years, forty seven percent have farmland aged 21-40 years. Having this aged farm could limit the production of tea in these farmlands.

Farmers need fertilizers to boost the nutrient of the soil.

Most of the farmland used are self established (61%).

Table 2 presented the challenges faced by tea producers and marketers in Taraba State. The challenges faced include poor soil fertility, low yield, pest infestation, labour shortage, lack of finance and lack of fertilizer/pesticide. Thirty five percent of tea producers and marketers in Taraba State reported that they faced the challenge of poor soil fertility.

Table 2. Challenges in Tea Production

Variable	Frequency	Percentage
Poor soil fertility	96	35.3
Low yield	54	19.9
Pest Infestation	42	15.4
Labour shortage	112	41.2
Lack of Finance	234	86.0
Lack of fertilizer/pesticide	228	83.8
N=272		

Source: Field survey, 2019.

Twenty percent faced the challenge of low yield, 15% reported pest infestation as a challenge. Also, 41.2% of tea producers and marketers in Taraba State faced the challenge of labour shortage meaning that on the average four out of 10 tea producers and marketers in Taraba State lack labour for their production. Eighty six percent lacked finance while 83.8% lacked fertilizer/pesticide. In Taraba State the two main challenges faced by tea producers and marketers are finance and fertilizer/pesticide.

The problems associated with marketing of Tea are as presented in Table 3.

Table 3. Problems Associated with marketing of Tea

Variable	Frequency	Percentage
Low market demand	150	55.1
Low price	44	16.2
Lack of access to market	150	55.1
High cost of transportation	50	18.4
N=272		

Source: Field survey, 2019.

The problems faced by tea marketers in Taraba State are low market demand, low price, lack of access to market and high cost of transportation. Fifty five percent of tea marketers faced the problem of low market demand. Sixteen percent faced the problem of low price, 55.1% faced the problem of lack of access to market while 18.4% faced the problem of high cost of transportation. The two problems that recorded the highest percentage are low market demand and lack of access to market. These two problems are huge and could discourage tea producers and marketers. When tea producers produce tea and consumers don't demand for what is produced, they are discouraged from producing. Also for tea marketers when they don't have access to market probably because the roads are bad and the markets are far from the farms. They may not want to buy tea from producers again thus producers may have tea but no one to buy from them.

CONCLUSIONS

In this study, thirty six percent of tea producers were between 17-30 years old, 50% of the producers were between 31-60years while 15% were above 60years. Majority of the producers are male (92.7%) while 7.3% were female.

Twenty four percent of the producers have no formal education while seventy six percent have either primary, secondary or tertiary education.

Seventy one percent of tea producers have a farm size of between 1 and 12.5 acres. The mean farm size is 12.2 acres. Thirty one percent of tea producers have farmland aged 11-20years, forty seven percent have farmland aged 21-40 years.

The challenges faced include poor soil fertility, low yield, pest infestation, labour shortage, lack of finance and lack of fertilizer/pesticide. I

n Taraba State the two main challenges faced by tea producers and marketers are finance and fertilizer/pesticide. The problems faced by tea marketers in Taraba State are low market demand, low price, lack of access to market and high cost of transportation. The two problems that recorded the highest percentage are lack of access to market and low market demand. Tea producers and marketers in Taraba State have great potential for development. Tea business can bring about economic development in Taraba State and Nigeria as a whole if government at various levels can put in place intervention programmes to overcome these challenges.

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ECONOMIC ANALYSIS OF TOMATO PRODUCTION IN GEOTHERMAL GREENHOUSES: A CASE STUDY OF AFYONKARAHISAR PROVINCE, TURKEY

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Abstract

The purpose of this study was to carry out an economic analysis for tomato production in geothermal greenhouses in Afyonkarahisar province which has a high potential with regards to geothermal greenhouse production. The primary material of the study consisted of original data collected by face-to-face questionnaires conducted with 20 producers carrying out their geothermal greenhouse production activities at Sandıklı district of Afyonkarahisar province. Results showed that the average greenhouse area of producers was 39.85 decare (da) and that the producers carried out their production activities in accordance with soilless (substrate culture) production. The total yield was calculated as 50.05 ton/da according to the average of all enterprises. The establishment cost per decare of geothermal greenhouses was 479 176.41 Turkish Lira (TL) and the majority of this expense consisted of greenhouse construction cost (73.80 %). Gross product value per decare was 170,415.81 TL according to the average of all enterprises. Whereas general gross profit, net profit, and relative return per decare were 102 424.62TL, 49,016.01 TL, and 1.40 respectively. It was found that large producers were more advantageous than smaller ones in terms of gross, net, and relative return criteria.

Key words: *geothermal greenhouse, tomato, cost, profitability*

INTRODUCTION

World population is increasing and with increasing income level there will be more need for food supplies. Thus, in order to sufficiently feed the world, food production should be increased. This will only be possible by industrialization coupled with advances in the agriculture sector. Nowadays, soil, weather, and water pollution and their continuous consumption result in a decline in agricultural production which in turn increases unhealthy and low quality food production. In addition, the increasing demand in world markets for food items makes it necessary to carry out production activities for export. Thus, it is necessary to take some measures for increasing and developing agricultural production. One of these measures is greenhouse production that ensures quality and continuous production possible [7]. Greenhouse production has rapidly increased in Turkey starting from the 1970s. Greenhouse production is more frequently observed in southern provinces where climate conditions are more suitable. The most important reason why greenhouse production cannot advance in other provinces is the fact that temperatures in the winter months are lower compared with southern provinces. The most important factor in greenhouse production is the establishment of the conditions that will provide the desired temperature. Heating is required when the desired temperature cannot be obtained due to climate conditions which leads to an increase in the costs involved [8]. Geothermal energy encompasses benefiting directly or indirectly from the hot water and vapor sources which can include substantial amounts of molten minerals, various salts and gases generated by the heat accumulated deep within the earth’s crust. Due to its heat content, geothermal energy is used in industry, lumbering, chemical substance production and electricity generation [4]. Geothermal sources comprise an important source of energy for greenhouse heating, fishing, and drying sectors in addition to the agriculture sector as well. The use of geothermal energy in various areas of

agricultural production enables the producer to provide the plant with the required temperature in addition to continuing production in all periods of the year excluding excessively hot periods. Thus, geothermal sources are of significant importance for agricultural production in addition to the benefits they provide to other areas of use [8].
Turkey's geothermal energy potential is around 31,500 MWt (megawatt heat). Turkey is ranked seven in the world with this potential and has the ability to meet 30 % of its thermal energy requirement. A total of 225 geothermal fields that are above 35–40 °C have been identified in Turkey [1].
The total geothermal greenhouse area in Turkey is 3908 da according to 2015 data. Izmir is ranked number one in terms of geothermal greenhouse area with a share of 20.97 % followed respectively by Manisa (19.34 %), Afyonkarahisar (17.01 %), Denizli (12.16 %), Şanlıurfa (10.82 %) and Kütahya (6.63 %) provinces. Of the total 3,908 da area on which geothermal greenhouse production takes place, "Good Agricultural Practices" are applied in 76 % and "Soilless Agriculture" in 90 % [2]. Afyonkarahisar province where the present study was conducted is ranked number 3 in Turkey in terms of geothermal greenhouse area. Soilless agriculture and good agricultural practices are implemented in all of these geothermal greenhouses examined for the study. The purpose of this study was to carry out an economic analysis for tomato production in the geothermal greenhouses located in Afyonkarahisar province which has a high potential with regards to geothermal greenhouse production in Turkey. General information such as family size, education level, age, experience, average enterprise size was collected for tomato producers according to different enterprise groups; whereas success criteria such as greenhouse establishment costs, production costs, gross product value, gross profit, net profit and relative return which were compared according to enterprise groups. The literature review showed that there has been insufficient studies analyzing geothermal greenhouse tomato production from an economic perspective. It is expected that the results obtained in the present study will be beneficial for policymakers, tomato producers, researchers, and related institutions and enterprises.

MATERIALS AND METHODS

The main material of the study consisted of original data obtained by face to face questionnaire applied to enterprises involved in tomato production activities at Sandıklı district of Afyonkarahisar province. Reports and statistics obtained from similar studies carried out by related individuals and institutions were also used. Questionnaire data included the 2019 production period. The total number and addresses of enterprises involved in geothermal greenhouses tomato production were obtained from Afyonkarahisar Provincial Directorate of Agriculture and Forestry. Records showed that 76.92 % of the total number of enterprises (26) and 68.87 % of the total geothermal greenhouse area in Afyonkarahisar province (1,157.27 da) were located in Sandıklı district. Thus, Sandıklı district was selected as the study area. All the enterprises in Sandıklı district were included in the study and questionnaires were conducted by face-to-face interviews with 20 enterprises [3]. Since the sizes of the areas owned by the enterprises differed, it was decided to classify them into different groups in order to ensure that the study population is homogeneous. Accordingly, enterprises were classified as group 1 (1-30 decares; 11 enterprises) and group 2 (>30 decares; 9 enterprises). The data obtained by questionnaire from enterprises were entered and calculated using Microsoft Excel and SPSS software. The questionnaire form included general information such as age, education, experience, family size, occupation outside of greenhousing, greenhouse area, age of greenhouse and production method along with questions on the economic activities of the enterprises such as the inputs used in the greenhouse and during production along with the expenses, yield and price. Of the total variable costs, 3 % was considered as general administration costs. Revolving fund interest is a variable cost that reflects the opportunity cost for the capital invested in the production activity. Revolving fund interest was calculated by applying half of the interest applied by Turkish Republic Ziraat Bank to greenhouse plant production credits (2.75 %) to the variable costs. Land rent was taken as 5 % of the bare land value. Greenhouse and machinery-equipment capital interest was calculated by applying 1.97 % real interest on total greenhouse and machinery-equipments' half-value [11]. Depreciation cost was found by multiplying greenhouse and machinery-equipments' value by 0.05 (5 %). Profitability indicators were calculated to report the level of success of geothermal greenhouse tomato production activities. Gross product value was calculated by multiplying the total tomatoes produced with the tomatoes sale prices. Gross profit was calculated by subtracting variable costs from gross product value, whereas, net profit was calculated by subtracting production costs from gross product value [12]. The relative return was calculated by dividing the gross product value by production cost [6].

RESULTS AND DISCUSSIONS

General information on tomato producers in geothermal greenhouses such as age, education, experience in geothermal greenhousing and family size are provided in Table 1. Average age of all producers was 49.7 years. The average age of the producers in the 1st group was lower than 2nd group. The average ages of the producers in groups 1 and 2 were 46.64 and 53.44 years, respectively, and differed from each other ($P<0.1$). The average education level of the producers was 14.2 years. When the two groups were compared in terms of average education level, producers in the 2nd group had higher education level than those in 1st group ($P<0.1$). The average education levels of producers in the 1st and 2nd groups were 13.91 and 14.56 years, respectively. The average experience of the producers in geothermal greenhousing was 4.35 years. The average experience of the producers in the 2nd group was longer than those in the 1st group. The average family size of the producers was 3.85 person. The family size of 1st group was larger than those in the 2nd group. The family sizes of the producers in the 1st and 2nd groups were 4 and 3.67 persons ($P>0.05$). The occupations of producers outside of greenhousing are provided in Table 2. As it can be observed from the table that only 10 % of the producers carry out only geothermal greenhousing. Whereas 90 % of the producers had other occupations outside of greenhousing. When the occupations of producers outside of greenhousing were examined it was found that 50 % of the occupations are not related with agriculture (doctor, pharmacist, civil engineer, self-employed, retired). Of the producers, only 10 % were graduates of Agricultural Faculty and 30 % were dealing with occupations outside of greenhousing. Geothermal greenhouse areas of the producers are provided in Table 3. The average geothermal greenhouse area of 1st and 2nd groups were 21.73, and 60 da, respectively. Whereas the average geothermal greenhouse area for all enterprises was 39.85 da. It was found that all the producers preferred plastic covers as greenhouse type and soilless agriculture as production method. When the ages of the greenhouses were examined, it was found that the greenhouses of the producers in the 1st group were newer than those in the 2nd group. The mean age of the greenhouses in the 1st and 2nd groups were 3.27 and 5.67 years, respectively ($P<0.05$). Average greenhouse age was 4.35 years for all producers.

Table 1. General information about producers

Features	Enterprise groups (da)		General	P value
	1. Group	2. Group		
Age (year)	46.64	53.44	49.70	0.076^{***}
Education level (year)	13.91	14.56	14.20	0.075^{***}
Experience in geothermal greenhousing (year)	3.27	5.67	4.35	0.142
Family size (person)	4.00	3.67	3.85	0.973

***: p<0.10
Source: Authors' calculation.

Table 2. Producers' occupation outside of greenhousing

Occupations	Enterprise groups (da)				General	
	1. Group		2. Group			
	N	(%)	N	(%)	N	(%)
No occupation	1	9.09	1	11.11	2	10.00
Farmer	4	36.36	2	22.22	6	30.00
Doctor	1	9.09	2	22.22	3	15.00
Self-employment	2	18.18	2	22.22	4	20.00
Construction engineer	1	9.09	0	0.00	1	5.00
Pharmacist	1	9.09	0	0.00	1	5.00
Retired	1	9.09	0	0.00	1	5.00
Agricultural engineer	0	0.00	2	22.22	2	10.00
Total	11	100.00	9	100.00	20	100.00

Source: Authors' calculation.

Table 3. Geothermal greenhouse area of producers

	Enterprise groups (da)		General	P value
	1. Group	2. Group		
Greenhouse type				
Plastic (da/farm)	21.73	62.00	39.85	0.037**
Production method				
Soilless agriculture (da/farm)	21.73	62.00	39.85	0.037**
Age of greenhouse (year)	3.27	5.67	4.35	0.142

**: $p<0.05$
Source: Authors' calculation.

Table 4. Geothermal greenhouse establishment cost (TL/da)

	Enterprise groups (da)				General		P value
	1. Group		2. Group				
	TL	%	TL	%	TL	%	
Greenhouse construction cost	360,831.64	73.24	344,850.96	74.54	353,640.33	73.80	0.195
Heating system cost	31,827.07	6.46	31,838.11	6.88	31,832.04	6.64	0.354
Fee paid to municipality	37,363.64	7.58	31,888.89	6.89	34,900.00	7.28	0.479
Greenhouse automation cost	62,668.80	12.72	54,080.44	11.69	58,804.04	12.27	0.253
Total greenhouse establishment cost	492,691.14	100.00	462,658.40	100.00	479,176.41	100.00	0.295

TL: Turkish Lira; 1 USD= 5.67 TL
Source: Authors' calculation.

Geothermal greenhouse establishment costs are provided in Table 4. The total average greenhouse establishment cost was 479,176.41 Turkish Lira (TL) per decare (da). Of this value, 73.80 % consisted of greenhouse construction cost, 12.27 % consisted of greenhouse automation cost, 7.28 % consisted of the fees paid to the municipality for geothermal connections and 6.64 % consisted of the heating system cost. Total greenhouse establishment costs for the 1st group were higher than those in the 2nd group. Total greenhouse establishment cost for the 1st group was 492,691.14 TL per decare, and the breakdown of this cost was as such: 73.24 % for greenhouse construction, 12.72 % for greenhouse automation, 7.58 % for fees paid to the municipality and 6.46 % for the heating system. Whereas the total greenhouse establishment cost for 2nd group was 462,658.40 TL per decare with 74.54 %, 11.69 %, 6.89 % and 6.88 % corresponding to greenhouse construction cost, greenhouse automation cost, fees paid to the municipality for geothermal connections and heating system respectively. A study conducted by Serpen et al. (2008) [13] indicated that the establishment cost for a geothermal greenhouse was 5 million $/ha. Since the exchange rate for dollar was 1.15 TL on average in 2008, the establishment cost per 1 decare of greenhouse was 434,782.61 TL.

Cost items related with geothermal greenhouse tomato production activity were analyzed by classifying into groups of fixed and variable costs. Variable costs are the costs that either decrease or increase according to production volume. These costs emerge in times of production and vary with production amount. Whereas fixed costs are those that do not change with production volume or in other words those that are present regardless of whether production is made or not [9]. Production costs per decare in tomato production are given in Table 5. As can be seen in the table, variable costs include seedling, pesticide, fertilizer, bumble bee, insurance, cocopeat, greenhouse heating, water analysis, machinery-equipment repair and maintenance, packaging, transport, electricity, meal, rope, and revolving fund interest. Whereas fixed costs consist of administrative costs, permanent labor, machinery-equipment depreciation, machinery-equipment capital interest, land rent, greenhouse depreciation, and greenhouse capital interest. Variable costs comprised the majority of the costs. The proportion of variable costs in total production costs was 55.19 % and 57.27 % for 1st and 2nd group respectively. The average proportion of variable and fixed costs were 56.01 % and 43.99 %. The proportion of packaging costs in total production costs was 21.57 %. Other important cost items were fertilizer (7.57 %), transport (5.89 %), seedling (4.88 %), cocopeat (4.28%) and greenhouse heating (3.74 %). Greenhouse capital depreciation (19.74 %) and permanent labor cost (16.25 %) had the highest proportion in fixed costs. A significant difference was observed between the groups with regard to water analysis, transport and land rent costs ($p<0.05$).

Table 5. Production costs in greenhouse enterprises

	Enterprise groups (da)				General		P value
	1. Group		2. Group				
Cost elements	TL/da	(%)	TL/da	(%)	TL/da	(%)	
Seedling	5,989.09	4.45	5,847.67	5.56	5,925.45	4.88	0.356
Pesticide	3,010.78	2.23	2,633.64	2.50	2,841.07	2.34	0.643
Fertilizer	9,693.33	7.20	8,561.81	8.14	9,184.15	7.57	0.446
Bumble bee	36.06	0.03	35.97	0.03	36.02	0.03	0.440
Insurance	762.27	0.57	560.38	0.53	671.42	0.55	0.963
Cocopeat	5,158.18	3.83	5,251.11	4.99	5,200.00	4.28	0.191
Greenhouse heating	6,145.21	4.56	2,566.32	2.44	4,534.71	3.74	0.152
Water analysis	47.96	0.04	17.62	0.02	34.31	0.03	0.029**
Machinery- equipment repair and maintenance	3,373.80	2.50	2,533.93	2.41	2,995.86	2.47	0.423
Packaging	28,546.05	21.19	23,312.43	22.17	26,190.92	21.57	0.193
Transport	8,033.36	5.96	6,063.17	5.77	7,146.78	5.89	0.040**
Electricity	507.40	0.38	415.95	0.40	466.24	0.38	0.528
Meal	515.88	0.38	398.44	0.38	463.03	0.38	0.321
Rope	550.18	0.41	397.62	0.38	481.53	0.40	0.500
Revolving fund interest	1,990.16	1.48	1,611.39	1.53	1,819.72	1.50	0.602
A. Total variable costs	74,359.72	55.19	60,207.45	57.27	67,991.20	56.01	0.602
Administrative costs	2,230.79	1.66	1,806.22	1.72	2,039.74	1.68	0.602
Permanent labour	25,648.85	19.04	12,478.09	11.87	19,722.01	16.25	0.697
Machinery-equipment depreciation	1,059.15	0.79	953.06	0.91	1,011.41	0.83	0.129
Machinery-equipment capital interest	208.65	0.15	208.38	0.20	199.25	0.16	0.129
Land rent	1,727.27	1.28	1,794.44	1.71	1,757.50	1.45	0.029**
Greenhouse depreciation	24,634.56	18.29	23,132.92	22.00	23,958.82	19.74	0.295
Greenhouse capital interest	4,853.01	3.60	4,557.19	4.33	4,719.89	3.89	0.295
B. Total fixed costs	60,362.28	44.81	44,930.30	42.73	53,408.61	43.99	0.396
C. Total production costs (A+B)	134,722.00	100.00	105,137.74	100.00	121,399.81	100.00	0.784

**: $p<0.05$
Source: Authors' calculation.

Table 6. Tomato yield and prices by months in greenhouse enterprises

Months	Enterprise groups (da)				General	
	1. Group		2. Group			
	Yield (ton/da)	Price (TL/kg)	Yield (ton/da)	Price (TL/kg)	Yield (ton/da)	Price (TL/kg)
March	1.00	6.13	1.11	6.29	1.05	6.20
April	3.27	6.22	3.44	6.37	3.35	6.29
May	4.64	3.12	4.44	3.23	4.55	3.17
June	6.55	2.15	6.78	2.23	6.65	2.19
July	8.09	3.03	8.33	3.07	8.20	3.05
August	8.18	2.09	8.78	2.26	8.45	2.17
September	6.00	2.65	6.22	2.92	6.10	2.78
October	4.91	4.17	5.22	4.41	5.05	4.28
November	3.73	3.28	4.00	3.42	3.85	3.34
December	2.73	3.07	2.89	3.16	2.80	3.11
Total	49.09	3.59	51.22	3.74	50.05	3.66

Source: Authors' calculation.

Tomato yield and prices by months in greenhouse enterprises are given in Table 6. As it can be seen from the table that the average tomato yield of 2nd group was higher than that of 1st group. Average tomato yield was 49.09, 51.22 and 50.05 tons/da for 1st group, 2nd group and all enterprises average respectively. When average tomato yields by months were examined, it was observed that yield increased continuously during March-August but decreased after August which continued until December. While tomato yield per decare was 1.05 tons in March, it increased by about 8 fold reaching 8.45 tons in August. Tomato yield decreased by about 3 folds during August-December from 8.45 tons to 2.80 tons. It was found that tomato yield was highest in August and lowest in March. When tomato prices were examined, it was found that the producers in the 2nd group sold tomatoes at a slightly higher price. Average tomato prices for 1st group, 2nd group and general enterprises were 3.59, 3.74 and 3.66 TL/kg, respectively. A fluctuation was observed in tomato prices by months. Highest tomato prices were observed in March and April. The prices in these months were 6.20 and 6.29 TL/kg respectively. Whereas the prices in other months generally varied between 2-4 TL/kg. In a study conducted on the geothermal greenhouses in Afyonkarahisar province, Kervankıran (2011) [10] found that tomato yield per decare varied between 60-70 tons in soilless production method. Sipahioğlu (2014) [14] found that tomato yields for conventional and soilless agriculture systems were 19. 8 and 31 tons/da respectively.

The gross product value of a production activity is the sum of the values based on market prices for the products obtained as a result of the agricultural activity and the annual productive inventory stock increases that emerge as a result of the aforementioned production activities [12]. Gross product value in greenhouse enterprises per decare for enterprise size groups is provided in Table 7. As it can be seen from the figure, gross product value is comprised of tomato product value and agricultural supports. It was found that the gross product value in enterprises increased parallel to enterprise size. Gross product value per decare for 1st and 2nd group enterprises was 165,072.76 TL and 177,146.16 TL respectively. Gross product value per decare for general average was 170,415.81 TL. Tomato product value comprised majority of the gross product value (93.84 %). It was observed that the producers received good agricultural practices, bumble bee use and biological control supports. In addition, it was also found that the producers received support from Turkish Employment Agency (İŞKUR) because they were employing female workers. The proportion of agricultural supports in total gross product value was 6.16 %.

Gross profit, net profit and relative return values per decare according to enterprise size groups are given in Table 8. Gross profit is an important success criteria for identifying the competitive powers of the production activities with regard to the use of the current scarce production factors in the enterprise. In other words, gross profit is an important criteria indicating the success of the enterprise organization [6]. It was found that gross profit increased with increase in enterprise size and that the gross profit per decare was greater in 2nd group than 1st group. Gross profits per decare were 90,713.04 and 116,938.72TL for 1st and 2nd group, respectively. It was shown that net profit per decare also increased with increase in enterprise size. Net profit per decare was 30,350.76 and 72,008.42 TL for 1st and 2nd group, respectively. Relative return values for the enterprise groups were 1.23 and 1.68 respectively. Relative return should be greater than 1 for an enterprise to be considered profitable. Both groups of enterprises were profitable based on obtained results. Profitability increased with increasing enterprise size. It can be stated that the 2nd group was more advantageous than the 1st group with regard to profitability indicators. In a study conducted on soilless agriculture tomato production in geothermal greenhouses, Eren (2017) [5] found that relative return was 1.70. Sipahioğlu (2014) [14] found out that relative return for soilless agriculture tomato production was 1.18.

The profit margin per kg and ratio of profit margin to sales price of tomato in enterprises are given in Table 9. It was found that profit margin increased with increase in enterprise size and that the profit margin per kg was greater in 2nd group than 1st group. Profit margin per kg were 0.85 and 1.69 TL for 1st and 2nd group, respectively. The ratio of profit margin to sales price (profit margin/sales price*100) criterion was calculated to determine how much of the sales price of tomato was cost and profit. The ratio of profit margin to sales price were 23.68 and 45.19% for 1st and 2nd group, respectively. Accordingly, it can be said that 23.68% of each one kg of tomato sold was profit in 1st group and 45.19% of each one kg of tomato sold was profit in 2nd group.

Table 7. Gross product value in greenhouse enterprises

Income elements	Enterprise groups (da)				General		P value
	1. Group		2. Group				
	TL/da	(%)	TL/da	(%)	TL/da	(%)	
Tomato product value	153,645.87	93.08	167,783.95	94.71	159,924.85	93.84	0.860
Agricultural Supports	11,426.90	6.92	9,362.21	5.29	10,490.96	6.16	0.141
Good agricultural practices	9,435.58	5.72	7,978.45	4.50	8,779.87	5.15	0.239
Biological control	659.36	0.40	466.25	0.26	572.46	0.34	0.324
Bumble bee use	362.11	0.22	339.35	0.19	345.04	0.20	0.764
Women labour support	969.85	0.59	578.16	0.33	793.59	0.47	0.594
Total gross product value	165,072.76	100.00	177,146.16	100.00	170,415.81	100.00	0.925

Source: Authors' calculation.

Table 8. Gross profit, net profit and relative return in greenhouse enterprises

Profitability indicators	Enterprise groups (da)		General	P value
	1. Group	2. Group		
Tomato product value (TL/da)	153,645.87	167,783.95	159,924.85	0.860
Agricultural support (TL/da)	11,426.90	9,362.21	10,490.96	0.141
Gross product value (TL/da)	165,072.76	177,146.16	170,415.81	0.925
Variable costs (TL/da)	74,359.72	60,207.45	67,991.20	0.602
Production cost (TL/da)	134,722.00	105,137.74	121,399.81	0.784
Gross profit (TL/da)	90,713.04	116,938.72	102,424.62	0.830
Net profit (TL/da)	30,350.76	72,008.42	49,016.01	0.711
Relative return	1.23	1.68	1.40	0.106

Source: Authors' calculation.

Table 9. The profit margin per kg and ratio of profit margin to sales price of tomato in enterprises

	Enterprise groups (da)			
	1. Group	2. Group	General	P value
Tomato production cost (TL/da)	134,722.00	105,137.74	121,399.81	0.784
Tomato yield (ton/da)	49.09	51.22	50.05	0.261
Tomato production cost per kg (TL/kg)	2.74	2.05	2.43	0.658
Tomato sale price per kg (TL/kg)	3.59	3.74	3.66	0.268
Profit margin per kg (TL/kg)	0.85	1.69	1.23	0.857
The ratio of profit margin to the sales price (%)	23.68	45.19	33.60	0.542

Source: Authors' calculation.

CONCLUSIONS

It was found that the average greenhouse area was 39.85 decare and that the average greenhouse age was 4.35 year that the producers carried out production activities according to both soilless agriculture and good agriculture practices. Average total greenhouse establishment cost per decare was 479,176.41 TL. Of this total greenhouse establishment cost, 73.80 % was greenhouse construction cost, 12.27 % greenhouse automation cost, 7.28 % fee paid to municipality for geothermal connections and 6.64 % as heating system cost. Total production costs per decare for all enterprises average was 121,399.81 TL with the proportion of variable and fixed costs in production costs being 56.01 % and 43.99 % respectively. It was observed that tomato yield increased continuously during March-August but decreased after August and that the decrease continued until December. It was found that the highest tomato yield took place in August whereas the lowest was in March. A fluctuation was observed in monthly tomato prices. Highest tomato prices were observed in March and April. Gross product value per decare for the average of all enterprises was 170,415.81 TL. A major portion of the gross product value was comprised of tomato product value (%93.84). The proportion of agricultural supports in total gross product value was 6.16%. It was observed that the producers in the 2nd group were more advantageous than those in the 1st group in terms of gross profit, net profit and relative return. Average gross profit, net profit and relative return per decare for all enterprises were 102,424.62 TL, 49,016.01 TL and 1.40, respectively.

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MICROGREENS - CURRENT STATUS, GLOBAL MARKET TRENDS AND FORWARD STATEMENTS

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Abstract

The recent statistical data and market studies have shown that the microgreens market is on a continuously upward trend in Europe and globally due to their healthier and nutritious qualities and for fast adoption of indoor and vertical farming especially in the cities. Worldwide the microgreens become of great interest due to their benefits for people`s health and beauty, being 40 times more nutritious than mature vegetables, increasing also the amount of available space that might be put into food production, with environmental benefits and economic profitability. The evolution of microgreens market to its real development potential depends of consumers behaviour and income level. Microgreens are considered 'desert food' by their huge potential to provide food in marginal areas affected by climate change becoming a part of sustainable farming. The present study pursued the evaluation of microgreens global market trends and forward statements in order to identify them as a potential profitable business in the era of Covid 19 pandemic when farmers should adapt food production to the new economic and social contexts. The study showed an increased consumer interest for "healthy" products, so that the change according to their behaviour shall generate an increase in the microgreens market worldwide.

Key words: *market, microgreens, statement, status, trend*

INTRODUCTION

During the last decade the agricultural market trends have been changed significantly due to the new cropping technologies adapted to people demand for food diversification and supply, population income, technical and genetically progress, impact of biotic and abiotic constrainers, machinery revolution, faster access to the information, cities development, social and economic context and climate changes that impact agricultural products and people movement from one region to another [2][3][4][5][6][7][8][9][10][11][12][13][14][15][16][17][26][27][28][30][31][32][33][36][37][39][42][43][44].

With over 10 billion people by 2050 feeding the world`s population will be one of the greatest challenges for both scientists and farmers.

In the light of recent Covid 19 pandemic, the agricultural systems had to face the challenge of food insecurity in many parts of the world. Further, it was a higher demand for ultra-processed food and fresh greens offered by Urban Agriculture (UA). Thus, Urban Agriculture (UA) become recently much more attractive being identified as an important tool in sustaining local food security, creating jobs and income in urban areas [18][25][35][38][40].

A recent report showed that in 2050 is estimated that 80% of the world`s food will be consumed in cities, therefor one current trend is to bring especially fresh food production closer to them [29].

An important part of Urban Agriculture is given by the microgreens production. They are known as green, young leafy vegetables which are harvested at their first stage of growth in a large variety of colours, textures and flavours, becoming a novel culinary ingredient used in salads and to enhance other types of dishes. The most common varieties of microgreens include Amaranth, Mustard, Parsley, Radish, Cabbage, Celery, Chard, Chervil, Cilantro, Cress, Fennel, Kale, Arugula, Beets, Basil, and Sorrel. Cereals such as rice, oats, wheat, corn and barley, as well as legumes like chickpeas, beans and lentils are also sometimes grown into micro greens.
Microgreens are rich in vitamins, minerals (Ca, Mg, Fe, Mn, Zn, Se and Mo) phytonutrients (ascorbic acid, β-carotene, α-tocopherol and phylloquinone) and antioxidants playing an increasing role in health promoting diets, being considered a good source of nutritious and bioactive compounds which prevent malnutrition and chronic disease [1][20][41][45][46][54][55].
The values of phytonutrients in microgreens were found to be up to 40 times more than those reported in mature vegetables leaves [55]. Thus, nutrients present in microgreens stimulate immune system, appetite, prevent muscular degeneration, diabetes, Alzheimer's disease, decrease risk of heart attack, are effective for eyes and skin and improve the overall hormonal balance of the body [21][22][50][53][56].
Microgreens can be produced easily, quickly and with low costs due to simple requirements and a rapid growing from 7 to 21 days [23].
Lately there is a huge and widespread awareness among the consumers to consume microgreens [19]. Thus, microgreens vegetable category has been registering significant growth in the last few years coming up under niche segment.
Considering the aspects above mentioned, the paper aimed to analyse the current status of microgreens consumption, as well as the global market trends and forward statements of this multi-benefits immature fresh vegetables, in order to identify microgreens as a potential profitable business in the era of Covid 19 pandemic when farmers should adapt food production to the new economic and social contexts.

MATERIALS AND METHODS

The research of the current study is based on a substantial documentation in the field in order to sustain a qualitative informative approach. There were collected various information from text books, scientific articles, news articles, reports and websites.
The relevant literature on the topic was identified and synthetized to provide an integrated overview of the current state-of-knowledge and forward statements on the article topic [51].
To reach the purpose of this paper there were used systematic, semi-systematic and integrative research approaches using an analytic comparation of current literature, papers, studies, reports and statistics in order to offer significant insights based on the article topic and to identify knowledge gaps within literature [47][48]. Text mining method, which is a popular text analytical technique, was used to extract relationships and knowledge from a large number of textual documents.
The literature, papers, studies and reports used in this review are organized into the following sections.

RESULTS AND DISCUSSIONS

The idea of microgreens started in San Francisco, California in the late `80 and they become popular first in to the finest restaurants and upscales grocery stores [52].
Nowadays the interest of people in fresh and nutraceutical foods has been on the rise due to the higher interest for healthy life and beauty [23].
The global microgreens market is expected to grow annually with 7.6%, reaching US$ 17,039.744 million in 2025 [23].
The microgreen market is segmentate by dominant vegetable type (broccoli, lettuce and chicory, arugula, basil, fennel, carrots, sunflower, radish, peas, others), by farming (indoor farming, commercial greenhouses,

vertical farming, others), by growth medium (soil, tissue paper, coconut coir, peat moss and other growth mediums), by end-use (food and beverages, cosmetics, others), by distribution channels (restaurants, hypermarkets /supermarkets, others), by geography (North America, Europe, Asia-Pacific, South America, and Middle-East and Africa).

Broccoli appears to play an important role in the development of microgreens market due to its extensive healthier and nutritious qualities.

According to the Food and Agriculture Organization, in 2017 China and India accounted for 73% of the global production of broccoli, with around 10.4 million metric tonnes, respectively 8.6 million metric tonnes. USA, Spain, Mexico, and Italy hold, each one, around 1 million metric tonnes or less in 2017 [18].

The low requirements for water, soil and inputs, as well as short growing period, recommend microgreens as having great potential for business utilized as a fresh source of nutrients in large geographic areas, even affected by drought, climatic events, soil degradation or other production limiting factors.

The evolution of microgreens market is driven especially by chefs for more colorful dishes and in cosmetic industry where are processed into oils and ingredients used in shampoo and skin care products. Thus, the market of microgreens is anticipated to grow in the next years, especially with adoption of indoor farming practices.

According with Agrilyst, an intelligence platform, the most profitable indoor farming system is deep water culture, followed by greenhouse farming system.

Among the most common grown crops indoors, microgreens recorded 60% profitability due to high revenue [49] (Fig. 1).

Also, in 2017 microgreens and leafy greens had the highest profit margin (40%) among profitable crops in indoor farming system (Fig. 2.)

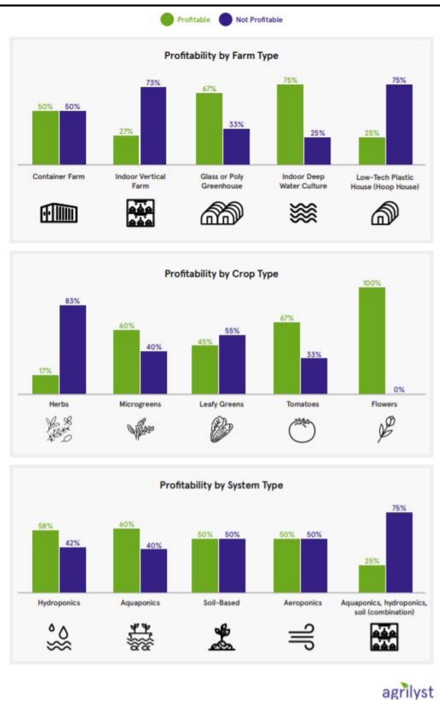

Fig. 1. Farm profitability by farm type, crop type, system type
Source: https://www.cropscience.bayer.com/sites/cropscience/files/inline-files/stateofindoorfarming-report-2017.pdf, [49].

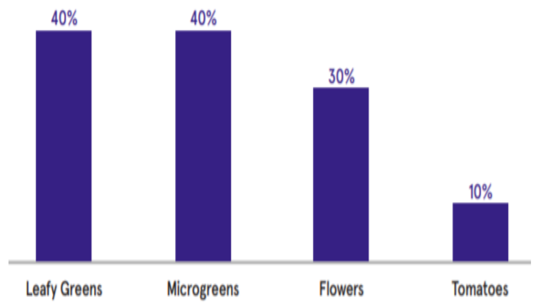

Fig. 2. Profit margin among profitable crops in indoor farming system
Source: https://www.cropscience.bayer.com/sites/cropscience/files/inline-files/stateofindoorfarming-report-2017.pdf, [49].

Also, in 2017 the microgreens have extended with 26% in large farms and 10% in small farms following an ascendent trend and being expected to increase with 6% annually in the next future [49](Fig. 3).

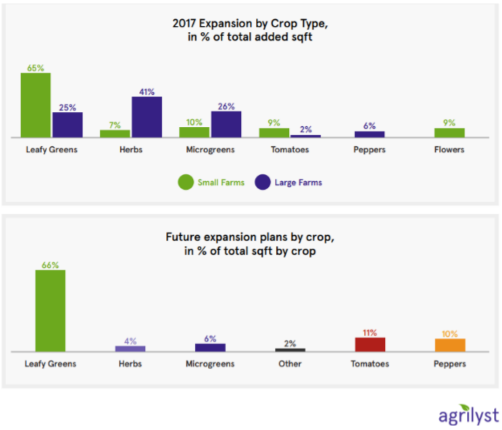

Fig. 3. Expansion of indoor farming by crop type
Source:
https://www.cropscience.bayer.com/sites/cropscience/files/inline-files/stateofindoorfarming-report-2017.pdf, [49].

The higher cultivation of microgreens in greenhouses was in the South and North of United States regions, recording 71% and, respectively 59% profitability, in 2020 [34] (Fig. 4).

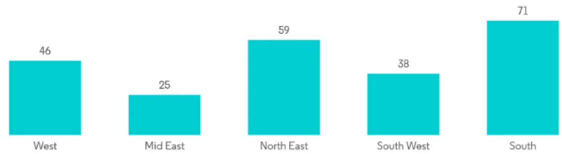

Fig. 4. Microgreens Market: % of microgreen cultivation in total greenhouse cultivation, United States, 2020
Source: Mordor Intelligence Platform, 2020 [34].

Moreover, hydroponic farming, indoor and vertical farming practices appear to enhance farmers to produce microgreens on large scale. The highest microgreens market was in 2020 in United States, Canada, Asia and Australia driven by the increased demand from chefs and cosmetic industry and tends to become more and more competitive market globally (Fig. 5).

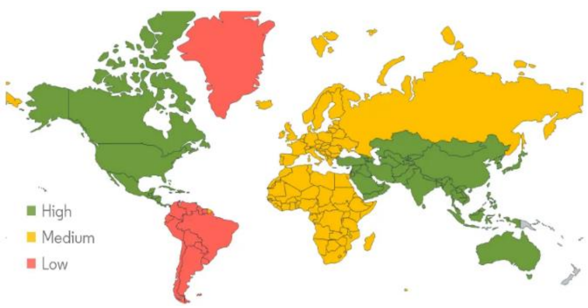

Fig. 5. Microgreens Market: Market size, by region, 2020
Source: Mordor Intelligence Platform, 2020 [34].

According with Knowledge Sourcing Intelligence Platform, in November 2020, Urban Oasis, a Swedish Vertical farming company raised USD 1.2 million to build a new facility completely automated which will surge the production by 15 to 20 times. This Mega Farm will become a huge competitor specialized in growth and cultivation of microgreens such as kale and Bok Choi. In September 2020 it was designed a smart garden, known as 'Solace' to cultivate and grow food in compact and small spaces [23].

CONCLUSIONS

The climate and social emergency, such as Covid 19 pandemic, are forcing us to rethink the ways that we produce food fortified with bioactive components that promote health and sustain immune system. Urban Agriculture (UA) comes as a driver for this new look approach, particularly in towns and cities. The microgreens production seems to reintegrate nature into the city, strengthen urban food production system, renew urban development, expand food security and change people`s buying and consuming habits and empower independence in homes. Also, microgreens provide adequate nutrition for the consumers demand while minimizing the negative impact on the environment. While the consumers are becoming more interested in healthier life style and beauty, microgreens could make future of farming more accessible and secure, with environmental benefits. As long as farmers are looking to avoid climate change impact on crops and to leave less carbon footprint, microgreens production will continue to grow worldwide.

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RESEARCH INFRASTRUCTURES IN THE GLOBAL SPOTLIGHT- CHALLENGES AND OPPORTUNITIES FOR AGRICULTURE, BIOECONOMY AND RURAL DEVELOPMENT

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Abstract

Research infrastructures are considered the pathway towards a prosperous economy and societal well-being in a long-term perspective. Based on these grounds, the European Commission emphasizes the role and importance of setting-up research infrastructures, at both European and International level, by promoting scientific excellence and frontier research. In this context, the purpose of this article is to present the framework and features of such research infrastructures. The document conveys the full involvement and commitment from the European Commission, in both financially and strategic terms, to build specific research infrastructures with the aim of addressing the big challenges that modern society faces in a fast-changing environment. Nevertheless, in spite of all efforts made, the financial sustainability still remains the main issue to which the decision-makers have to come up with solutions and ways of making these infrastructures everlasting in order to fulfil their mission, to achieve great objectives and priceless results for the benefit of the whole society.

Key words: *Research Infrastructure, ESFRI, Roadmap, research & innovation, agriculture*

INTRODUCTION

The European Commission (EC) stresses that ‘research and innovation’ is the primary driver of the European economic growth and global prosperity, as well.
Knowledge and technology development contribute to the overall progress of the world economy and society. This is the reason for which the EC puts an emphasis on creating large and complex research infrastructures (RIs) that attract world-class researchers [14] and cutting-edge technologies so as to boost innovative discoveries in strategic areas (energy, environment, health & food, physical sciences & engineering, social & cultural innovation, digitalization). To this end, the EC set up European Strategy Forum on Research Infrastructures (ESFRI) a forum designed to prepare the policies on European Union (EU) research infrastructures [13] and to facilitate multilateral agreements and to offer guidance and financial support to those pursuing the creation of such infrastructures [5].
To tackle the global challenges such as scarce resources, demographic change, human health, food security and so on, it is necessary to embrace a more collaborative, interdisciplinary approach, pooling equipment, researchers and money [1] to co-create added-value. Only in this way, research organizations can co-create new knowledge, technology, products and services that will bring long-term multiple benefits for the whole society.
Agriculture, bioeconomy and biotechnology play a major role in several RIs which address great challenges in energy, environment and health & food areas.
The whole environment and its negative changes have a strong impact on population health, food production and food security, demographic change, sustainable agriculture and forestry, bioeconomy and so on.

World food demand is expected to grow exponentially reaching 100% by 2050, opposite to crop yield (e.g., wheat, maize and soybean) and livestock production which face a significant decrease due to extreme climate changes. Consequently, substantial improvements and action measures should be taken urgently to secure food production by increasing both crop yield and livestock production. To this end, one option is to foster the usage of precision agriculture which is considered to be the future of farming in Europe [4]. By doing so, we not only increase food supply, but we also ensure the rural development in the long run.

All in all, Health & Food RIs along with Environmental RIs and Energy RIs are critical to tackle the challenges associated with agriculture, bioenergy, food and non-food systems.

MATERIALS AND METHODS

For analysing the context and necessity of setting-up ESFRI research infrastructures, a range of data and information was collected and processed from reliable sources, such as relevant, official webpages, press releases, documents and reports published mainly by EC and ESFRI.

Various tables, charts and diagrams were created for a visual representation of the results of the RIs analysis.

The financial data related to the structure, typology, level of maturity and costs of RIs are based on the provisions of ESFRI Roadmaps [4] and the Romanian Roadmap of Research Infrastructures [16].

The European Map indicating the countries which elaborated national roadmaps was prepared according to the official data posted by ESFRI on https://www.esfri.eu/national-roadmaps [2].

RESULTS AND DISCUSSIONS

Brief history of the EC policy on research

Since the ‘50s, ‘research and innovation’ has been put in the spotlight of the European community and opened the path towards research programmes.

In 1984, the first Framework Programme for research was launched and in 1986, ‘research’ has officially become a community policy aiming to strengthen the scientific and technological basis of the European industry and to encourage development of its competitiveness at international level.

Later on, in 2000, the EU created the European Research Area to support the free circulation of research technology and scientific knowledge. Subsequently, the EU showed ongoing support and full commitment for R&I allocating significant funds, higher from one programme to the following one in the pursuit of achieving its strategic objectives and raising awareness among national governments and private sector that this is the only way to a better society, translated into an efficient resources utilization, environmental protection, poverty and social exclusion combat, etc. [8]. As such, for the new programming period 2021-2027, the EC allocated a budget of 100 billion euros for Horizon Europe (HE) which will be distributed through three main pillars (Fig.1), as follows:

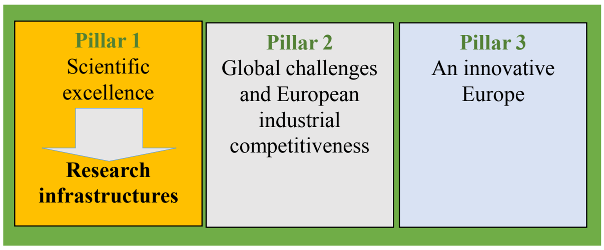

Fig. 1. The three pillars of HE

Source: European Commission, Horizon Europe - The next EU research & innovation investment programme (2021 – 2027) [9].

2.4 billion euros are dedicated to sustain integrated and interconnected RIs [9], as they incur substantial funds due to their mission and complexity.

Scope of RIs

According to the EC, two thirds of EU economic growth come from research and innovation, accounting for 15% of labor productivity growth in Europe over the period 2000-2013 [7].

Therefore, RIs play an essential role in promoting a higher cohesion in Europe by facilitating the excellence science [11]. Their scope is to find the best solutions to the global societal, environmental and economic challenges (e.g., sustainable development) that modern society faces. Their contribution is of utmost importance to the world prosperity, by offering new technologies, sustainable solutions and disruptive innovations.

A proper distribution of RIs will contribute to reducing the "excellence gap" caused by the different capacities of research organisations in various countries [6]. Investments in RIs will lead to increasing regional competitiveness and hence, will trigger the regional development on the long term.

Moreover, RIs offer to researchers the facilities and instruments needed to perform the research activities at the highest level in order to achieve the highest goals, to generate new knowledge and technology.

Typology of RIs

The EC defines research infrastructures as "facilities, resources and services" which are used by the scientific community to perform cutting-edge research activities and enhance innovation in their areas of intervention. RIs entail major research equipment or instruments, important databases used by high qualified researchers for attaining scientific excellence in research and innovation. Such infrastructures are classified into 'single-sited', 'virtual' or 'distributed'" [12].

Single-site RIs represent research facilities that are geographically located in a single location or in several complementary sites having European or international governance (e.g., FAIR, EST, ILL). This allows the research community to use resources and services which are located in a single site/complementary sites, even if its governance may include several countries [3].

Distributed RIs (Fig.2) represent research facilities that are geographically dispersed. They consist of a Central Hub and an interconnected network of National Nodes, the facilities being located in different locations (e.g., ACTRIS, DANUBIUS-RI, ELI) [10].

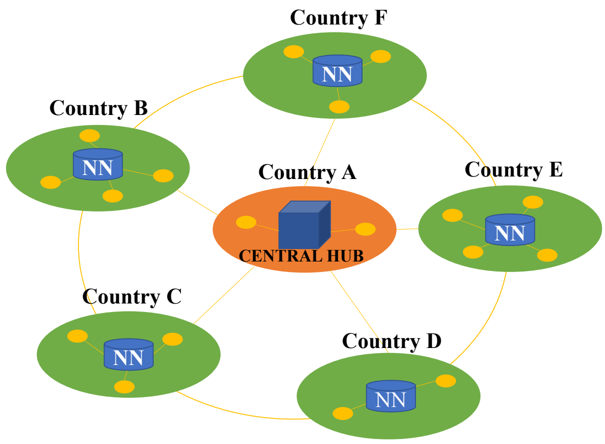

Fig. 2. Distributed RIs
Source: European Commission - Supporting the Transformative Impact of Research Infrastructures on European Research [10].

Virtual/ electronic RIs represent research facilities consisting in electronic infrastructure, providing electronic services, networks, archives and databases (e.g. PRACE) [6].

As it can be seen in Fig.3, in addition to the definition given by the EC, MERIL platform includes a fourth type of RIs, namely **mobile RIs,** referring to vehicles specifically designed for scientific research, all virtual RIs being considered mobile as well [15].

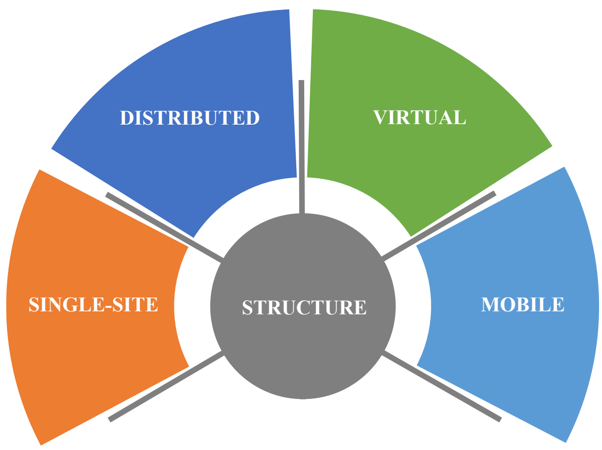

Fig. 3. RIs depending on structure
Source: Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020) and Repealing Decision No 1982/2006/Ec, Article 2, paragraph (6). Official Journal of the European Union. www.portal.meril.eu/meril/[15].

Depending on the maturity level, ESFRI RIs can be classified into three types as shown in Fig. 4.

ESFRI Emerging Projects are those in the inception phase when the research organizations are forming the consortium, identifying main RI's objectives, performing a rough estimate of costs, so, at this stage the RIs are at a low level of maturity [16].

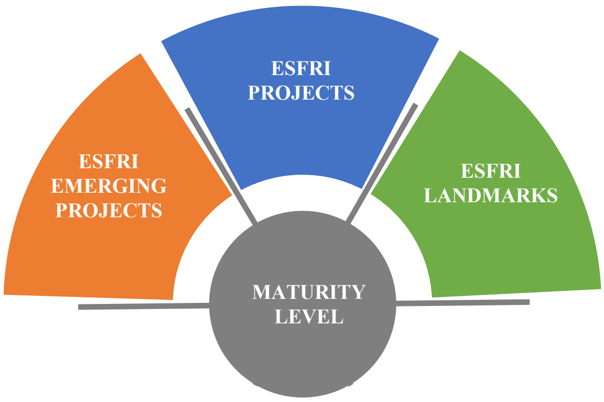

Fig. 4. RIs depending on the maturity level
Source: ESFRI Public Roadmap 2018 Guide
Romanian Committee for Research Infrastructures (Comitetul Român pentru Infrastructuri de Cercetare - CRIC), 2017, Romanian Roadmap of Research Infrastructures [16].

ESFRI Projects are those considered by ESFRI as being active and included in the preparation phase. These RIs have reached a high level of maturity and have a well-defined structure and governance; At the end of the preparation phase, the RI will be registered as a new legal entity/ association [3].

ESFRI Landmarks are RIs included in the implementation or construction phase which means that RIs needs to make the adequate investments in order to become fully operational [3].

Also, depending on the location (Fig. 5), RIs can be grouped by:

National RIs refer to RIs located in one country having an impact at national level

Regional RIs refer to RIs serving a specific objective which contributes to the development of a specific region of the country.

Macro-regional RIs refer to RIs located in a European region aiming to address some regional challenges

European/International RIs refer to RIs developed for instance under ESFRI Roadmap, having multiple locations in different countries.

Fig. 5. RIs depending on geographical area
Source: Romanian Committee for Research Infrastructures (Comitetul Român pentru Infrastructuri de Cercetare - CRIC), 2017, Romanian Roadmap of Research Infrastructures [16].

Roadmap

ESFRI Roadmap is a key tool through which ESFRI sets out a long-term European strategic planning for the development of RIs. However, the inclusion in the ESFRI Roadmap does not guarantee the construction of a RI.

ESFRI Roadmap identifies new pan-European research infrastructures or major upgrades to existing ones, meeting the needs of European research communities over the 10–20-year horizon. Also, it presents a list of different research infrastructures according to size, phase, scope and complexity. It is regularly updated based on the needs of the European scientific community for research infrastructures.

The EC and ESFRI foster Member States and associated countries to adopt national Roadmaps for Research Infrastructures. The national Roadmap forms the basis of a strategic planning that facilitate governments to set national priorities and allocate funds to national and European RIs, including ESFRIs. Therefore, it serves as a strategic planning tool and reference document for decision-making in the field of research and innovation [16]. It is used in monitoring and evaluating the progress made by research infrastructures in Romania with national, European and international relevance.

Fig. 6 shows the current countries that implemented a national roadmap while others are in the process of preparing their roadmaps [2].

Fig. 6. Countries having implemented national roadmaps
Source: ESFRI National Roadmaps, www.esfri.eu/national-roadmaps, Accessed on 21.03.2021 [2].

Lifecycle
Each RI sustained by ESFRI has to pass throughout different phases (Fig.7) starting from the project identification, then designing and preparation and eventually, if ESFRI considers that the project is sufficient mature in terms of legal, organisational, financial aspects and so on, the RI will be implemented and get ready to full operation.
Each phase involves performing several tasks, as follows [3]:
Phase 1 - Concept Development: defining the concept, establishing the project consortium, identifying financing sources, setting project and scientific management
Phase 2 – Design: preparing design study and business case, finding political and economic support from ministries, defining the access policy, preparing a top-level breakdown of costs, defining governance and HR
Phase 3 – Preparation: elaborating the business plan and the cost book, securing political and financial support, describing data policy and data management plan, defining the legal form of RI
Phase 4 – Implementation: construction and deployment of RI, recruitment of personnel, IPR & innovation policies, operational and upgrade plan, securing funding for RI operation
Phase 5 – Operation: achieving frontier research results, performing services to scientific community, outreach activities, upgrading the facilities, securing ongoing political and financial support
Phase 6 – Termination: dissolution, dismantling of facilities, reuse, merger of operations and organisation

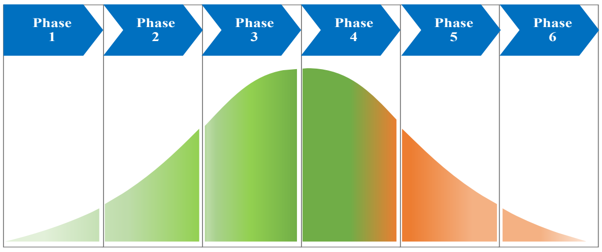

Fig. 7. Lifecycle of RIs
Source: ESFRI Public Roadmap 2018 Guide [3].

Current situation of ESFRI RIs [5]
The first edition of ESFRI Roadmap was published in 2006 and included 35 projects. The list has been monitored and continuously updated in the subsequent editions in 2008, 2010, 2016 and 2018, the latter being the latest, displaying a number of 55 of pan-European RIs, out of which 18 ESFRI Projects and 37 ESFRI Landmarks.
The RIs are listed by the 6 key areas of intervention which have been defined by the EC as primary goal for action: energy (EN), environment (ENV), health & food (H&F), physical sciences & engineering (PHSC & ENG), social & cultural innovation (S&C INNOV) and digitalisation (DIG).
As it can be noted in Fig.8, most of ESFRI projects are distributed RIs, 15 in total, while only 3 are single-sited RIs.
This means that the research organisations are focusing on achieving objectives with wider impact at European or international level.
It is worth mentioning that this indicates that research organizations are willing to share assets, knowledge and expertise, as well as to strongly collaborate to fulfill great objectives.

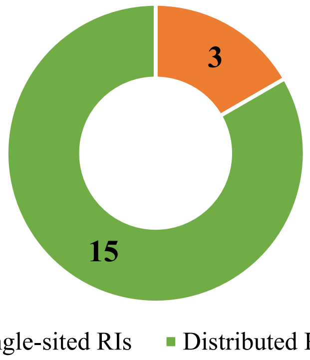

Fig. 8. ESFRI Projects
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

Health & Food area is the main concern of the ESFRI Projects (6 projects), followed by environment (4 projects), both of them weighting more than 50% in total of ESFRI Projects (Fig. 9).

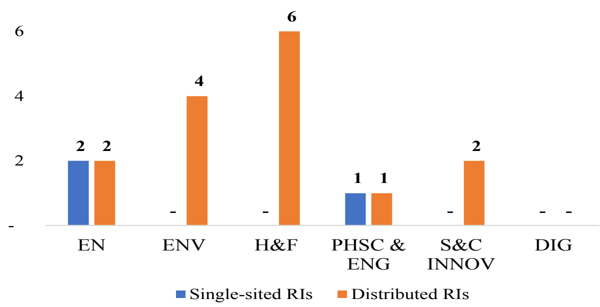

Fig. 9. ESFRI Projects in key areas
Source: ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

There is no good or bad approach, nor an obligation related to the structure of an RI, the decision depending on the objectives and activities proposed, partners involved, impact of research results and of course, the recommendations made by ESFRI in the early phase. However, the maturity level is decided by ESFRI based on the proposal submitted by the RI, followed by a hearing with ESFRI representatives.

Some examples of RIs connected to agriculture and biotechnology are presented below:

AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems) - State-of the-art experimental facilities, to support scientists in testing the potential impacts of climate change and land use in Europe, and forecasting the risks on European ecosystems, including agricultural systems [4].

EU-IBISBA (European Industrial Biotechnology Innovation and Synthetic Biology Accelerator) - Industrial biotechnology with applications in energy (liquid biofuels), chemicals (organic acids), materials (bioplastics) and ingredients for the food, feed, cosmetics and pharma sectors (enzymes, antioxidants, antibiotics) [4].

METROFOOD-RI (Infrastructure for promoting Metrology in Food and Nutrition) - High quality metrology services in food and nutrition, comprising an important cross-section of highly inter-disciplinary and inter-connected fields throughout the food value chain, including agro-food, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health [4].

MIRRI (Microbial Resource Research Infrastructure) - Offering long-term deposition of raw material of high scientific and economic value for basic research and innovation in biotechnology [4].

Regarding the ESFRI Landmarks (Fig.10), distributed RIs are twice as number (25) compared to single-sited RIs (12).

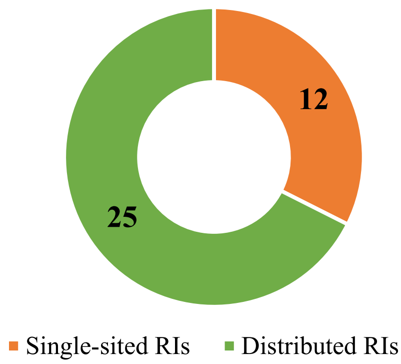

Fig. 10. ESFRI Landmarks
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

However, in terms of the topic selected (Fig.11), 'Physical sciences & engineering' area (12 projects) is on the top being mostly established as single-sited, very closely followed by 'health & food' area with 10 projects.

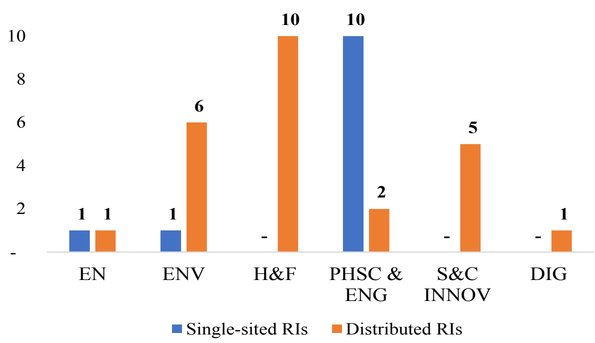

Fig. 11. ESFRI Landmarks in key areas
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

Some examples of RIs connected to agriculture and biotechnology are presented below:

ICOS ERIC (Integrated Carbon Observation System) - High precision measurement on carbon cycle in agricultural systems, support for climate-smart agriculture, evaluation of bioenergy, common analyses of plant and microbial adaptation to change in relation to carbon cycle [4].

LifeWatch ERIC (e-Infrastructure for Biodiversity and Ecosystem Research) - Advancement of scientific and technological research on conservation of biodiversity in species of agricultural interests, ecosystem impacts on/from agriculture, fisheries and aquaculture [4].

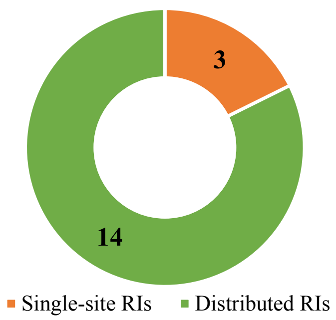

Fig. 12. Situation of RIs sustained by ESFRI in which Romania is member depending on the RI's structure
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

EU-OPENSCREEN ERIC (European Infrastructure of Open Screening Platforms for Chemical Biology) - Developing novel small chemical compounds which elicit specific biological responses on organisms, cells or cellular components. It also covers the production of crop-protective compounds, which are of paramount importance to society via the understanding of the response of wild or crop plants to environmental and agricultural substances [4].

Romania is included as member in 17 ESFRI RIs (Fig.12) thereof, 14 are distributed and 3 single-sited, weighting around 31% in total ESFRI RIs.

As regards the level of maturity (Fig.13), Romania is mainly part of ESFRI Landmarks (12 projects) which represent projects under the implementation phase and therefore, considered by ESFRI as sufficient mature to be established and able to start their operation.

The Romanian research organisations committed to bring their contributions in the following areas (Fig.14): environment (6 projects), physical sciences & engineering (5 projects), health & food (3 projects) and social & culture innovation (3 projects).

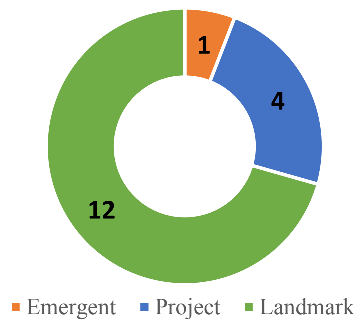

Fig. 13. Situation of RIs sustained by ESFRI in which Romania is member depending on the maturity level
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

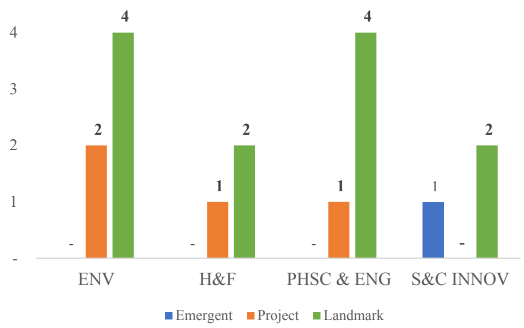

Fig. 14. Situation of RIs sustained by ESFRI in which Romania is member
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

Costs incurred in setting-up ESFRI RIs

ESFRI requires applicants to prepare a cost book analysis and a business plan with the aim of calculating the costs for project implementation and operation. Based on the estimated costs, the applicants have to show the potential financing sources starting with the provision of economic endorsements from the national governments involved in the project, expressing their financial commitment to the creation of the RI.

The analysis of these RIs, shows that the operation costs weight nearly 10% of the implementation costs for the majority of RIs.

As of ESFRI Roadmap 2018, ESFRI Projects, estimated the highest costs for the implementation of projects in the environment area (Fig.15) with around 4.1 billion euros, followed by energy with 1.7 billion euros.

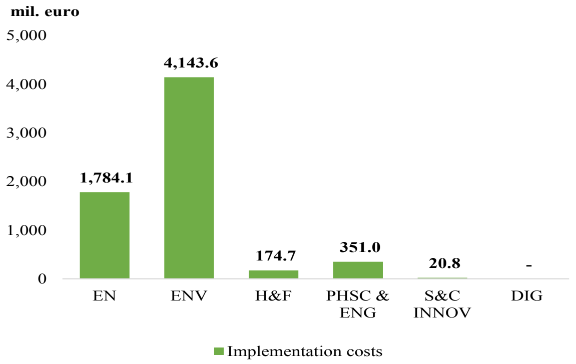

Fig. 15. Implementation costs of ESFRI Projects
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

On the other side, 'health and food' area seems to require almost 40% for operation costs (Fig.16).

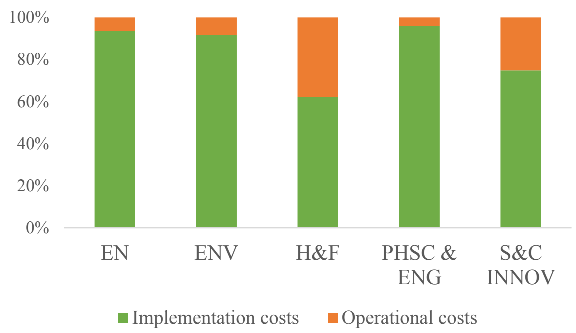

Fig. 16. Cost structure of ESFRI Projects
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

In respect of the implementation costs estimated by ESFRI Landmarks, 'physical sciences & engineering' area requires approximately 8.9 billion euros, followed at long distance by 'energy' area with 2.8 billion euros. On the other side, operational costs (Fig. 18) fall within the average value estimated. Considering the phase, we can state that costs of ESFRI Landmarks (projects in the implementation phase) are more accurate than costs of ESFRI Projects (projects in the preparation phase).

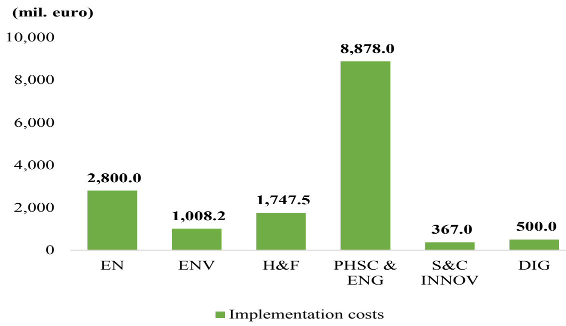

Fig. 17. Implementation costs of ESFRI Landmarks
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

Regarding the implementation or operational costs, it is important to highlight that there is no rule, no lower or upper limit set for the creation of an RI, but this should be estimated considering the government support, the potential financing sources, other grants or revenues generated by RI from paid services (if any) and somehow balanced with the investment needs in performing high-quality research activities so that to fulfil the pre-set objectives and to obtain remarkable results.

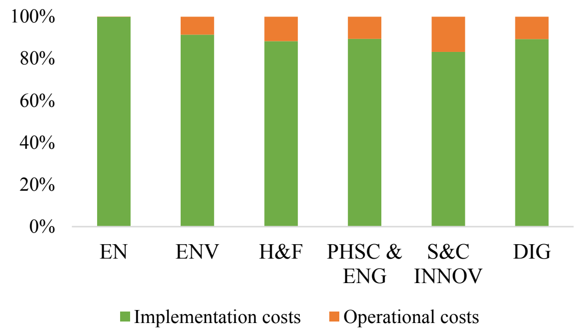

Fig. 18. Cost structure of ESFRI Landmarks
Source: Own calculations based on ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [4].

Overall, it is worth mentioning, that the difference between the values laid down in Fig. 15 and the ones in Fig. 17 comes from a range of variables such as number of projects per area, project phase, area of intervention, number of partners, project type and complexity.

CONCLUSIONS

It is worldwide acknowledged that scientific excellence is the main trigger for rapid progress of research, regardless of scientific area.

By sharing knowledge and technology, synergies will occur, avoiding thus the duplication of efforts. In this way, large RIs ensure that science is led by excellence and not by the research capacity of each country.

ESFRI sustains RIs all along their lifecycle to make sure they reach the right level of maturity in order to be implemented and also, invites the policy-makers of each country involved in the RIs to join their efforts by offering full political and economic support which will eventually, lead to the RIs materialization. Additionally, it encourages RIs partners to access both public and private funds available which can help them in making the necessary investments in research facilities/instruments and cover all costs incurred in carrying out their activities. Even so, due to the large amounts involved by these infrastructures, their sustainability on the long-term still remains a major issue/challenge that ESFRI tries to settle it.

A special attention should be paid to the rural development because this is the key to overcoming world hunger and poverty.

Research and innovation in agriculture and biotechnology is essential to finding proper solutions to the global challenges related to food security, well-being, environment and energy. Therefore, the EU draws attention on the need of creating pan-European RIs on food and nutrition, in sustainable agriculture and bio-economy.

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SUPPORTING YOUNG FARMERS AND THE SUSTAINABILITY OF RURAL REGIONS. CASE STUDY - OLT COUNTY, ROMANIA

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Abstract

The support system for young farmers within the CAP, through the large volume of projects, has one of the strongest effects on the development of Romanian agriculture. In Romania, support for young farmers under the CAP has been introduced since 2007, with Romania's accession to the European Union. The scheme provides financial support to people under the age of forty who want to start an agricultural business. Moreover, the support measure for the establishment of young farmers was continued in the 2014-2020 programming period, the intensity of support being even higher. Other non-direct support measures for young farmers through National Rural Development Program (NRDP) funding have also served to change future generations of farmers. The purpose of this paper is to present the results of a survey in Olt County that considered the link between the sustainable development of the county region through the actors that make it up: a new generation of young farmers. As a main tool of the analysis, a questionnaire was completed and applied to 170 beneficiaries of sub-measure 6.1. "The installation of the young farmer". The implementation of the questionnaires resulted in a series of benefits that young farmers obtained, but also the difficulties they encounter in their activity. We could see that the financial benefits obtained by young farmers through sub-measure 6.1. from the NRDP shows that this system contributes greatly to supporting the level of development of agricultural holdings they own, with positive long-term results on increasing their incomes, improving the quality of life. According to a significant percentage of the 170 farmers participating in the study, one problem they face is mainly related to finding new markets. Many of those interviewed do not have large quantities of agricultural products in order to enter the free market, to be able to negotiate a competitive price, being at the beginning of activity in this field. That is why some consider that a solution for capitalization through cooperatives or producer associations would be a beneficial solution in the future.

Key words: *young farmers, rural areas, Common Agricultural Policy, support measures, sustainability*

INTRODUCTION

The concept of young farmers is widely presented in the literature on topics related to the EU's Common Agricultural Policy [8], [11], [13], [17], [19]. The effects of support for young farmers on the basis of the CAP have been analyzed in various studies and identify the positive impact of the support they receive on the sustainability of rural areas [2], [3], [7], [16].

Young farmers are considered to be the main driving force in agriculture. Not only do young farmers have a higher entrepreneurial spirit, but the new generation of farmers is much more concerned about the environment than the older ones. [5]. Analyzing the effects of agricultural activities on the natural environment, in terms of soil degradation and/ or sustainable use, we can say that young farmers who associate their future income with agricultural activities, are more likely to care for the environment, soil quality, its long-term use in terms of sustainability, compared to older farmers, whose time horizon is a maximum of 5-10 years and who have no openness to the new [18]. This, together with greater risk tolerance and acceptance of innovation, puts young farmers at the forefront of shaping the agricultural sector in the medium and long term [6]. Due to the fact that most agricultural land in EU Member States has already been allocated to existing agricultural units, the support scheme for setting up young farmers under the CAP has been introduced to facilitate the entry of

young people into agricultural activities and to maintain a generational change in agriculture.
On the other hand, young people in rural areas are among the most vulnerable groups and support measures are needed to attract them to the agricultural sector [4], [14]. The low percentage of young farmers in the EU and the main obstacles to starting agricultural activities are related to difficulties in renting or purchasing land, machinery or other factors of production [20].
Thus, the support of young farmers serves not only as a precondition for increasing the educational level of farmers through the vocational training courses they benefit from, but also as a tool for maintaining the rural population, to stop the exodus from the village to the city to reduce pressure on urban areas or from one region to another that poses a threat to EU agriculture, calling into question the possibility of the EU meeting its food demand in the future [9], [10], [12].

MATERIALS AND METHODS

As a main tool of the analysis, a questionnaire was completed and applied to 170 beneficiaries of sub-measure 6.1. The questionnaire is an appropriate tool for obtaining information on the intentions and perceptions of young farmers in order to clarify their socio-economic characteristics and attitudes [1], [15].
In the survey, we defined a young farmer as a person engaged in agricultural activities who is less than 40 years old and who settles as the sole head of the agricultural holding, definition in accordance with art. 2 of Regulation (EU) no. 1305/2013.
The limitations of our research come from the fact that we rely on the sample of only Romanian farmers in Olt County. The results obtained can be applied at national or regional level which share similar development paths, but the results cannot be extrapolated to the level of the old EU Member States.

RESULTS AND DISCUSSIONS

European Union (EU) agriculture has undergone several changes over time, driven by changes in food safety and security. In addition to food safety and security issues, EU policies also have an impact on the viability of rural areas. It is therefore important to examine the links between the multiple valences of EU policy measures, farmers' decisions and the effects on the rural economy and the increase in quality of life.
In the case of agriculture, the access of young farmers is encouraged through the measures promoted by the Common Agricultural Policy (CAP), and farmers entering the market contribute to the viability of rural areas. It is therefore important to identify the factors that determine the effectiveness of the support measures taken in this regard, as well as ways to make better use of the products obtained by them.
The participation in the survey considered 170 respondents, with 170 questionnaires accepted after validation. The questionnaire for young farmers included three main groups of questions:
- the degree of difficulty in accessing the installation measure of young farmers, as well as the demand for counseling services;
- how the project is implemented and the interaction with the authorities responsible for managing EU funds during the implementation period;
- the benefits of the payment scheme for young farmers

The specific questions in each group of questions were chosen to cover as many dimensions of the medium- and long-term sustainability of rural areas as possible.
Regarding the age samples, the 170 respondents 60.6% were male managers and 39.4% female managers. The survey participants covered all age segments between 18-40 years: 18-24 years (19.4%), 25-30 years: 27.6%, 31-35 years: 29.4% and 36- 40 years: 23.5%. Regarding the place of residence, all young farmers who participated in the survey live in rural areas. Half of the participating farmers (50.6%) are high school graduates, and 21.8% have a university degree. Regarding the specialization of the farm, due to the positioning in the plain area of Olt county, 90.6% of the respondents are

specialized in vegetable production and 9.4% are employed in mixed agriculture.

The first part of the questionnaire considered questions about the degree of difficulty that young farmers encountered in submitting the project.

Accessing the sub-measure for the installation of the young farmer was considered easy and very easy by 58.9% of the respondents and only 41.1% of the farmers considered it difficult and very difficult (Fig.1).

The main difficulty encountered by almost half of the interviewed farmers (47.5%) referred to the large number of documents required, excessive bureaucracy. A second difficulty was the lack of necessary information, considering that the guide for sub-measure 6.1. it is not very explicit (28.3% of respondents), followed by the lack of a consultant (7.3%). The rest of the farmers (16.9%) stated that they did not encounter any difficulty in accessing this sub-measure.

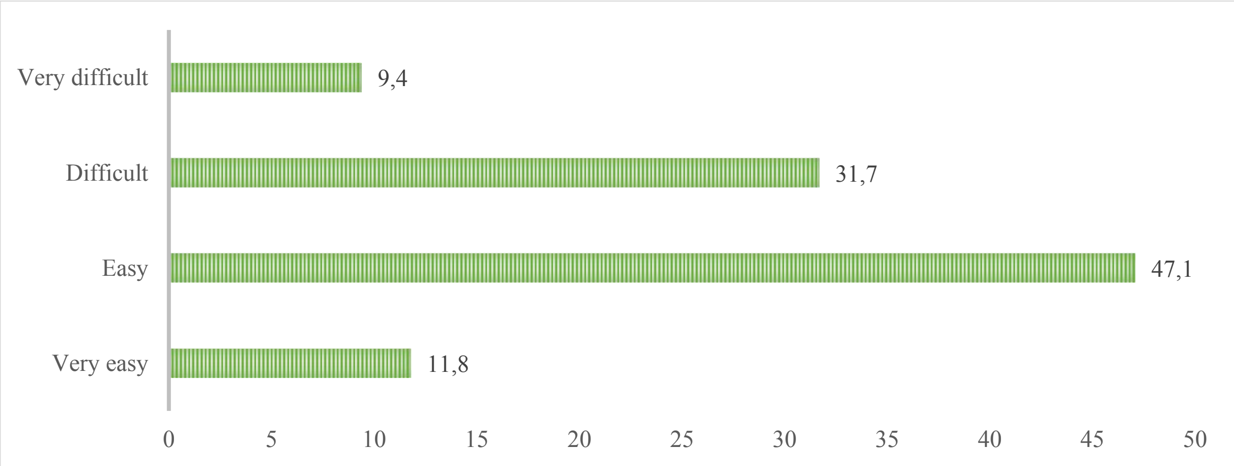

Fig. 1. How difficult was it to access sub-measure 6.1?
Source: Own design based on questionnaire output data.

The support of a consultant for support in writing the funding application was needed in 85.3% of cases, either for writing the whole project (72.9%) or only partially (12.4%). Only 14.7% of farmers stated that they did not turn to the consultant (Fig. 2). Of those who benefited from the services of consultants, 51.2% considered that the support provided by them was adequate, 21.2% considered that the aid received was beneficial only to a certain extent, 10% believe that the aid was adequate in small and 2.9% said that the consulting service was not at all beneficial.

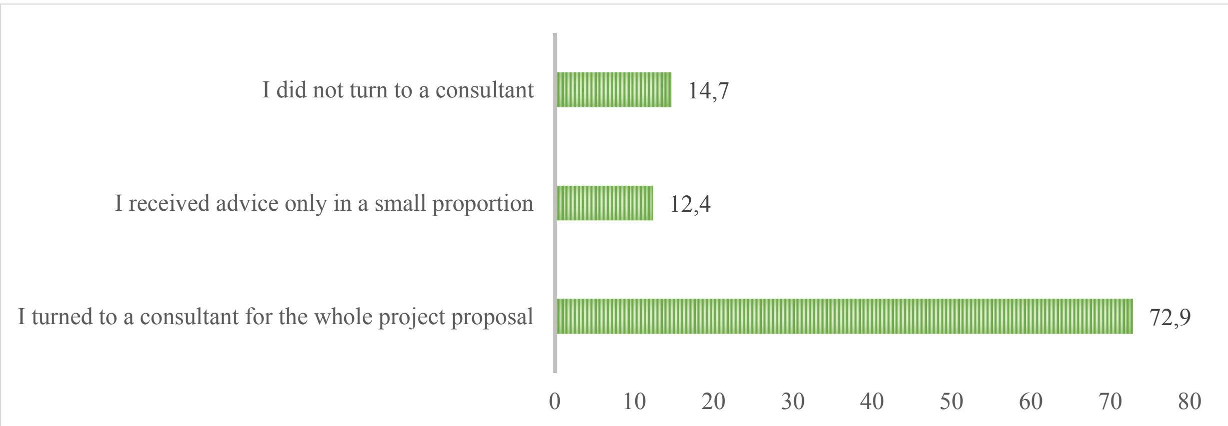

Fig. 2. Did you benefit from the support of a consultant in drawing up the funding application file?
Source: Own design based on questionnaire output data.

The second part of the questionnaire followed the implementation of the project and the interaction with the authorities responsible for managing EU funds during the implementation period.

Farmers were asked if during the project implementation period they encountered difficulties and if it was necessary to amend the financing contract by an additional act. 85.3% of respondents stated that they had no problems with implementation and no changes were needed through additional documents.

At the same time, 92.9% of farmers stated that during the implementation there were no failures in the objectives assumed in the business plan, they met all the indicators assumed by the business plan of the project and only 7.1% encountered problems that had as consequence penalties.

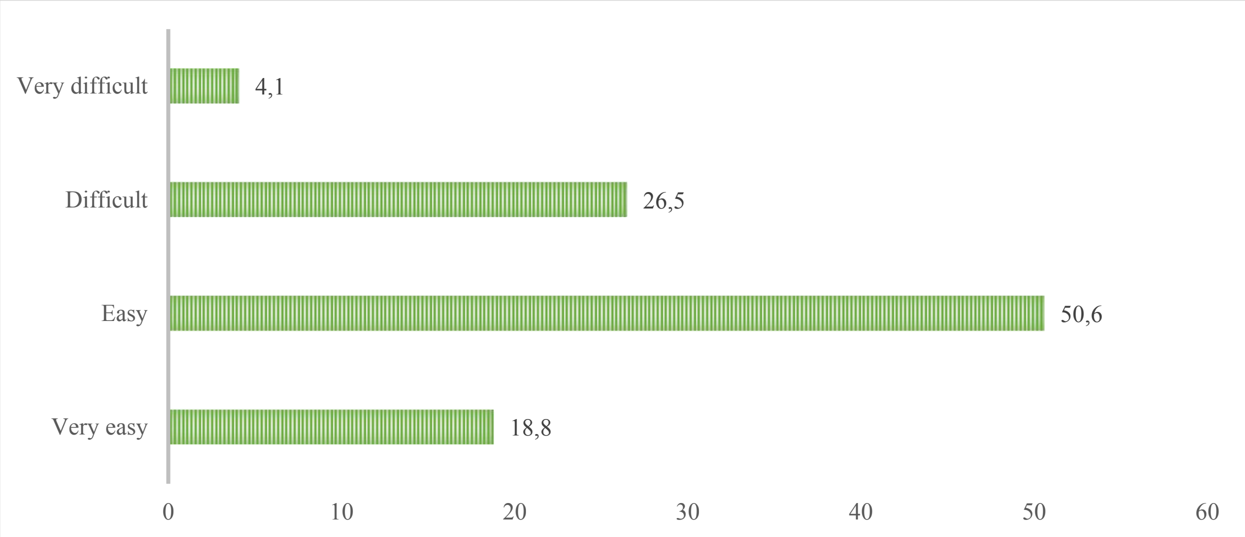

Fig. 3. How to interact with the authorities?
Source: Own design based on questionnaire output data.

Interaction with the authorities responsible for managing EU funds during the implementation period was considered easy and very easy by 69.4% of young farmers, 26.5% said they had a difficult interaction with the authorities and 4.1% collaboration with institutions in field was very difficult (Fig. 3). In the final part of the questionnaire, farmers were invited to express their opinion on the benefits of the project, if they registered economic growth at the level of their own farms and implicitly if they felt an increase in living standards. More than half of the farmers (55.9%) consider that the implemented project had largely beneficial results, 27.6% to a certain extent, 15.3% to a small extent and only 1.2% believe that the project it did not bring them any change for the better (Fig.4). At the end of the questionnaire, one last question concerned the intentions of farmers regarding the interest in accessing new measures regarding the modernization or diversification of their activity. Of the 170 interviewed farmers, 72.9% want to access new measures for the next programming period: 38.2% want to access the farm modernization measure, 18.8% want to access non-agricultural measures, 5.9% processing measures of agricultural products, 10% other measures from the National Rural Development Program. It is important to note that 27.1% of farmers no longer want to access European funds to modernize or diversify their activities (Fig. 5).

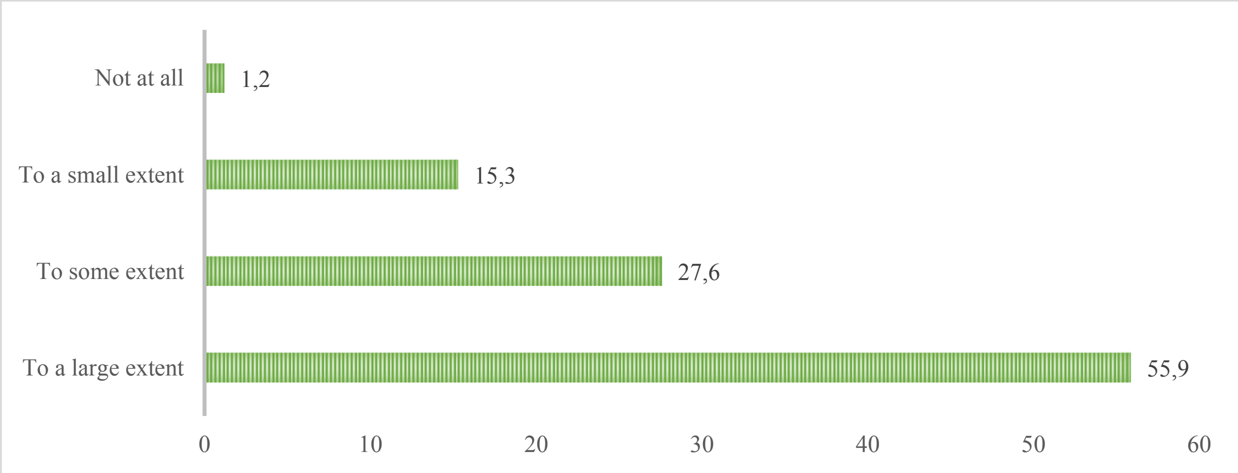

Fig. 4. Did the investment on sub-measure 6.1 result in the economic growth of your activity and implicitly in the increase of the living standard?
Source: Own design based on questionnaire output data.

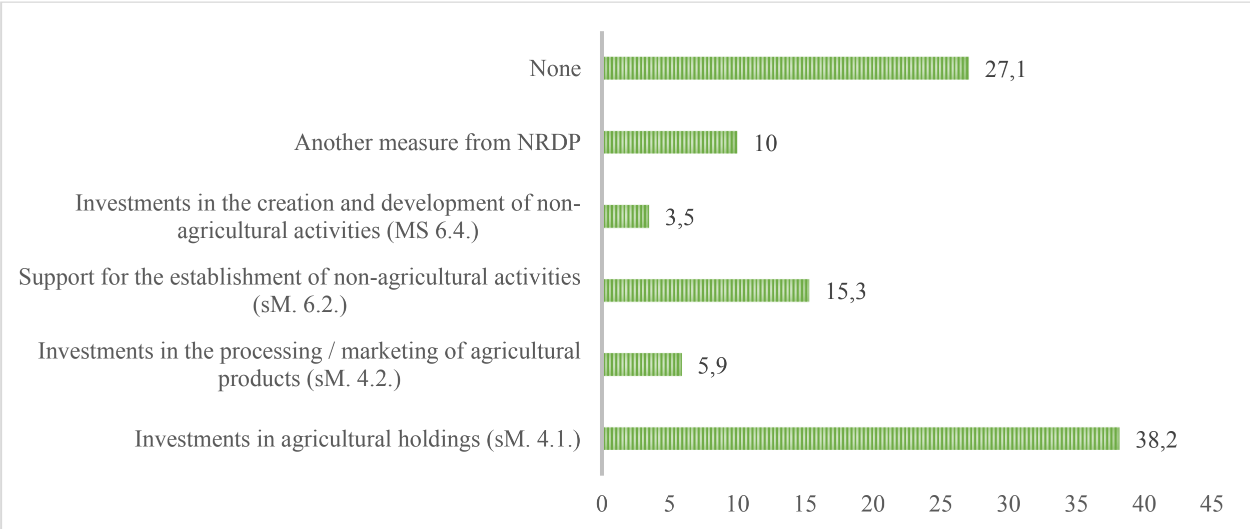

Fig. 5. Are you interested in accessing new measures to modernize or diversify your current business?
Source: Own design based on questionnaire output data.

CONCLUSIONS

Opportunities for generational change in agriculture by supporting investments from European funds for young farmers are a beneficial way to set up and develop their own farms.

Financial benefits obtained by young farmers through sub-measure 6.1. from the NRDP shows that this system contributes greatly to supporting the level of development of the farms they own. At the same time, the support received from the European Union for eligible farmers in the form of a single area payment (young farmers being eligible for these payments) also helps to ensure the income levels of their farms by creating additional sources of income. These additional financial revenues are essential for smaller farms because the development of the farm from own funds is sometimes impossible.

From the survey we found that farms operated by young farmers with higher education are more likely to seek support for investment, for the establishment and development of farms. This shows the importance of education in making decisions to start and continue farming. They said they are open to innovation, acceptance of innovations and usually have better financial results and use modern management techniques, thus confirming the need to support these agricultural entities to increase the sustainability of rural areas.

Regarding the profile of the farms of the farmers who participated in the study, a significant difference was found, 90.6% of the young farmers own farms with plant profile, and the remaining 9.4% mixed profile. No farmer in the study had a strict zootechnical profile, this being argued that the field of animal husbandry requires a lot of work.

It was important to note that the demand for counseling services was very high, about 85% of respondents confirmed that they needed and used these services. Some of the farmers received counseling during the implementation of the project, for the submission of the second tranche file, but for the vast majority the counseling ended when the financing contract was signed.

Farmers who did not use consulting services had in their projects mainly purchases of agricultural equipment and considered that the support of a consultant is not appropriate. Also, farmers with higher education in the field of agriculture stated that they used a consultant only in a small proportion to write the project, or not at all.

One issue that has resulted in the 170 farmers participating in the study is supporting the diversification of agricultural activities for young farmers. In the long run, diversification can improve farms' resilience to market uncertainty. Although measures to support farmers in diversifying agricultural activities exist, only a small percentage of them have indicated that they are interested in this area. Consequently, the support for diversification granted to farmers in general, but to young people in particular, who have a greater openness to new, to technology, to new environmentally friendly activities, should be intensified to ensure the sustainability and resilience of the Romanian agricultural sector.

The difficulties that most young farmers face are mainly related to finding new markets, many of those interviewed do not have large quantities of agricultural products to enter the free market, to be able to negotiate a competitive price, being at the beginning activity in this field. That is why some consider that capitalization through cooperatives or producer associations would be a beneficial solution in the future.

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EFFICIENCY OF LABOR FORCE USE IN THE EUROPEAN UNION'S AGRICULTURE IN THE PERIOD 2011-2020

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Abstract

The paper aimed to analyze the efficiency of labor force input in the EU using the most representative indicators: agricultural production and gross value added per 1,000 AWU and also of Factor A in the decade 2011-2020. The applied methodology included fixed basis index in 2020 vs 2011, average annual growth rate in the interval, and market share. In the period 2011-2020, the EU agricultural output value and gross value added have definitely increased, accounting for Euro 411.77 Billion and, respectively, Euro 176,96 Billion in 2020, while labour input continued to decline reaching an employment rate of 4.37%. In 2020, the EU agricultural output value per 1,000 AWU accounted for Euro 60 Million while GVA for Euro 20.83 Million. While Denmark, Netherlands, Belgium, Luxembourg, Germany, Sweden, France are in the top compared to the EU average for agricultural output per AWU, Latvia, Bulgaria, Slovenia, Poland, Croatia and Romania are situate in the opposite corner. Compared to the EU average of Euro 20.83 Million for GVA/1,000 AWU, Netherlands, Denmark, France, Germany are on the top positions, while Bulgaria, Latvia, Slovenia, Croatia, Poland and Romania are on the last positions. Indicator A or Factor income reached 124% in 2020 being by 24% higher than in 2010. The highest Indicator A belongs to Bulgaria and Hungary, while the lowest one to Germany, Austria, Finland, Netherlands and Belgium. In conclusion, the efficiency of the use of labour force differs from an EU member state to another depending on its efforts to increase net gross value and decrease labour input. Only the growth of agricultural output, the optimization of intermediate consumption, the raise of net GVA, the decline in labor input but using only a high qualified, conscious, responsible, workable labor force and taking measures to face the climate change, the EU could grow the labour productivity.

Key words: *efficiency, labor force use, agriculture, productivity, European Union*

INTRODUCTION

The EU and the USA are the most important players in the world agricultural market and the competition between these two economic powers becomes stronger year by year [16, 17].
As a primary sector of the EU economy, agriculture is the key provider of raw materials for food processing industry and whose noble purposes are to nourish the population and assure its food security, to bring incomes and welfare to farmers and their families and to contribute to the environment protection and biodiversity conservation and also to sustain its export of agro-food products.
Despite that the EU agriculture is dominated by millions of small-sized farms, most of them being family farms, farming is still a big deal taking into account its purposes as mentioned above [39].
Agricultural production value and gross value added have increased in the EU, but still there are huge differences between the member states [32, 33].
More than this, even thou the contribution to the EU GDP is only 1.3% compared to other economic branches, in various member states the importance of agriculture in the economy

is different reflected in terms of agricultural output value, gross value added and intermediate consumption etc. according to the peculiarities of the local geographical, economic, social, and environment conditions [23, 24, 25, 26, 27].

In general, during the last decades it was noticed the decline in the agriculture's contribution to GDP, the decrease of the number of employed persons, and the productivity growth in the EU countries [1, 28, 31, 36].

The results obtained in agriculture are due to the use of agricultural land and technologies applied, and to the efficiency how human, fixed and working capital are utilized [18, 19, 20, 35, 37].

Human capital is the most precious resource, the main driver in producing food and in the EU rural areas the population is still high, with large variations from a country to another, and agriculture is still the main business providing income and assuring the living standard for the local population [13, 21, 22, 40].

The EU agricultural labor force in the EU varies from a member state to another. Significant differences between the Northern and Central regions and the Eastern and Mediterranean regions were found regarding labour force and productivity taking into consideration various agricultural systems applied in the EU countries [11, 41, 42, 43].

The results obtained by [12] proved that in the old EU member states there is no sigma, but beta divergence in labour productivity which is statistically significant, while in the new member states both sigma and beta convergence coexists.

In terms of gross value added per employed person, labour productivity still reflects large discrepancies among the EU countries but the gap is slowly declining [14, 45].

However, the general tendency is the decreasing trend of number of persons involved in agricultural activities, which on one side is a positive aspect, as it contributes to the improvement of labor productivity and farm size, but on the other side, it is a negative aspect as it is caused by farmers' ageing and rural population especially of the young people's migration to urban areas or abroad [38].

More than this in the EU labor force input has a large diversity referring to form of employment (full time or part time), source of getting income (salaried and nonsalaried), age and gender structure, training level, and productivity [29, 30].

The impact of the new CAP on the dynamics of agriculture could not be evaluated without taking into consideration the structural changes in labor productivity in close relationship with the environmental exigencies for a sustainable development [3].

CAP subsidies increase agricultural labour productivity, due especially to the decoupled Pillar I payments and the mixed impact of Pillar II [10].

Despite of the decline of Total Factor Productivity (TFP) dynamics in the EU member states in the period 2003-2014, there is still a gap between productivity in the new states compared to the old ones, but also a slight productivity convergence [2, 15].

At present in the EU, labor productivity is measured by an index named "Factor A expressing the net value added by the equivalent of each full time worker dealing with agriculture" as defined by Eurostat [6]. Its level is deeply influenced by its two determinants:

-net value added, which is gross value added adjusted for the consumption of the fixed capital and subsidies and taxes for production;

-agricultural labor input in terms of annual work unit (AWU), meaning the equivalent of full time worker in the agricultural sector.

While gross value added and, respectively, net value added produced in agriculture is increasing, agricultural labor input has a general declining trend [4].

In this context, the paper aimed to analyze the efficiency of labor force input in the EU in terms of agricultural production and gross value added per 1,000 AWU and also in terms of Factor A as the key index reflecting labor productivity. The selected period of the study was 2011-2020, and the level of the main indicators involved in this research were comparatively studied in 2020 versus 2011 both at the EU level and by each member state. Finally, a few proposals were issued regarding how to increase the efficiency of labor force use in the EU agriculture, more exactly of labor productivity.

MATERIALS AND METHODS

This research is based on the data provided by Eurostat data and Reports, and also on the results presented by the literature on the topic. The following aspects have been approached:

-agriculture as a big employer in the EU, emphasizing total labor force input and its structure by salaried and non salaried persons;

-agriculture performance in terms of agricultural output value and gross value added;

-economic efficiency of the use of labor force in agriculture in terms of three indicators; agricultural output value per 1,000 AWU, gross value added per 1,000 AWU and Factor A- as real income by the equivalent of each full-time worker in the agricultural industry.

All these aspects were presented at the EU level and by each member state.

The study period was 2011 - 2020, but the results shown in this study regards only the changes in 2020 versus 2011, using as methodological procedures: fixed index in 2020 vs 2011, average annual growth rate in the whole interval, and structural indices like market share.

More than this, based on the results for each studied indicator, the EU member stated have been classified establishing their hierarchy in comparison with the EU average.

The obtained results were displayed in tables and graphics, being accompanied by the corresponding comments and at the end of the study there were drawn the main conclusions.

RESULTS AND DISCUSSIONS

Agriculture - a big EU employer

Agriculture still is the big employer in the EU economy, despite that in the interval 2011-2019 the employment rate declined from 5.6% in 2011 to 4.37% in 2019 [44].

Table 1. Total labor force input in the EU's agriculture, in 2020 versus 2011

	2020 (1,000 AWU)	2020 vs 2011 % 2011= 100	2020 Market share (%)
EU	**8,494.35**	**-15.9**	**100.00**
Belgium	54.73	-5.0	0.64
Bulgaria	178.0	-52.4	2.10
Czechia	102.02	-4.0	1.20
Denmark	52.13	+0.1	0.61
Germany	465.0	-10.2	5.47
Estonia	17.72	-27.3	0.20
Ireland	160.7	-3.0	1.89
Greece	405.9	-9.7	4.77
Spain	784.56	-13.2	9.23
France	720.26	-10.0	8.47
Croatia	176.38	-11.4	2.09
Italy	1,084.2	-5.5	12.76
Cyprus	20.87	-17.9	0.24
Latvia	68.78	-22.1	0.80
Lithuania	127.59	-10.6	1.50
Luxembourg	3.4	-7.4	0.04
Hungary	337.6	-22.8	3.97
Malta	5.04	+5.7	0.05
Netherlands	153.76	+1.3	1.81
Austria	113.83	-10.0	1.34
Poland	1,675.8	-12.5	19.72
Portugal	221.34	-26.1	2.60
Romania	1,331.0	-13.2	15.66
Slovenia	76.46	-2	0.90
Slovakia	42.2	-26.5	0.49
Finland	60.4	-25.7	0.71
Sweden	53.68	-16.4	0.63

Source: Own calculation based on the data from [5].

In 2020, the total labor force input in the EU accounted for 8,494.35 (1,000 AWU), meaning by 15.6% less than in 2011, where there were 10,99.8 (1,000 AWU).

Of the total labor force input, about 24% are salaried person and the difference are non-salaried employees.

The fact that agriculture needs an important labor force input is justified by the complexity of the agricultural activities both in the vegetal and animal sector, the seasonality of the technological processes, farm structures, technical endowment, soil and climate conditions which varies from a member state to another.

The general trend in the most of the EU countries is a decreasing one in various proportions which varies from a member state to another.

In the period 2011-2020, the highest decline was noticed in Bulgaria (-52.4%, Estonia -27.3%, Latvia -22.1%, Hungary -22.8%, Portugal -26.1%, Slovakia -26.5% and Finland -25.7%.

The smallest decline was recorded by Slovenia - 2% and Ireland -3%.

A few states registered an increase of labor force input in agriculture like: Denmark +0.1%, Malta +3.7% and Netherlands +1.3%.

In 2020, the highest percentage of labor force input in terms of AWU was recorded in Poland 19.72%, Romania 15.66%, Italy 12.76%, Spain 9.23%, France 8.47%, Greece 4.77%, and Hungary 3.97%. The first four countries accounted for 57.37% of the EU labor force input in agriculture and together with the last three they accounted for 74.58% (Table 1).

The main economic effects of the use of labour force input in the EU agriculture

Discussing about agriculture, it is worth to point out its role in the economy, assuring raw materials for processing industry, food security for the population, and giving its contribution to GDP, export, trade and payment balance.

This cannot be achieved without the contribution of the labour force which is one of the key production factors.

Despite that the number of people working in agriculture has a general declining trend, agricultural production value and GVA created in agriculture have continuously increased with a few inflexions in specific years in close relationship with the negative effects of the climate change.

Of course, we have not to deny the social effects of agriculture development, which is still the main sector in the rural areas providing jobs and income, and also contributing to the living standard and welfare of the local population.

More than this, agriculture development nowadays is closely related to the capacity of adaptation to climate change, and environment protection and biodiversity preservation.

In this paper there are approached only the economic effects of the use of labour force in terms of agricultural output and gross value added.

Output value in agricultural industry

In the analyzed period, 2011-2020, the value of agricultural industry output increased by 1.89% from Euro 404 Billion in 2011 to Euro 411.77 Billion in 2020. This was due to the high efforts made by all the member states to diversify production, improve the production structure and raise its volume and quality.

However, among the member states there are differences regarding the growth rate in agricultural industry. The highest growth rate in 2020 versus 2021 was recorded by Latvia +55.4%, Ireland +33.2%, Lithuania +33.85, Luxembourg +25.5% and Estonia +20.2%. The lowest growth rate was noticed in Malta +0.7% and Slovakia +1.4%.

In a few countries, agricultural output declined by -10.8% in Croatia, -9.5% in Bulgaria, -6.7% in Romania and -2.6% in Finland.

In consequence, the contribution of the member states to the EU-28 agricultural output value varied from a country to another, the highest contribution being given by France 18.31%, Germany 13.79%, Italy 13.07%, Spain 12,85%, Netherlands 6.89%, Poland 6.60%, Romania 4.08%, all together summing 76.15% of the EU agricultural output (Table 2).

Table 2. EU agricultural output value and gross value added in 2020 versus 2011

	Agricultural output value			Gross value added		
	2020 (Euro Million)	Change 2020 vs. 2011 (%)	Market share in 2020 (%)	2020 (Euro Million)	Change 2020 vs. 2011 (%)	Market share in 2020 (%)
EU	**411,772.2**	**+1.89**	**100.0**	**176,966.93**	**+7.27**	**100.0**
Belgium	8,661.4	+2.7	2.10	2,275.13	+8.00	1.28
Bulgaria	3,964.6	-9.5	0.96	1,663.15	+1.80	0.93
Czechia	5,494.8	+13.6	1.33	1,845.28	+28.0	1.04
Denmark	11,089.7	+3.2	2.69	2,961.08	+5.90	1.67
Germany	56,804.2	+2.1	13.79	20,257.3	+2.20	11.64
Estonia	974.3	+20.2	0.24	242.03	-22.00	0.13
Ireland	8,763.2	+33.2	2.12	3,086.87	+65.10	1.74
Greece	11,813.9	+11.3	2.86	6,144.42	+13.40	3.47
Spain	52,919.3	+29.1	12.85	29,287.97	+37.80	16.54
France	75,428.1	+3.2	18.31	30,182.49	+3.60	17.05
Croatia	2,552.7	-10.8	0.62	1,254.60	-3.30	0.70
Italy	56,320.4	+7.4	13.67	31,448.59	+9.30	17.77
Cyprus	760.6	+7.7	0.18	340.25	+4.50	0.19
Latvia	1,681.7	+55.4	0.40	591.98	+128.38	0.33
Lithuania	3,461.2	+33.8	0.84	1,6503.72	+66.94	0.84
Luxembourg	438.8	+25.5	0.11	124.60	+38.30	0.07
Hungary	8,464.5	+9.1	2.05	3,647.14	+26.10	2.06
Malta	127.2	+0.7	0.03	62.04	+7.60	0.03
Netherlands	28,235.5	+8.5	6.85	10,574.15	+24.70	5.97
Austria	7,712.5	+7.7	1.87	3,241.37	+5.50	1.83
Poland	27,177.7	+19.5	6.60	11,045.32	+23.30	6.24
Portugal	7,829.1	+19.6	1.90	2,912.23	+22.40	1.64
Romania	16,847.0	-6.7	4.08	7,921.71	-2.40	4.47
Slovenia	1,353.3	+10.2	0.32	603.27	+27.9	0.34
Slovakia	2,329.4	+1.4	0.56	677.12	+7.90	0.32
Finland	4,463.0	-2.6	1.08	1,430.88	+13.50	0.80
Sweden	6,103.0	+3.1	1.48	1,742.22	+2.50	0.90

Source: Own calculation based on the data from [7, 8].

The performance in agricultural production value at the EU level was carried out by the contribution of the three subsectors or activity: vegetal sector 52.8%, animal sector 38.6% and service sector 8.6%.

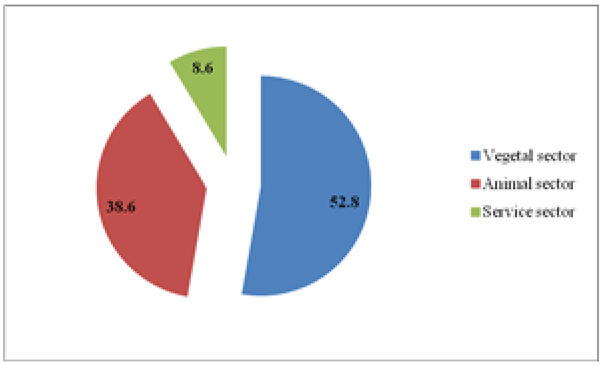

Fig. 1. The contribution of the subsectors to the EU agricultural output value in 2020 (%)
Source: Own design based on the data from [9].

Gross value added in agricultural industry

At the EU level, in the agricultural industry, gross value added increased by 7.27% in the analyzed interval, in the last year 2020 accounting for Euro 176,966.93 Million, representing 42.98% of the agricultural output value.

The differences of 57.02% being represented by the value of the intermediate consumption, that is of the inputs required involved in the production process, adjusted for taxes and subsidies on products (Fig. 2).

Therefore, making a calculation, we may notice that in 2020, at the EU level, one Euro spent on intermediate consumption (goods and services involved in agricultural production process) produced Euro 0.75 value added.

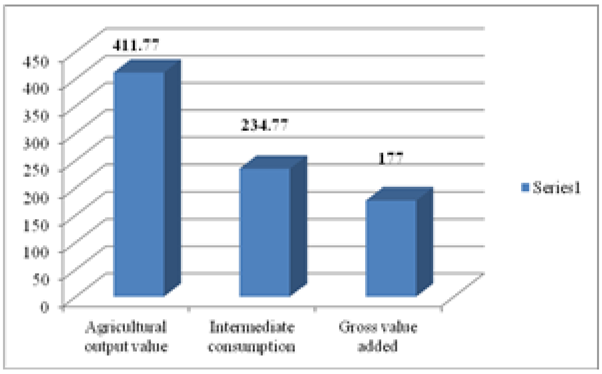

Fig. 2. EU agricultural production output value, intermediate consumption and gross value added in 2020 (Euro Billion)
Source: Own design based on the data from [9].

Most of the member states registered a higher GVA in 2020, with a few exceptions.
The highest growth rate was recorded by Latvia +128.38%, Lithuania +66.94%, Ireland +65.15 and the lowest growth rate by Bulgaria 1.8%.

Compared to 2011, a few countries registered a decline in GVA in 2020 as follows: Estonia -22%, Croatia -3.3% and Romania -2.4%.
The highest contribution to the EU GVA in agriculture was given in 2020 by Italy 17.77%, France 17.05%, Spain 16.54%, Germany 11.44%, Poland 6.24%, Netherlands 5.97%, Romania 4.475, Greece 3.47%, all together accounting for 82.95% (Table 2).

Economic efficiency of the labor force use in the EU agriculture

In this respect, there are many alternatives to quantify the economic efficiency of the use of labor force in agriculture: agricultural output value per 1,000 Annual Work Unit (AWU), gross value added per 1,000 AWU and factor income as a measure of net value added by the equivalent of each full-time worker in real terms adjusted for inflation and expressed as an index [4].

Table 3. Agricultural output value and gross value added per 1,000 AWU in the EU countries in 2020 versus 2011

	Agricultural output value Euro Million/1,000AWU			Gross value added Euro Million/1,000 AWU		
	2020 (Euro Million/1,000 AWU)	Change 2020 vs. 2011 (%) 2011=100	Average annual growth rate, 2011-2020 (%)	2020 (Euro Million/1,000 AWU)	Change 2020 vs. 2011 (%) 2011=100	Average annual growth rate, 2011-2020 (%)
EU	**60.2**	**+25.5**	**2.5**	**20.83**	**+27.5**	**2.7**
Belgium	158.2	+14.4	1.5	41.57	+13.7	1.4
Bulgaria	22.1	+90.5	7.4	9.29	+114.0	8.8
Czechia	53.9	+18.4	1.8	18.08	+33.3	3.2
Denmark	212.7	+3.1	0.3	56.80	+5.7	0.6
Germany	122.1	+13.2	1.3	93.56	+13.8	1.4
Estonia	55.0	+65.6	5.7	13.65	+7.3	0.7
Ireland	54.5	+37.2	3.5	19.20	+70.2	6.0
Greece	29.1	+23.3	2.3	15.13	+25.5	2.5
Spain	67.4	+48.7	4.5	37.33	+58.7	5.2
France	104.7	+14.6	1.5	41.90	+15.1	1.5
Croatia	14.5	+0.69	0.06	7.11	+9.2	0.9
Italy	51.9	+13.5	1.4	29.00	+15.6	1.6
Cyprus	36.4	+30.9	3.0	16.30	+27.2	2.7
Latvia	24.4	+100.0	8.0	8.60	+193.5	12.7
Lithuania	27.1	+49.7	4.5	11.78	+86.6	7.1
Luxembourg	129.0	+35.5	3.4	36.64	+49.3	4.1
Hungary	25.1	+41.8	3.9	10.80	+63.3	5.6
Malta	25.2	-2.8	-0.4	12.30	+3.7	0.4
Netherlands	183.6	+7.0	0.7	68.77	+23.1	2.3
Austria	67.8	+18.7	1.9	28.47	+17.2	1.7
Poland	16.2	+36.1	3.4	6.59	+41.1	3.8
Portugal	35.4	+61.6	5.4	13.15	+65.6	5.7
Romania	12.6	+6.7	0.7	5.95	+12.4	1.3
Slovenia	17.7	+12.7	1.3	7.89	+30.6	3.0
Slovakia	55.2	+38.0	3.6	13.67	+46.8	4.3
Finland	73.9	+31.0	3.0	23.69	+52.6	4.8
Sweden	113.7	+23.4	2.3	32.45	+22.7	2.2

Source: Own calculation based on the data from [5, 7, 8].

Agricultural output value per 1,000 AWU increased by 25.5% in the analyzed at the EU level from Euro 40 Million in 2011 to Euro 60 Million in 2020.

In most of the member states, it was noticed an increased efficiency of the labor force input use, except Malta where it was recorded a decline of -2.8%.

The highest increase of this indicator was noticed in: Latvia +100, Bulgaria +90.5%, Estonia +65.6%, Portugal +61.6%, Lithuania +49.75, Spain +48.7% and Hungary +41.8%.

The lowest growth rate, accounting for +0.69%, was registered in Croatia, practically meaning a stagnation at the same level with the one recorded in 2011 (Table 3).

Based on the value of agricultural output per 1,000 AWU, in 2020, the EU countries were classified in various groups as presented in Table 4.

Table 4. Classification of the EU countries in comparison with the EU average agricultural output value per 1,000 AWU in 2020, accounting for Euro 50.2 Million

Classes	Interval Euro Million	Countries
Higher than the EU average = Euro 50.2 Million		
Over 100% higher than the EU average	Over 50.2	1. Denmark 2.Netherlands 3.Belgium 4.Luxembourg 5.Germany 6.Sweden 7.France
76-99.9% higher than the EU average	87.85-100.4	None
51-75.9% higher than the EU average	75.3-87.84	None
25-50.9% higher than the EU average	62.75-75.2	1.Finland 2.Austria 3.Spain
0-24.9% higher than the EU average	50-62.74	1.Slovakia 2.Estonia 3.Ireland 4.Czechia 5.Italy
Lower than the EU average = Euro 50.2 Million		
-25.6: -0.1% lower than the EU average	50.1- 37.65	None
-50; -25.1% lower than the EU average	37.66- 24.6	1.Cyprus 2.Portugal 3.Lithuania 4.Greece 5.Malta 6.Hungary
-75; -50.1% lower than the EU average	24.5 - 12.5	1.Latvia 2.Bulgaria 3.Slovenia 4.Poland 5.Croatia 6.Romania

Source: Own conception and results.

Gross value added per 1,000 AWU increased by 27.5% in the analyzed interval at the EU level from Euro 16.33 Million per 1,000 AWU in 2011 to Euro 20.83 Million per 1,000 AWU in 2020.

The highest level in the decreasing order of the absolute value was recorded by Netherlands (68.77), Denmark 956.8), Germany (43.56), France (41.9), Belgium (41.57), Spain (37.33), Luxembourg (36.64), Sweden (32.45), Italy (29) and Austria (28.47).

The EU countries were also classified based on gross value added per 1,000 AWU registered at the EU level in 2020 which accounted for Euro 20.83 Million (Table 5).

Table 5. Classification of the EU countries in comparison with the EU average gross value added per 1,000 AWU in 2020, accounting for Euro 20.83 Million

Classes	**Interval Euro Million**	**Countries**
Higher than the EU average = Euro 20.83 Million		
Over 200% higher than the EU average	Over 62.49	1. Netherlands
175- 199.9% higher than the EU average	57.28 - 62.48	None
150 - 174.9% higher than the EU average	52.07 -59.27	1. Denmark
126 - 149.9% higher than the EU average	47.07-52.06	None
100-125.9% higher than the EU average	41.66-47.06	1.France 2.Germany
75-99.9% higher than the EU average	36.45 - 41.65	1.Luxembourg 2.Spain 3.Belgium
50-74.9% higher than the EU average	31.24 - 36.44	1.Sweden
25- 49.9% higher than the EU average	26.03-31.23	1.Austria 2.Italy
0-24.9% higher than the EU average	20.93- 26.02	1.Finland
Lower than the EU average = Euro 20.83 Million		
-25.%: -0.1% lower than the EU average	15.63 -29.82	1.Cyprus 2.Czechia 3.Ireland
-50; -25.1% lower than the EU average	10.42 - 15.62	1.Greece 2.Slovakia 3.Estonia 4.Portugal 5.Malta 6.Lithuania 7.Hungary
-75; -50.1% lower than the EU average	5.21-15.61	1.Bulgaria 2.Latvia 3.Slovenia 4.Croatia 5.Poland 6.Romania

Source: Own conception and results.

Using the Point method and giving points for each country according to its position in this classification based both on the value of the agricultural output per 1,000 AWU and also on gross value added per 1,000 AWU, it was obtained a final hierarchy where the top countries having the highest efficiency of the use of labor force input are the following ones: Denmark and Netherlands on the 1st position, Germany and Belgium on the 2nd position, France and Luxembourg on the 3rd position, Sweden on the 4th position, Spain on the 5th position, Austria and Finland on the 6th position and Italy on the 7th position.

Labour productivity in terms of Indicator A or Factor income, according to the economic accounts of agriculture, is generated by two factors: net income obtained in agriculture from goods and services and the amount of work achieved in farming activities expressed in full time labor equivalent (AWU).

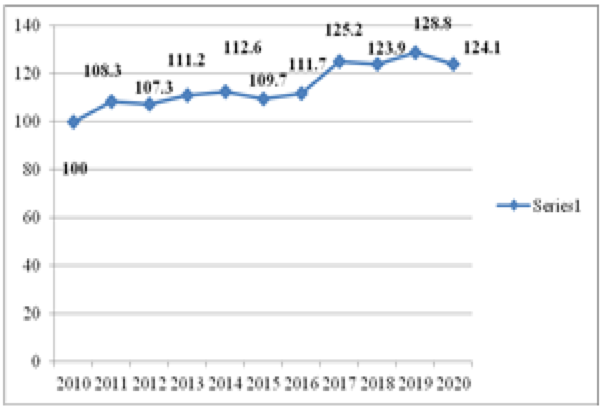

Fig. 3. Dynamics of Labor productivity in the EU agriculture in terms of Factor A in the period 2011-2020 compared to 2010= 100 (%).
Source: Own design based on the data from [6].

At the EU level, Factor A registered a general ascending trend in the period 2011-2020 compared to its level in 2010, considered term of reference (Fig. 3). Considering 2010 = 100, in Table 6, it is shown the level of Indicator A in 2020 compared to 2011 in the EU countries. From this point of view, we may notice that the counties which registered the highest Indicator A in 2020 compared to 2010, in the descending order, are: Bulgaria, Hungary, Slovakia, Lithuania, Latvia, Czechia, Croatia, Spain, Poland, Ireland, Italy and Portugal, while Belgium, Malta, Netherlands, Austria and Finland recorded lower levels than 100 (Table 6).

Table 6. Labor productivity in agricultural industry in the EU countries in terms of Factor A in 2020 and 2011 compared to 2010=100

Country	2011	2020	Percentage change in 2020 versus 2011 (%)
EU	**108.28**	**127.20**	**+18.92**
Belgium	89.34	84.16	-5.18
Bulgaria	115.64	246.21	+130.52
Czechia	134.84	150.26	+15.42
Denmark	112.38	106.43	-5.95
Germany	118.14	100.40	-17.74
Estonia	124.39	112.62	-11.77
Ireland	127.98	140.68	+12.7
Greece	89.07	114.38	+25.32
Spain	101.19	144.60	+43.41
France	104.58	107.12	+2.54
Croatia	95.50	150.00	+54.5
Italy	117.23	134.14	+16.91
Cyprus	74.93	126.35	+51.42
Latvia	95.82	177.98	+82.16
Lithuania	125.89	180.23	+54.34
Luxembourg	99.81	118.34	+18.53
Hungary	149.33	204.24	+54.91
Malta	87.85	83.43	-4.42
Netherlands	85.56	90.83	+5.27
Austria	114.14	99.84	-14.3
Poland	113.77	141.44	+27.67
Portugal	86.03	134.12	+48.09
Romania	129.06	120.65	-8.41
Slovenia	114.01	127.50	-13.49
Slovakia	118.63	193.49	+74.87
Finland	86.38	91.61	+5.23
Sweden	103.88	110.43	+7.55

Source: Own calculation based on the data from [6].

The classification of the countries in comparison with the EU average for Factor A, taking into consideration various intervals superior and inferior the EU mean 127.20% in 2020 is presented in Table 7. We may observe that 14 countries that is 51.85% of their total number succeeded to exceed the EU average. However, most of the member states made huge efforts to improve labor productivity. Bulgaria and Hungary are in the top position with a Factor A by 50% higher than the EU average. At the opposite corner there are Germany, Austria, Finland, Netherlands, Belgium and Malta with a Factor by 26-50% below the EU average.

Table 7. Classification of the EU countries in comparison with the EU average Factor A accounting for Euro 127.20% in 2020

Classes	Interval (%)	Countries
Factor A higher than the EU average = 127.20%		
By 50% over the EU average	Over 202.23	1. Bulgaria 2.Hungary
By 26-50% higher than the EU average	152.22- 202.22	1.Slovakia 2.Lithuania 3.Latvia
By 25% higher than the EU average	127.21-152.21	1. Czechia 2.Croatia 3.Spain 4.Poland 5.Ireland 6. Italy 7.Portugal 8.Slovenia 9.Cyprus
Factor A lower than the EU average = 127.20%		
By 25% below the EU average	102.2-127.20	1.Romania 2.Luxembourg 3.Greece 4.Estonia 5.Sweden
By 26-50% below the EU average	77.19-102.1	1.Germany 2.Austria 3.Finland 4.Netherlands 5.Belgium 6.Malta

Source: Own conception and results.

CONCLUSIONS

The EU is still a big employer in agriculture due to the specificity of the production processes in this field. However, the employment rate is declining and in 2019 it accounted for 4.37%. the member states with a higher employment rate than 8% are Poland, Romania, Italy, Spain and France.

The study analyzed the dynamics of labour productivity in the EU countries and pointed out that its level is influenced by two key factors: net value added obtained in this sector and agricultural labor input in terms of annual work unit. While net value added has a general increasing trend, labour input is declining.

In the period 2011-2020, the EU agricultural output value and gross value added have definitely increased, accounting for Euro 411.77 Billion and, respectively, Euro 176,96 Billion in 2020. About 76.15% of the EU agricultural output is given by 7 countries: France, Germany, Italy, Spain, Netherlands, Poland and Romania. Regarding GVA, the highest contribution to its level is given by: Italy, France, Spain, Germany, Poland, Netherlands, Romania and Greece, all together accounting for 82.95%.

Of course, there are still discrepancies regarding both agricultural output value and GVA from a country to another, and in consequence labour productivity has various levels.

In 2020, agricultural output value per 1,000 AWU reached Euro 60 Million and GVA Euro 20.83 Million. The average agricultural output value per 1,000 AWU at the EU level in 202O was Euro 50 Million, but only Denmark, Netherlands, Belgium, Luxembourg, Germany, Sweden, France succeeded to reach levels higher than 100% of the EU mean. At the opposite pole, there are countries like Latvia, Bulgaria, Slovenia, Poland, Croatia and Romania with an agricultural output value per 1,000 AWU representing between -50 and -75% of the EU average.

Concerning Gross value added per 1,000 AWU the EU average level accounted for Euro 20.83 Million in 2020, and only Netherlands, Denmark, France, Germany succeeded to reach a level by over 100% higher than the EU mean. The countries with the lowest GVA in agriculture per 1,000 AWU were Bulgaria, Latvia, Slovenia, Croatia, Poland and Romania (till -75% of the EU mean).

Labour productivity in terms of Indicator A or Factor income accounted for 124% of the level 100% in 2010. In 2020, the highest level of Indicator A was recorded by Bulgaria and Hungary,

which succeeded to reach a level by 50% higher than the EU average 124%. Germany, Austria, Finland, Netherlands, Belgium are a group which recorded a level by 25-50% lower than the EU mean.

In conclusion, the efforts for increasing agricultural production value and GVA per 1,000 AWU made by the EU member states have led to various results in term of efficiency of the use of labour force, and for the moment we could not affirm that there is a convergence regarding this aspect.

How to increase the efficiency of labor force input in the EU agriculture?

Looking at the determinants of labor productivity, we may consider that they could offer the right answers to this question as follows:

(a) To increase agricultural output performance, meaning to pay attention to grow its volume, to improve its structure, product and service quality and also to take into consideration price level;

- To raise agricultural production output value requires either a higher input of goods and services, that is intermediate consumption or lower inputs, and the strategies adopted to be suitable to each member state depending on the structure of agriculture by sectors.
- Also, the improvement of product and service quality has to be an important objective resulting in a higher output value is the quality is higher and closely linked to a better price;
- To improve the structure of agricultural output means to balance the ratio between vegetal , animal and service sectors, the changes being justified by market requirements, production input and output, price/quality ratio.

(b) To optimize intermediate consumption regarding the main inputs; seeds, planting materials, fertilizers, pesticides, insecticides, soil improvers, fuels, animal feedstuffs, medicines, veterinary services and the cost of these inputs must be the solution to the game between the purchasing volume, structure and price.

(c) The solutions are subject of decision making which belongs to each member state depending on the local situation in vegetal, animal and service sectors, but having in mind the general directions established by CAP for ensuring the sustainable agriculture development in the EU.

In this respect, a special attention has to be paid to pesticides which have to be used according to the EU regulations regarding the reduction of risks.

Fertilizers are still needed, but their use, especially regarding Nitrogen and Phosphorus as active substance, have to be scientifically justified for avoiding the excessive utilization which could increase soil and water pollution and diminish biodiversity and also the deficit.

(d) The reduction of labor force input in agriculture depends on the potential available working population as age, education level and also on the technical endowment and technologies applied and farm structure in terms of size and profile. In this respect, rural population aging and migration could be favorable factors, but it is needed to continue to offer incentives to create the new generation of young farmers with high knowledge and skills able to develop a successful entrepreneurship.

(e) More than this, the increase of labor productivity has to keep pace with the need of adaptation to the challenges imposed by climate change. New technological solutions and new areas of favorability suitable to various crops have to be found in order to diminish the negative effects of the extreme climate phenomena.

(f)Not to forget that since May 2020, the EU adopted a new Farm to Fork strategy as mentioned by the European Green Deal, which aims to transform this part of the world in a " healthy and environmentally friendly food system by 2050". This means a high agricultural performance based on land use diversity, soil water and air protection, biodiversity conservation and landscape preservation.

An efficient labor force use in agriculture means high qualified, conscious, responsible, workable and devoted labor input.

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LABOR PRODUCTIVITY IN ROMANIA'S AGRICULTURE IN THE PERIOD 2011-2020 AND ITS FORECAST FOR 2021-2025 HORIZON

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Abstract

The paper analyzed labor productivity in Romania's agriculture in the period 2011-2020 and established the forecast for 2021-2025 horizon using the Eurostat data. The processing procedures included fixed basis index, average growth rate, average annual growth, regression models, determination coefficient, descriptive statistics (mean standard deviation and variation coefficient), comparison methods and forecast modeling. The results proved that agriculture productivity is increasing with a lower growth rate, being deeply influenced on output value, gross value added and labour input. Per 1,000 AWU, agricultural output value decreased by 6.77%, gross value added increased by 12.47% and factor income raised by 20.65%. However, for its level of output value and GVA, Romania comes on the last position and for factor income level it comes on the 15th position in the EU. For agriculture development, labour productivity must be increased paying attention to the key determinants: farm structure and size, labour input, technical endowment, and investment.

Key words: *labor productivity, agriculture, dynamics, forecast, Romania*

INTRODUCTION

Economic growth in agriculture depends on labour productivity [2]. Labor productivity is determined by a large range of factors among which the most important ones are: agricultural output, gross value added, employment and its type in agriculture: full or part-time [11], farm structure, average farm size, average economic farm size [9], farm specialization and production structure [26], mechanization degree, the production potential of the used varieties and animal breeds, chemicalization degree (fertilizers, herbicides, pesticides) [3], the share of production for onfarm consumption, labour input [27], investment level, farmers' training level, age and experience, natural conditions (soil, climate etc.). Agriculture needs special farm inputs for increasing production performance, but the increasing trends in purchasing price has raised production costs and diminished profit, an aspect which justify why farmers are complaining [12] The discrepancies from a country to another in labour productivity are mainly determined by the regional specificity, farm structural conditions and availability of part-time jobs [4, 10, 25]. In the rural areas population is enough high from a numerical point of view, but its economic performance is lower than in the urban areas taking into consideration employment, labour input, GDP and GVA per inhabitant, labour productivity, education level [1]. As agriculture is a highly labour-intensive sector, productivity level in negatively influenced by labour input data while gross value added has to be intensified to contribute to the growth of agricultural output and gross value added [27, 13, 14].
More than this, the seasonality of agricultural processes has a deep influence on the type of

work especially on part-time work required in the peak of production, and this is the reason why labour input is measured in annual work unit (AWU) reflecting the working time of one person engaged in agriculture on a full-time basis in a year [24].

Romania is one of the EU member states where rural population has a high share and also agriculture has still a high labour input [22], agriculture has a high contribution to GDP [16, 18], agricultural production has increased [20, 21], labour productivity is increasing but with a lower growth rate than in other countries [15, 17]. However, agricultural production has become more and more affected by climate change which produced considerable damages to farmers and production losses [19, 23]. Despite that, Romania is still one of the main contributors to the EU agricultural output value. In this context, the purpose of the paper was to analyze the dynamics of labour productivity in Romania's agriculture in the period 2011-2020 in order to identify how agricultural output, gross value added, factor income per 1,000 AWU have changed during the last decade and to establish the forecast for the horizon of the next five years.

MATERIALS AND METHODS

Labor productivity was analyzed using three specific indicators: agricultural output value, gross value added and Factor A (factor income) all of them per 1,000 annual work unit (AWU).

The statistical data were provided by Eurostat for the period 2011-2020, which have been processed utilizing the following methods:

- The dynamics index with fixed basis, $I_{FB} = (X_n/X_1)x100$, for establishing the increase/decrease in 2020 compared to 2011 level;
- Average annual growth, $\bar{\Delta} = (X_n/X_1)/n$, where: X_n is 2020 and X_1 is 2021.
-Descriptive statistics including mean, standard deviation and coefficient of variation;
-Graphical illustration of the dynamics pointing out the regression model and the coefficient of determination;
-Forecast model based on the result in the last year of the time series and average annual growth, according to the mathematical formulas: $X_{F2021} = X_{2020} + \bar{\Delta}$, $X_{F2022} = X_{F2021} + \bar{\Delta}$ etc.

The results have been commented and presented in graphics and tables and finally there were drawn the main conclusions.

RESULTS AND DISCUSSIONS

Agriculture output value per 1,000 AWU

In the analyzed period 2011-2020, in Romania's agriculture, labour productivity in terms of agricultural output value per 1,000 AWU increased by +6.77% from Euro 11.8 million in 2011 to Euro 12.6 million in 2020 (Fig. 1).

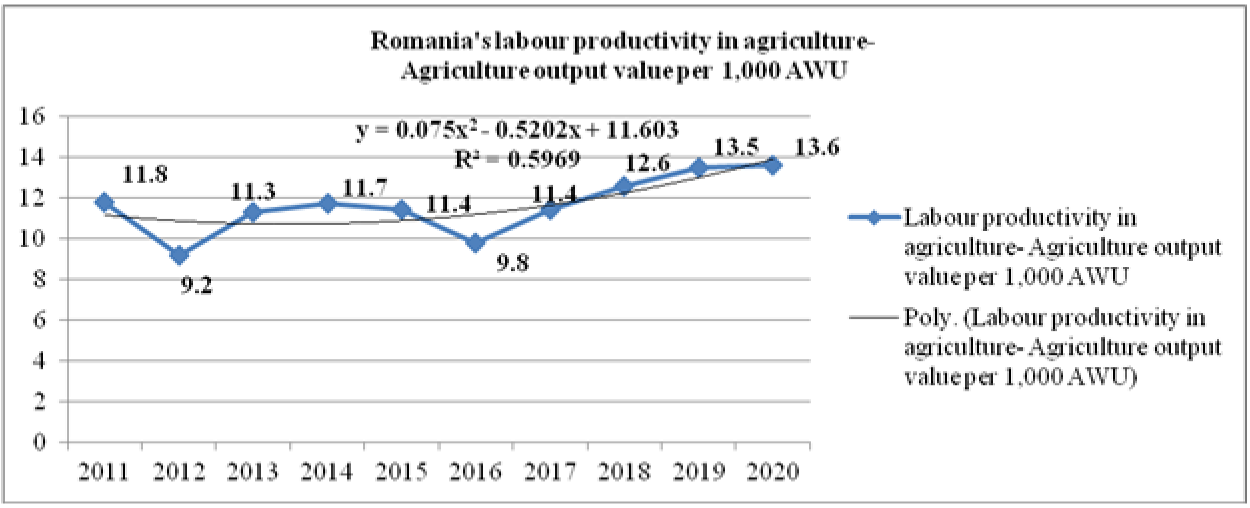

Fig. 1. Agriculture output value per 1,000 AWU, Romania, 2021-2020 (Euro Million)
Source: Own design and calculation based on Eurostat [5, 8].

This growth rate on the whole interval was 3.76 times lower than the growth rate at the EU level which accounted for +25.5% during the studied decade.

In 2020, the labor productivity in Romania in terms of agricultural output value per 1,000 AWU represented 25% of the EU average which was Euro 50.2 million and placed the country on the last position among the member states.

Therefore, we can't consider that Romania has a high performance in agriculture regarding labour productivity.

The causes which have determined this situation were the following ones, looking at the two factors: agricultural output value and labor force input:

-In the period 2011-2020, *the agriculture output value* declined from Euro 18,048 million in 2011 to Euro 16,847 million in 2020, meaning by - 6.66%. This means a contribution of only 4.08% to the EU agriculture in 2020.

However, Romania is situated on the 7th position for its contribution to the EU agricultural output value after France, Germany, Italy, Spain, Netherlands and Poland [20, 21].

The decrease of agriculture output value was caused by the negative impact of climate change in terms of extreme weather phenomena like severe and long drought (in 2012, 2015, 2016, 2019 and 2020) in the period of vegetation for the main agricultural crops, low temperatures and cold rains in the period of fruit trees blooming, and fast, short but huge rainfalls with hail producing important damages. In addition, the irrigation systems are assured just on a small surface of the agricultural land.

The South Muntenia and especially the Eastern Romania were the most affected regions by drought with a negative impact on production level [19, 23].

More than this, Romania's agriculture is dominated by small size farms, especially family farms which have a low technical endowment, apply traditional technologies, farmers have a low training level and are over 60 years old, are lacked of a corresponding fixed and financial capital.

-*Labour force input* in Romania's agriculture is very high compared to other EU countries. In 2020, Romania had 1,331 thousand AWU labour input, being situated on the 2nd position after Poland. However, labour input registered a considerable decline accounting for -13.25 in the last decade from 1,532 thousand AWU in 2011 to 1,331 thousand AWU in 2020.

Labour input in Romania represents 15.66% of the total labour input in the EU's agriculture in 2020, being ranked the 2nd after Poland which had 19.72% market share.

Despite that labour input is higher in agriculture, it is characterized by aging and low training level. Just a few farmers, managers of commercial companies which represent about 1% of all the agricultural holdings are well trained and the holdings are endowed with modern equipments which allow the application of modern technologies.

Family work is dominant and part time workers are rarely used, in fact agriculture suffers of a lack of part time workers especially in the field of viticulture and fruit tree growing especially at harvesting.

Gross value added per 1,000 AWU

The level of GVA per 1,000 AWU in Romania increased by =12.47% in the analyzed period from Euro 5.29 million in 2011 to Euro 5.95 million in 2020, and the level of the last year represented 28.56% of the EU average which accounted for Euro 20.83 million per 1,000 AWU.

For this reason, Romania occupied the last position in the EU like in case of agricultural output value.

GVA had substantial fluctuations from a year to another at the beginning of the decade, but starting from 2015, it registered a continuous growth till 2019 and then it declined in 2020, due to the unfavorable last years (Fig. 2).

For its growth rate of 12.47% in the studied period, Romania came on the 23rd position in the EU reflecting a contribution of only 1.3% to the EU GVA from agriculture.

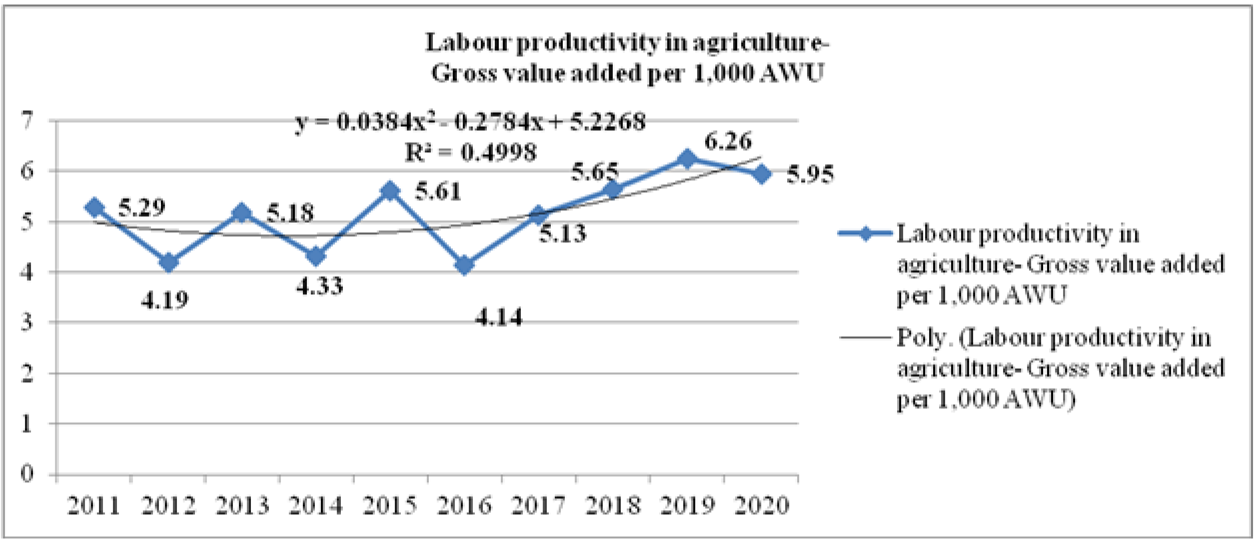

Fig. 2. Gross value added per 1,000 AWU, Romania, 2021-2020 (Euro Million)
Source: Own design and calculation based on Eurostat [5, 7].

Factor income per 1,000 AWU
The level of this indicator in Romania accounted for 120.65% in 2020 being by +20.65% higher than in 2010, considered equal to 100. This means a difference of -3.45% compared to the EU average of 124.1% in 2020 (Table 1 and Fig. 3).

Table 1. Factor income per 1,000 AWU in Romania compared to the EU, 2011-2020

	EU	Romania	Difference RO vs EU
2010	100.0	100.0	-
2011	108.3	129.06	+20.76
2012	107.3	96.13	-11.17
2013	111.2	113.56	+2.16
2014	112.6	123.94	+11.34
2015	109.7	116.22	+6.52
2016	111.7	119.99	+8.29
2017	125.2	136.01	+10.81
2018	123.9	138.37	+14.47
2019	128.8	139.97	+11.17
2020	124.1	120.65	-3.45

Source: Own calculation based on Eurostat [6].

For the level of Factor income, Romania came on the 15th position in the EU after Bulgaria, Hungary, Slovakia, Latvia, Czechia, Croatia, Spain, Poland, Ireland, Italy, Portugal, Slovenia and Cyprus.

Descriptive statistics for labour productivity in Romania's agriculture in terms of mean, standard deviation and variation coefficient is presented in Table 2.

The variation coefficient varying between 10 and 20% reflects relative homogenous values for all the indicators in the time series. Therefore, the means are could be considered representative.

Forecast of labour productivity in Romania's agriculture for 2021-2025 horizon

Taking into account the average annual growth for each of the three indicators characterizing labour productivity, it was set up the forecast for 2021-2025 horizon.

In the interval 2011-2020, the average annual growth per 1,000 AWU accounted for Euro 0.08 million in case of agricultural output value, Euro 0.066 million in case of GVA and 2.06% in case of Factor income.

Taking into consideration the level of each indicator in 2020 and the average annual growth, the forecast for the next 2021-2025 is shown in Table 3.

The results show that in 2025, Romania will reach a labour productivity per 1,000 AWU of Euro 13 million agricultural output value, Euro 6.30 million gross value added and 130.95% factor income.

The figures do not show too much progress but they had to be predicted in order to have an image of what we could expect to happen in the next five years.

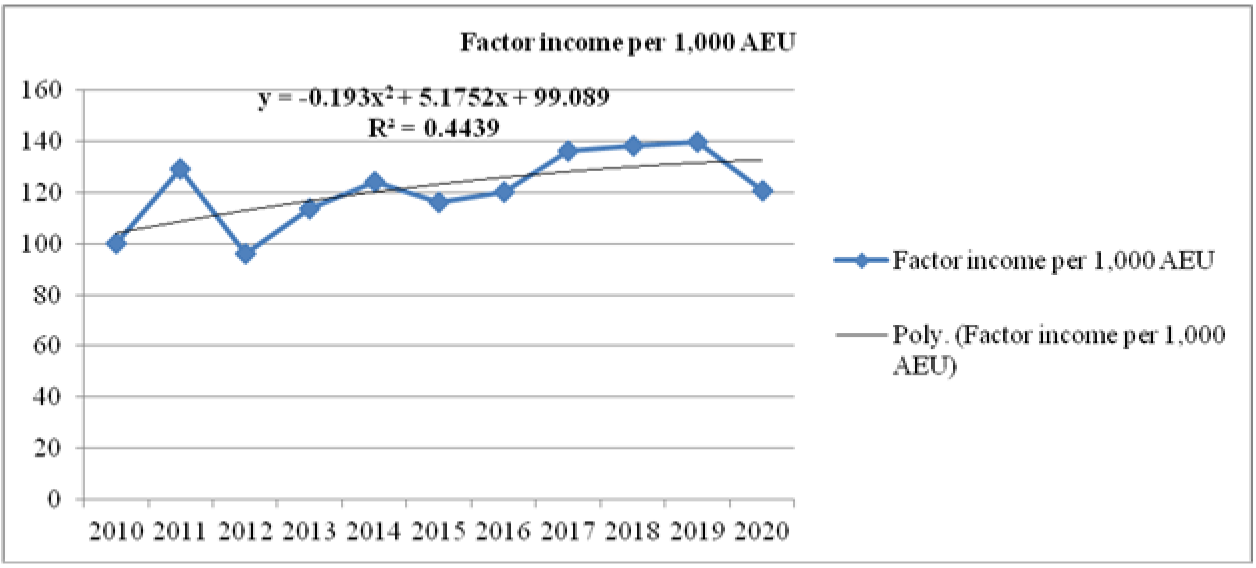

Fig. 3. Factor income, Romania, 2011-2020 (%)
Source: Own design based on Eurostat [6].

Table 3. Forecast for Romania's agriculture labour productivity for 2021-2015 horizon

	Agricultural output value/1,000 AWU	Gross value added/ 1,000 AWU	Factor income/1,000 AWU
2021	12.68	6.02	122.71
2022	12.76	6.09	124.77
2023	12.84	6.16	126.83
2024	12.92	6.23	128.89
2025	13.00	6.30	130.95

Source: Own calculations.

CONCLUSIONS

Romania has still a low productivity in agriculture due to the high labour input, lack of agricultural production concentration, small farm size, unefficient technologies and obsolete endowment.

This was proved by the obtained results per 1,000 AWU in the analyzed period.

However, agricultural output value decreased by 6.77%, gross value added increased by 12.47% and factor income increased by 20.65%.

That is why Romania is situated on the last position for agricultural value and gross value added per 1,000 AWU and on the 15th position for factor income.

Therefore, the improvement of labour productivity in agriculture requires: a higher concentration of agricultural production, a better farm structure, a lower labour input, technological modernization, a new technical endowment, a higher training level for farmers, and encouraging young people from the rural areas to develop business in agriculture.

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POLLINATION AND ITS CONTRIBUTION TO THE FRUIT PRODUCTION VALUE IN ROMANIA'S ORCHARDS IN THE PERIOD 2011-2020

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Abstract

The paper studied the dynamics of the economic value of pollination in Romania's orchards taking into account the main trees species producing fruits: plum, apple, cherry, apricot, pear and peach fruit trees in the period 2011-2020. The data provided by National Institute of Statistics were used to quantify fruit production and value based on the average annual purchase price, and the economic value of fruit production produced by pollinators, taking into consideration de dependence degree by fruit tree species. After a period of decline, fruit tree growing has recovered especially during the last years making investments in new plantations of apple, plum, cherry, peach trees etc. In 2020, Romania had 138,000 ha of orchards, over 74 million fruit trees, a fruit production of 1.6 million tons of which 93.33% came from the six main fruit tree species: plum (48.4%), apple (34.4%), cherry(4.6%), pear (3.09%), apricot (1.74%) and peach trees (1%).The total value of fruit production from the six species accounted for Euro 1,303.69 Million at purchase price, being by 42.2% higher than in 2011. The results proved that the pollination economic value contributed by Euro 1,032 Million, that is by about 80% to fruit production value in 2020, which reflects how important is insect pollination in fruit trees growing. In 2020, the economic value of pollination per fruit tree accounted for: Euro 12.2 for plum tree, Euro 15.7 per apple tree, Euro 13.2 per pear tree, Euro 12.4 per peach tree, Euro 26.6 per cherry tree and Euro 14.5 per apricot tree. Therefore, the entomophilous fauna has to be preserved not only for biodiversity conservation but mainly for helping the sustainable development of fruit tree growing to produce more and of higher quality.

Key words: *fruit production, dependence rate on pollination, pollination economic value, dynamics, Romania*

INTRODUCTION

Insect pollinators provides vital ecosystem services for sustaining agriculture and food production and for preserving plant biological diversity.

Fruit and vegetable crop production and quality depends on pollination services.

Pollination services contribute significantly to the agricultural production and its quality which assures about 75% of world food production, also to seeds spreading and plant reproduction, that is to biodiversity conservation [5, 6, 7, 9].

However, the modern agricultural technologies whose purpose is land use intensification as well as the growth of the global population are affecting the insect pollinators and their useful services [11].

Using the data from 200 countries, Klein et al (2007) found that "fruit, vegetable or seed production from 87 of the leading global food crops is dependent upon animal pollination". Also, if we consider the volume of the world production, "60% comes from crops without dependence animal pollination, and only 35% from crops that depend on pollinators" [14].

In agriculture, pollination efficacy depends on the variety and density of entomophilous insects existing in an area, on the structure of agricultural crops, vegetables, orchards, grasslands, on the dependence degree of each crop on pollinator services and average purchasing price of the obtained products [23].

Each crop has a different insect pollination (IP) dependency ratio (DR) as mentioned by Klein et al. (2007), and Gallai et al. (2009), who established the following yield dependence classes: *essential*, DR = 0.95 (between 90 and 100%), *great*, DR = 0.65 (40–90%), *modest,* DR = 0.25 (10–40%), and *little*, DR = 0.05 (0–10%) [5, 6, 14, 23].

In Europe there is a large variety of pollinators like: bees, butterflies, bumblebees, flies, wasps, beetles, moths and other insects with an important role for agriculture and wild flora and for maintaining biodiversity.

Among the pollinators, honey bees occupies a special role, position and attention worldwide [3, 12].

The large range of agricultural crops (sunflower, rape etc) is an important nectar and pollen source for bees [10, 16, 39, 42].

Grace to bees, the performance in crop yield, product quality and even in the shelf life and commercial value could be improved [13].

Honey bees have a special preference for the nectar pickings in the orchards of apple, apricot, cherry, plum, peach trees sustaining fruit production by their pollination services [4, 19]. The production gains varying between 80% for apple and pear trees and 30% for cherry and plum trees could be obtained grace to pollination [8, 25, 37].

Also, pollination is partially important for vegetables, while cereals, sugar beet and potatoes do not need pollination [16].

In Europe, *Apis mellifera* L. represents a peculiar species of pollinators with a special organization, work distribution among the members of the bee family, behaviour, communication relationships, and ability to transmit information about the place and position of the feed sources and their quality, and a high efficiency in pickings and producing honey for increasing the bee family power.

Spain, Greece, France, Italy, Poland and Romania have the highest number of bee colonies and hives, an aspect which is in the benefit of agriculture, beekeepers, environment and biodiversity [40].

That is why beekeeping is encouraged and financially sustained in the EU countries to increase the number of hives, bee families, apiaries, and apiculturists [40].

Bees contribution to agricultural production, biodiversity and the beauty of the landscapes reflects their importance for maintaining life on the Earth. But, we know that honey, pollen, royal jelly, propolis, venon, wax, and other wonderful products of the bee families are so important for human life. Beekeeping is a wonderful job outdoors and offering important income sources for apiculturists [26].

In Romania, beekeeping is highly developed, the number of bee colonies as well as their contribution to honey production [35, 39, 40, 41], trade [28, 31], profitability in beekeeping [27, 29, 30, 33], honey price [34], landscapes, biodiversity and environment protection and to pollination in agriculture have an ascending trend. An important growth was also carried out in fruit production [32, 36].

However, various factors such as: intensification of agriculture, the loss of habitat, reduction of fee availability, pollution, climate change, and diseases affect pollinators number [2].

Compared to the Western EU countries where agriculture is highly intensified, in Romania there is still a low intensity of farming. Studying the major pollinator groups-wild bees, hoverflies and butterflies in traditional farmlands in the Transylvanian Basin, Romania, Kovács-Hostyánszki et al (2016) found that arable fields and grasslands have abundant flower resources for sustaining pollinator communities [15, 43].

The European Parliament also adopted new regulations in order to diminish pollinators decline and also to sustain beekeeping [1, 17, 24].

In Romania there are no studies about the impact of pollination on agricultural production and biodiversity.

In this context, the paper aimed to study the economic impact of pollination in Romania's fruit production taking into consideration the main fruit trees species: plum, apple, cherry, pear, apricot and peach trees in the period 2011-2020 and using the data from National

Institute of Statistics. In fact, it was estimated the value of fruit production which is due to insect pollination services by fruit tree species, based on fruit production, dependency ratio and average annual fruit purchase price.
This paper is original being the first time when in Romania this topic is approached in the methodological manner described in the next paragraph.

MATERIALS AND METHODS

The study was based on the empirical data provided by National Institute of Statistics and Ministry of Agriculture and Rural Development for the period 2011-2020.
The following indicators were analyzed:
- Orchards surface and its distribution by fruit trees species;
- Number of fruit trees and its dynamics, trend line, regression equation, coefficient of determination and structure by species;
- Fruit production for the main six fruit trees species: plum, apple, cherry, apricot, pear and peach trees and its dynamics and structure;
-Total fruit production evolution and its trend line, regression equation and coefficient of determination;
- Fruit purchase price in Euro per ton, taking into account the average exchange rate RON/Euro in the period 2011-2020 according to National Bank of Romania;
- Dependence ratio of fruit production on pollination: 93% for cherry (average between sweet and sour cherry), 90% for apple, 70% for plum, apricot, peach and pear trees;
- Value of fruit production (FPV) at purchase price for each type of fruit, calculated according to the formula:

$$FPV = FP \times AAP \quad (1)$$

where:
-VFP is value of fruit production;
-FP is fruit production;
-AAP is the average annual purchase price of each fruit type;
-Total fruit production value (TFPV) according to the formula:

$$TFPV = \sum_{i=1}^{n} FPV \quad (2)$$

where n = 6, and represent the fruit tree species;
-Share of each fruit type in total value of fruit production;
- Economic value of insect pollination (EVIP) of the main orchards, calculated with the formula:

$$EVIP = TVFP \times D_{\%} \quad (3)$$

where:
-TVFP is total value of fruit production;
-$D_{\%}$ is the dependence ratio of fruit trees species on pollination.
-Total economic value of insect pollination (TEVIP) was determined with the formula:

$$TEVIP = = \sum_{i=1}^{n} FVIP \quad (4)$$

-The dynamics of these indicators was studied using the index with fixed basis, $I_{FB} = (X_n/X_1) \times 100$, where X_1 is the level of the indicator in the year 2011 and X_n the level of the indicator in the year 2020;
-Structural indices were utilized for emphasizing the percentage contribution of each fruit trees species to the total production, total production value and total economic value of pollination.
-Graphical illustration of the dynamics pointing out the regression model and the coefficient of determination.
The results were depicted in graphics and tables and the corresponding interpretation and comments were done, and finally the main conclusions were drawn.

RESULTS AND DISCUSSIONS

Main fruit trees cultivated in Romania
Romania has a large variety of fruit plants, but the main species are represented by fruit trees, among which the most important ones are:
- *Prunus domestica* L. - the plum tree cultivated for its fruits which could be consumed as fresh fruits or processed in jams, canned, sweets, cakes and the well know Romanian brandy named "tuica";
-*Malus pumila* Mill or *Malus domesticus* L.- the apple tree producing the most valuable fruit for human health, which could be utilized

as fresh fruit, a real medicine, and also as dried apple or processed in soft drinks, cider, distillates, pies, cakes etc.;

-*Prunus avium* L. - sweet cherry tree and *Prunus cerasus* L. - sour cherry tree, which are well known for their delicious fruits which could be consumed as fresh fruits, but also like industrialized fruits: candied, frozen and canned cherries, jams, soft drinks, alcoholic drinks (cherry brandy, liqueurs), syrups, pies, cakes, ice-cream, sherbet, spump, souffle, salads, sauces;

-*Prunus communis* L. - the pear tree produces wonderful sorts of fruits which are preferred to be consumed fresh or processed in canned fruits and juice;

-*Prunus armenica* L.- the apricot tree provides tasty and flavoured fruits used as fresh fruits or processed in jams, liqueur, juice or included in biscuits and cakes;

-*Prunus persica* L.- the peach tree produces juicy and flavoured fruits which could be consumed as such or in jams and juices.

All these fruit trees are pollinated by various insects, but especially by honey bees.

Cultivated area with fruit trees

According to Ministry of Agriculture and Rural Development, in 2018, the apple trees plantations were situated on the top position covering 53,900 ha (39.2%), the plum trees orchards had 53.400 ha (39.1%) and 30,000 ha were cultivated with other species (cherry, pear, apricot, peach, nut trees etc, all of them summing 137,300 ha. But, this area was by 5.5% smaller than 145,300 ha in 2009 [20].

In 2019, the same surface like in 2018 included about 47% (64,530 ha) plum trees and 40% (55,000 ha) apple trees, and the remaining of 13% belonged to other species.

Romania is on the top position in the EU for its surface covered by orchards of plum trees and on the 2nd position for the area of the apple trees orchards.

In 2020, Romania reached 138,000 ha fruit trees plantations, therefore it was recorded a slight increase of 0.5% in new plantations [21].

In 2020, Romania had 6,780 ha cultivated with cherry trees, by 10% more than in 2016 and representing 4.9% of the orchards area. The growth of the surface was due to the interest of the growers for cherry trees whose technologies are simple, production is high and the market price is good [18].

Also, in 2020, the pear trees were cultivated on about 3,250 ha, apricot trees on 2,370 ha and peach trees on about 1,700 ha (Fig. 1).

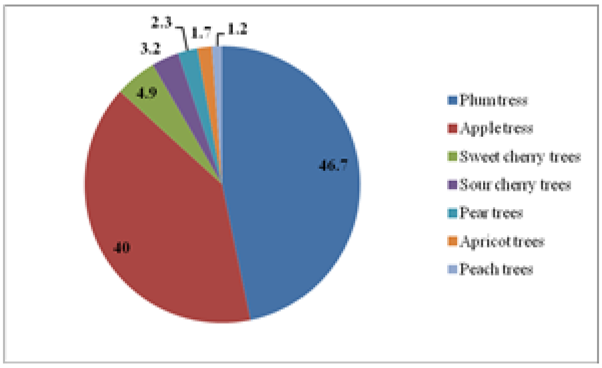

Fig. 1. The share of the fruit trees in the orchards surface in 2020, Romania (%)
Source: Own design based on the data from [22].

Number of fruit trees

In Romania, in the period 2011-2020, the number of fruit trees registered a general decreasing trend from 85,741,132 trees in 2011 to 74,059,510 trees in 2020, meaning by 13.63% less in the last year of the interval compared to the first year (Fig. 2).

In fact, after the year 1990, the orchards were facing a severe degradation, just a few investments were made in new plantations, the fruit trees growers were lacked of labour force for maintaining the plantations, climate change affected the orchards at blooming or at fruit maturity or harvesting, causing production losses and fruit quality was diminished.

Only during the last year, new plantations were installed especially for apple trees, cherry and peach trees.

As a result, the main accent was done on these three species and a weak attention was given to the other sorts of trees: pear, apricot and peach trees.

In consequence, fruit production declined and at present, import is required to cover consumption needs in the domestic market.

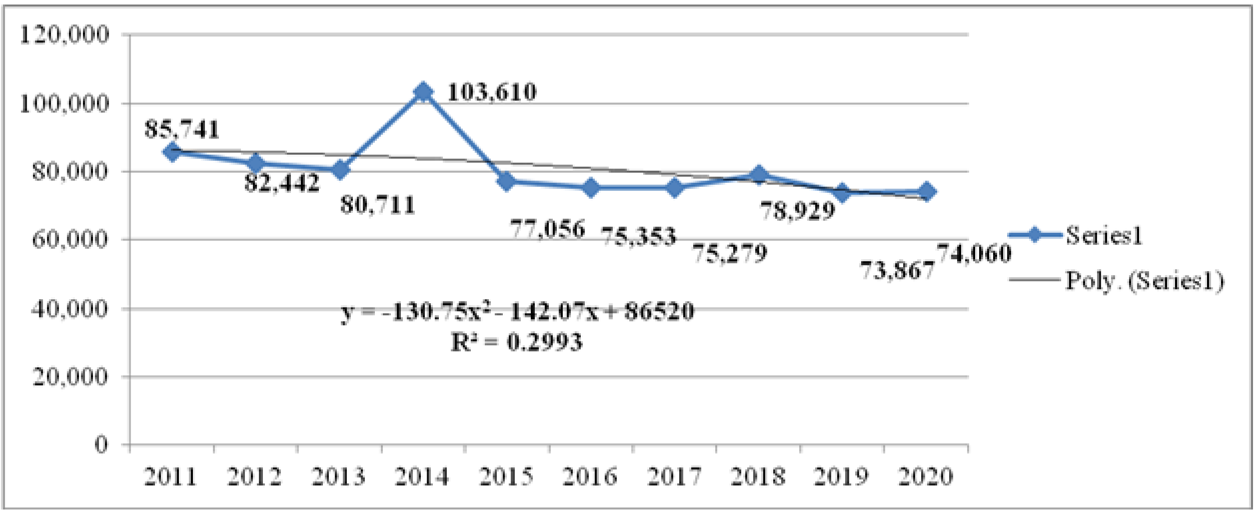

Fig. 2. Number of fruit trees in Romania, 2011-2010
Source: Own design based on the data from [22].

In 2020, the highest share in the total number of fruit trees belonged to plum trees, 46.48%, and apple trees, 32.70%, the both species summing 79.18%.

From a numerical point of view, on the next positions came sweet and sour cherry trees with a share of 7.26%, pear trees with 4.46%, apricot trees 2.8% and peach trees 1.47%.

All these six species together represent 95.17% in the total number of fruit trees, and the remaining of 4.83% belongs to nut and hazelnut trees etc (Fig. 3).

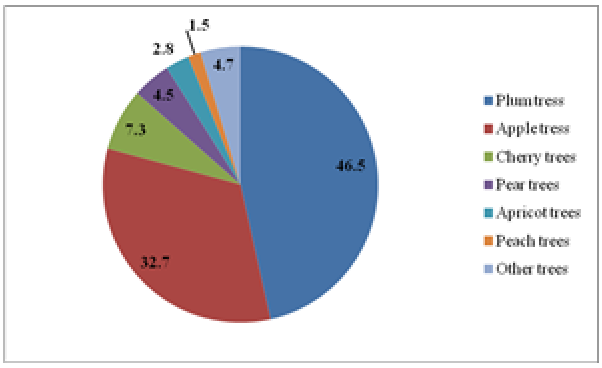

Fig. 3. Share of various fruit trees species in the total number of fruit trees, Romania, 2020 (%)
Source: Own design based on the data from [22].

Fruit production

Fruit production in Romania registered a slight increase of only 8.17% during the last decade. In 2020, it reached 1,601 thousand tons in comparison with 1,480 thousand tons in 2011. This happened because during the last year new plantations were set up using EU funding. Of the total production, 837 thousand tons, meaning 52.27%, came from six fruit trees selected in this study: plum, apple, cherry, pear, apricot and peach trees [21] (Fig. 4).

However, the level recorded in 2020 was by 11.72% lower than in 2018, when Romania reached the highest fruit production in the last decade, accounting for 1,813 thousand tons.

In the production structure, plums had the share of 46.4%, apples 35.5%, summing 81.9%, and the remaining of 18.1% belonged to cherries (5%), pears (3.3%), apricots (2%), peaches (1.2%), and strawberries (1.4%).

The data from Figure 4 showed variations in fruit production from a year to another, the lowest and critical level was 1,058 thousand tons registered in the year 2017 and also 1,129 thousand tons recorded in 2012, and the highest performance was 1.913 thousand tons in 2018, the most favourable year. Also, after a decline to 1,487 thousand tons in 2019, fruit production was better in 2020 accounting for 1,601 thousand tons.

The annual changes were determined by the variations in the number of trees and climate conditions.

As a result, the production structure changed from 2011 to 2020, especially regarding apple and plum trees. If in 2011, on the top position came apple output with a share of 41.92%, in 2020, it was ranked the 2nd with 34.43%. the plums contributed by 38.755 to fruit output in 2011, but in 2020 they passed on the 1st position with 48.43%.

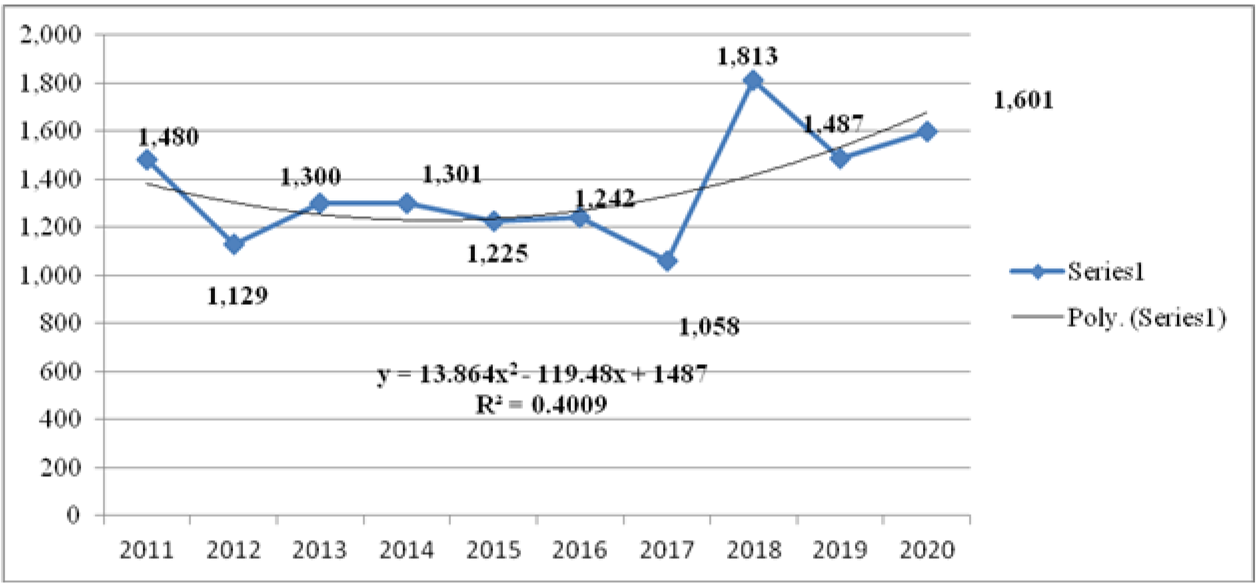

Fig. 4. Dynamics of fruit production, Romania, 2011-2020 (Thousand tons)
Source: Own design based on the data from [22].

This situation is explained by the structure of the fruit trees, where the plum trees are more numerous than apple trees as Romanians like to consume not only fresh plums or jam, but mainly "tuica", the traditional plum brandy. The share of cherries, pears, apricots and peaches declined in favour of other fruits (Table 1).

Table 1. Structure of fruit production by fruit type, Romania, 2020 versus 2011 (%)

	2011	2020
1.Plums	38.75	48.43
2.Apples	41.92	34.43
3.Cherries (sweet and sour)	5.53	4.64
4.Pears	4.52	3.09
5.Apricots	2.28	1.74
6.Peaches	1.42	1.00
Total, 1+2+3+4+5+6	94.42	93.33
7.Other fruits	5.58	6.67
TOTAL	100.00	100.00

Source: Own calculation based on the data from [22].

Fruit purchase price

An ascending trend was noticed regarding fruit purchase price in the analyzed interval. Compared to the level in 2011, in 2020, the average annual purchase price was higher by 66.7% for cherries, 45.6% for peaches, 43.9% for apricots, 41.6% for plums, 32.95 for pears and 24% for apples.

In 2020, by fruit type and in the decreasing order, price level was: cherries, apricots, pears, peaches, plums and apples.

Nevertheless, fruit price is strongly correlated with fruit production. In the years when production was high, average purchase price was lower, while in the years with a low production and a high demand, fruit price was high.

Of course, fruit price depends on fruit type and consumer preferences as well as on changes in the domestic and external market (Table 2).

Table 2. Fruit purchase price per fruit type, Romania, in 2020 versus 2011 (Euro/Ton)

	Apple	Plum	Cherries	Apricots	Pears	Peaches
2011	618.2	547.4	1,240.0	1,071.2	953.3	844.7
2020	766.9	775.2	2,068.3	1,542.2	1,267.3	1,230.0
2020/2011 %	124.0	141.6	166.7	143.9	132.9	145.6

Source: Own calculation based on the data from [22].

Fruit production value

The value of fruit production (FPV) resulted from multiplying fruit production by average annual purchase price for each type of fruit.

Summing the value of fruit production from the all six fruits considered in this study as being the most important, in 2020, the total value of fruit production (TFPV) accounted for Euro 1,303.69 Million, being by 42.20% higher than in 2011, when it was Euro 422.93 Million (Table 3).

Table 3. Fruit production value (FPV) for the selected six fruits, Romania, 2011-2020 (Euro Million)

	Apples	Plums	Cherries	Apricots	Peaches	Pears	Total (TFPV)
2011	383.51	313.99	101.48	36.14	17.87	63.79	916.78
2012	278.41	246.47	111.60	28.85	15.87	51.03	732.23
2013	324.22	271.35	109.81	26.90	17.22	63.23	812.73
2014	317.51	278.60	115.51	40.72	19.94	67.84	840.12
2015	294.53	283.68	99.45	34.31	18.08	46.67	776.72
2016	290.31	287.83	111.71	34.21	19.86	57.32	801.24
2017	226.66	327.24	93.57	31.64	15.67	55.74	750.52
2018	444.13	515.72	131.57	42.81	23.04	66.62	1,223.89
2019	311.79	527.27	157.72	33.84	18.10	59.80	1,108.52
2020	422.93	601.26	154.00	43.13	19.53	62.84	1,303.69
2020/2011 %	110.27	191.49	151.75	119.34	109.28	98.51	142.20

Source: Own calculation.

The contribution of the main fruit trees species to the fruit production value was the following one in 2020: plums 46.11%, apples 32.44%, summing 78.55%, and being followed by cherries with 11.81%, pears 4.82%, apricots 3.3% and peaches 1.51% (Fig. 5).

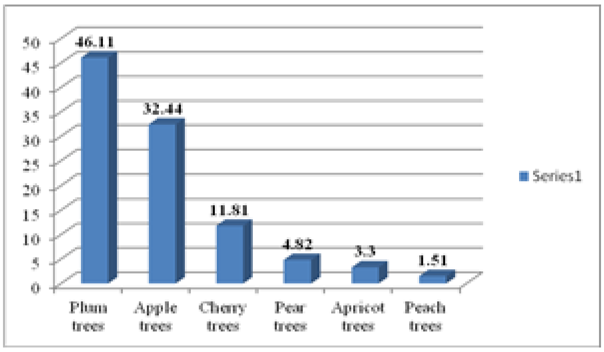

Fig. 5. The contribution of fruit type to the total fruit production value in 2020 (%)
Source: Original design and calculation.

Economic value of insect pollination for the six selected fruit trees species

For calculating the economic value of insect pollination (EVIP) for each of the six selected fruit trees species, there were taken into consideration the fruit production value (FPV) and the dependence ratio ($D_{\%}$) of production on the pollinating insects as mentioned at the methodological aspects: 93% for cherry, as an average between sweet and sour cherry, 90% for apple and 70% for plum, apricot, peach, and pear trees.

In 2020, TFPV accounted for Euro 1,032.59 Million, being by 39.2% higher than Euro 741.78 Million registered in 2011.

Versus 2011, in 2020, the contribution of the pollinators to the economic value of fruit production was higher by 91.49% for plums, 51.75% for cherries, 19.33% for apricots, 10.28% for apples, 9.27% for peaches and by 1.485 lower for pears (Table 4).

Also, in 2020, the share of EVIP for each fruit type in the total TEVIP was the following one: plums 40.75%, apples 36.86%, cherries 13.86%, pears 4.26%, apricots 2.92% and peaches 1.35% (Fig. 6).

As a result, the contribution of insect pollination to TEVIP in 2020 accounted for 79.20% compared to 80.91% in 2011, the difference being very small of just -1.71%. Therefore, we may consider that, in average, about 80% of the total value of fruit production is given by pollination.

Taking into account the surface covered by the orchards of the six selected main fruit trees species accounting for 138,000 ha in 2020, the value of fruit production given by pollination was Euro 7,482.5 per ha in average.

Table 4. Economic value of insect pollination (EVIP) for the selected six fruits, Romania, 2011-2020 (Euro Million)

	Apples	**Plums**	**Cherries**	**Apricots**	**Peaches**	**Pears**	**Total (TEVIP)**
2011	345.15	219.79	94.38	25.30	12.51	44.65	741.78
2012	250.56	172.53	103.79	20.19	11.11	37.52	593.90
2013	291.79	189.94	102.12	18.83	12.05	44.26	658.99
2014	285.75	195.02	107.42	28.50	13.96	47.49	668.14
2015	265.07	198.58	92.49	24.02	12.65	32.67	625.48
2016	261.28	201.48	103.89	23.95	13.90	40.12	644.62
2017	203.99	229.07	87.02	22.14	10.97	39.02	592.21
2018	399.72	361.00	122.36	29.97	16.13	46.63	975.81
2019	280.61	369.09	146.67	23.69	12.67	41.86	874.59
2020	380.64	420.88	143.22	30.19	13.67	43.99	1,032.59
2020/2011 %	110.28	191.49	151.75	119.33	109.27	98.52	139.20

Source: Original calculation.

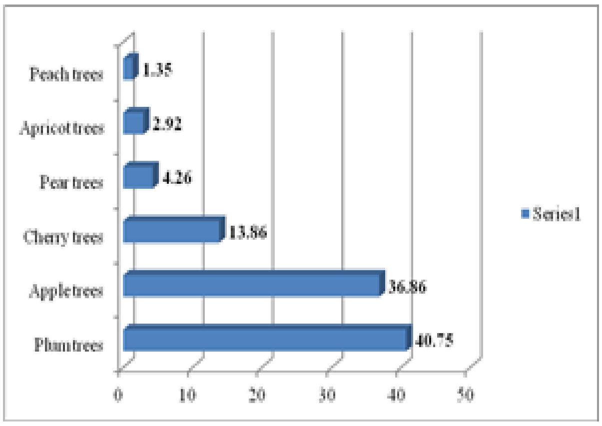

Fig. 6. The share of each trees species in the total economic value of the insect pollination (TEVIP) in 2020 (%)
Source: Original design and calculation.

By fruit tree species and per ha of orchard, the economic value of pollination was in 2020 the following one: plum tree 6,522 Euro/ha, apple tree 6,921 Euro/ha, cherry tree 12,845 Euro/ha, pear tree 13,535 Euro/ha, peach tree 8,041 Euro/ha and apricot tree 12,738 Euro/ha.
By fruit tree species, taking into account the number of fruit trees in the year 2020, it could be concluded that the economic value of pollination accounted for: Euro 12.2 per plum tree, Euro 15.7 per apple tree, Euro 13.2 per pear tree, Euro 12.4 per peach tree, Euro 26.6 per cherry tree and Euro 14.5 per apricot tree (Table 5).

Table 5. Pollination economic value per ha of orchard and per tree by fruit tree species in Romania, 2020

Economic value of pollination	**Apple tree**	**Plum tree**	**Cherry tree**	**Apricot tree**	**Peach tree**	**Pear tree**
Euro/ha	6,921	6,522	12,845	12,738	8,041	13,535
Euro/tree	15.7	12.2	26.6	14.5	12.4	13.2

Source: Original calculation.

CONCLUSIONS

The results of this study proved that the contribution of the entomophilous species to fruit production must not be denied.
This shows how important are insects in helping the farmers for obtaining a high performance in fruit trees growing and not only, if we consider that in Romania there are cultivated many agricultural crops and also the wild flora need to be pollinated.
Pollination made by various insects, especially by honey bees sustains vegetal production and also the wild flora to perpetuate and develop and preserve biodiversity both in the flora and insect fauna world.
The economic value of pollination in the fruit trees plantations depends on fruit tree species, the number of fruit trees, the structure of orchards and their area, the dependence ratio of fruit production on the activity of the insects, and also on the climate conditions, production technologies and performance, average annual purchase price of fruits in the domestic market.
The analysis in the period 2011-2020 showed that pollination contributed by Euro 1,032,59

Million to the value of fruit production which accounted for Euro 1,303.69 Million in 2020. Therefore, about 80% of the economic value of fruit production is achieved due to the activity of the insects.

The value of pollination per ha and per tree differs from a fruit tree species to another, but it is important for farmers to know which are the advantages from a quantitative point of view for increasing production performance and fruit quality and for getting a higher selling price and satisfy better consumer needs.

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LEADER - THE SOCIAL DEVELOPMENT OF THE RURAL AREA IN ROMANIA

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Abstract

The paper presents an analysis of the situation of social services in rural areas, as well as the physical infrastructure - in which they take place. Given the degree of poverty and vulnerability of the population in rural areas, integrated interventions through LEADER come in response to local needs. LAGs participate in developing and strengthening the role of local governance by involving public authorities, the private sector and civil society in community-based decision-making. Some of these decisions are aimed at solving social problems at the local level. Through LEADER, the LAG is a facilitator for the implementation of intervention and social assistance programs, as well as other community services. The situation of the distribution of LEADER interventions by regions is presented, detailing the number and value of projects financed by EAFRD and those financed by ESF.

Key words: *LEADER, Local Action Group, local initiatives, social issues, rural area, Romania, social infrastructure*

INTRODUCTION

LEADER is a development instrument for local communities, which is based on the principle of "bottom-up" approach acting by identifying the needs of a defined territory and finding solutions that contribute to its socio-economic development. LEADER is implemented by Local Action Groups (LAGs), which play an important role in the multisectoral development of local communities and contribute to increasing the quality of life in rural areas. At European level, the subject of LEADER has been the subject of numerous analyzes and studies, given the impact of this instrument on the community [3, 14, 15, 16, 17].

Between 2011 and 2020, when Romania received support from the European Fund for Agriculture and Rural Development (EAFRD), there was an increase in the use of European non-reimbursable funds, which led to improved living conditions in rural areas through infrastructure, services basic quality, job creation and social services.

The Local Action Group (LAG) is a private-public partnership made up of representatives of the public sector, the private sector and civil society, from a delimited territory that includes communes and small towns with a population of up to 20,000 inhabitants. The role of LAGs is to develop and implement a Local Development Strategy that includes identifying local needs and finding concrete solutions to address them. European funds for agriculture and rural development provide Member States with funding to implement the strategies, which are managed locally by LAGs. One of the aims of LAGs is to increase the quality of life at local level, including from a social point of view, by addressing vulnerable groups.

In the programming period 2014-2020, through measure 19 - Support for local development LEADER (DLRC - Local development placed under the responsibility of the community) from the National Rural Development Program 2014-2020, Managing Authority for the National Rural Development Program (MA PNDR) selected 239 Local Development Strategies (SDLs) which are implemented by 239 Local Action Groups (LAGs) authorized by the PNDR MA for operation. The Local Action Group elaborates the Local Development Strategy, within which are established the activities, the necessary resources for the development of the communities and realizes the selection of the projects submitted by the applicants related to all the measures proposed in the SDL. LAGs include 2,735 communes and 142 cities with less than 20,000 inhabitants, covering 92% of the LEADER eligible area and about 86% of the LEADER eligible population, with a positive impact on the development of local communities and rural areas in Romania [2, 6, 8].

The social services infrastructure represents the framework that allows and determines the provision of social services. The quality of social services provided at national or local level is influenced by the level of development of the specific infrastructure. Investments in the development of social infrastructure are one of the instrumental variables that can increase the quality of social services provided to the categories of beneficiaries.

MATERIALS AND METHODS

In order to present the stage of implementation of the LEADER instrument in Romania regarding the social infrastructure through the Local Action Groups, a series of indicators were used: number of contracts through which social infrastructure objectives were financed through LEADER, number of contracts through which operationalized this infrastructure through HCOP and the total value of the contracts.

The analysis covers the period between 2014 and May 31, 2021, using the bibliography and processing of information and data provided by the Ministry of Agriculture and Rural Development, the Agency for Financing Rural Investments and the Ministry of Investment and European Projects on the analysis and evaluation of vulnerable groups, NRDP and HCOP financing contracts.

RESULTS AND DISCUSSIONS

Starting with the 2014-2020 programming period, the European Commission has proposed a new initiative to support territorial development, Community Local Led Development (CLLD). Noting the impact of the LEADER program initiated in 1991 and continued to date with significant results at the level of the territories benefiting from this funding from the funds included in the Common Agricultural Policy, to achieve a scaling of the LEADER approach from a niche development to a broader method of integrated local development, the European Commission proposed in 2014 through Regulation 1303 a multi-fund approach. Thus, the CLLD initiative proposes to maintain the bottom-up approach, expanding the intervention territory and providing more types of funding to identify and cover local needs. The funds available to finance Local Development Strategies are the EAFRD (European Agricultural Fund for Rural Development), which remains the only fund with a mandatory minimum contribution of 5% of each Member State's financial envelope allocated to rural development, ERDF (European Regional Development Fund), ESF (European Social Fund) and EMFF (European Maritime and Fisheries Fund) [4, 5, 11, 12, 13].

At European level, in the 2014-2021 programming period, there were several types of approaches, starting from the full use of a single fund out of the 4 (most local action groups), to the possibility of choosing 2, 3 or even all funds. In Romania, the Partnership Agreement stipulated the implementation of CLLD only at urban level, by combining ERDF and ESF; instead, for the Local Action Groups in rural areas (funded by the EAFRD) and the fisheries (funded by the EMFF), the single-fund approach was maintained. In order for the Local Development Strategies of the rural LAGs to obtain other types of funding, a complementary approach was taken, in the sense that priority axis 5 was reserved from the HCOP (Human Capital Operational Program). Only the beneficiaries of social infrastructure projects selected by LAGs and financed by the LEADER measure could participate in the calls for project proposals. Thus, LEADER finances the infrastructure component for social services "hard component", and through HCOP - Priority Axis 5 "Local development under the responsibility of the community" - Specific objective 5.2 "Reducing the number of people at risk of poverty and social exclusion from marginalized communities in rural areas and cities with a population of up to 20,000 inhabitants ”, the services -“soft component”, are financed aiming at the operationalization of the social infrastructure projects financed by LEADER. The potential beneficiaries of the projects supported by HCOP are the local authorities with responsibilities in the field, in partnership with the relevant social actors or LAGs, providers of social services under the law. Within these integrated projects, social service providers will operate in the infrastructure financed for this purpose by NRDP - LEADER measure [1, 7].

The LAGs initiated animation actions that included workshops, seminars, etc. in order to collect data that reflect the reality in the territory, so that the measures introduced in the SDL meet the real needs, specific to the territory concerned. Within the Local Development Strategies (LDS), the Local Action Groups (LAGs) have planned, following the diagnostic analysis of the territory, social infrastructure measures, mentioning the eligibility and selection conditions for the projects related to the target group for which the investments in social infrastructure (insufficiently developed or non-existent). Social infrastructure projects must ensure their operation by operationalizing the infrastructure by an entity accredited as a provider of social services and in this regard was agreed collaboration/ cooperation with HCOP which ensures the operationalization of structures made by LAG with adequate staff and trained by HCOP.

Among the 239 LDS selected by MA NRDP through Measure 19 - LEADER Local Development:

-130 LDSs were scored in the selection process for the inclusion of social infrastructure measures, with a total non-reimbursable allocation of 28,728,374 Euro;

-106 LDSs include combined measures (social infrastructure + actions dedicated to minorities) with a total non-reimbursable allocation of 20,114,347 Euro.

Analyzing the available data, it results that at the level of AFIR were signed 289 contracts totaling 21,705,797.34 euros, which are in various stages of implementation, or part of them completed, financed through Local Development Strategies covering the territory of 181 LAGs.

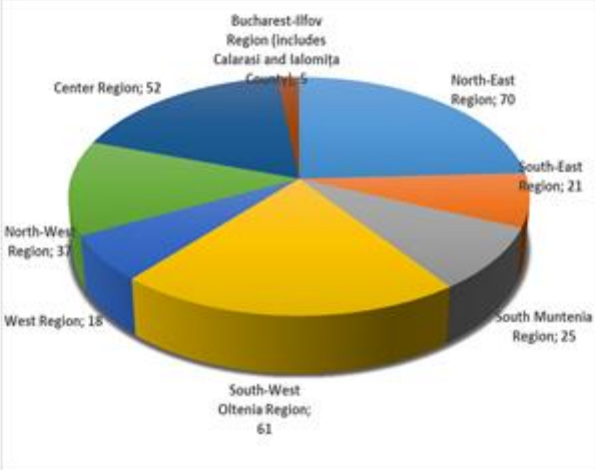

Fig. 1. Regional distribution of LEADER-funded social infrastructure projects (number of projects)
Source: Processing of authors according to the data available on http://opendata.afir.info/, Accessed on 20.07.2021.

According to the research "Analysis and evaluation of vulnerable groups in order to establish the need for social services" developed in 2018 by the Directorate of Social Services Policy within the Ministry of Labor and Social Justice, covering the period 1.09.2016 - 20.03.2018, "for 4 of the 8 regions development group the group with the highest share is represented by people in poverty.

These regions are Bucharest Ilfov, North East, Center and North West with over 40%; In 4 development regions, the share of elderly people identified as the most vulnerable group is high, reaching 45% in the case of the West region ”, which makes the need for social services as necessary as possible. Through LEADER, the need for social services as well as the contracts that have been financed as presented in Table 1.

Comparing the number of contracts through which social infrastructures were financed by the LEADER measure at regional level with the level identified by MMPS for the need for social services, it is noted that the LAGs in the North-East and North-West regions performed a diagnostic analysis based on the real needs of the territory, financing through both LEADER and HCOP, social infrastructure structures in a proportion similar to the necessary needs; in the South-West and Central regions, the LAGs financed a higher percentage of projects related to the needs of social services, and in the South-East, South-Muntenia, West and Bucharest-Ilfov regions there is a lack of interest in covering the need for social services.

Table 1. Regional distribution of the need for social services and contracts financed by LEADER

Region	Regional distribution of social service needs	Regional distribution of contracts for social infrastructure through LEADER	Regional distribution of contracts for the operationalization of social infrastructures through HCOP
North- East Region	19%	24%	23%
South-East Region	13%	7%	9%
South-Muntenia Region	17%	9%	4%
South West Oltenia Region	12%	21%	24%
West Region	11%	6%	3%
North-West Region	13%	13%	16%
Center Region	12%	18%	20%
Bucharest Ilfov Region (includes Calarasi and Ialomita County)	3%	2%	0%

Source: Processing of the authors of the research "Analysis and evaluation of vulnerable groups in order to establish the need for social services", 2018 _-_ Analysis_and_evaluation_of_vulnerable_groups.pdf (mmuncii.ro) and according to the data available on http://opendata.afir.info/, Accessed on 10.06 .2021 and by processing the document "List of POCU projects contracted by implementation regions as of May 31, 2021" published on June 7, 2021 on the MIPE website.

The distribution of contracts for the development (through LEADER) and the operationalization (through HCOP) of social infrastructures, is presented in Table 2 [9, 10].

Table 2. Distribution by region of social infrastructure contracts

Region	**No of projects by LEADER**	**Total public value (mil. euro)**	**No of projects by HCOP**	**Total public value (mil. euro)**	**% of projects by both funds**	**Total amount of social intervention (mil.euro)**
North- East	70	5.3	22	21.13	31.43%	26.49
South-East	21	2	9	8.24	42.86%	10.24
South-Muntenia	25	2.16	4	3.81	16.00%	5.97
South West Oltenia	61	4.45	23	22.49	37.70%	26.93
West	18	1.07	3	2.74	16.67%	3.81
North-West	37	2.9	15	14.43	40.54%	17.33
Center Region	52	3.29	19	18.14	36.54%	21.43
Bucharest Ilfov Region (includes Calarasi and Ialomita County)	5	0.46	0	0	0.00%	0.46
TOTAL	289	21.63	95	90.97	32.87%	112.67

Source: Processing of authors according to the data available on http://opendata.afir.info/, Accessed on 10.06.2021 and by processing the document "List of POCU projects contracted by implementation regions as of May 31, 2021" published on June 7, 2021 on the page internet at MIPE.

CONCLUSIONS

Local Action Groups are active partnerships that develop and implement their own strategies, playing an important role at the level of local communities through actions aimed at identifying social problems and solutions to them in rural areas.

Through local development strategies, LAGs identify the real needs of people in marginalized communities at risk of poverty or social exclusion, for which they propose solutions and provide funding to achieve the objectives proposed through strategies based on the needs identified in the territory. It is well known that in rural areas the lack of social services is exacerbated, although the worst problems are encountered here, the intervention of LAGs thus complements public policies on the provision of social services (which address general issues) by meeting specific needs at the level of some communities.

There are differences depending on the region in terms of social infrastructure developed and operationalized through the LEADER and POCU instrument, by reference to the level identified by the MLPS for social services needs, as follows:

- In the North-East, South-West Oltenia and Center regions, several requests for financing for infrastructure and social services were registered compared to the identified needs;
- In the South-East, South Muntenia and Center regions, the requests for non-reimbursable support are in a smaller proportion than the identified needs for social services;
- In the North-West and Bucharest-Ilfov regions, including Ialomița and Călărași counties, it is found that funding applications for social services cover the percentage identified for those needs.

The differences between the level of infrastructure contracts and those for the support of social services can be explained by the fact that the infrastructure part or the operational part is supported by local funding sources (public or private).

The LAGs, through the measures included in the development strategies, facilitate the provision and development of social, socio-medical, educational services to the people who are part of the vulnerable groups in the rural communities.

These activities are complemented by activities in the field of legal assistance for the regulation of identity documents, property, civil status (where applicable), obtaining social assistance rights (assistance benefits / social services), the field of combating discrimination or of segregation (by promoting multiculturalism, addressed equally to Roma and non-Roma ethnic groups), housing (including housing rehabilitation and / or legalization of utility insurance).

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VARIATION OF SOME PHYSIOLOGICAL INDICES AND FRUITS BIOMETRIC PARAMETERS IN RELATION TO APPLE FOLIAR FERTILIZATION

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Abstract

The present study evaluated the variation of some physiological indices and biometric parameters of the fruits under the influence of foliar fertilization in apple. The plantation was of semi-intensive type, in non-irrigated conditions; the 'Florina' apple cultivar was studied. The products Biocomplex 900, Foliarel, Megafol, Uvafol, Waterfert and calcium chloride were used. The combination of fertilizer resources resulted in 8 experimental variants (V2 - V9), tested compared to a control variant (V1). Physiological indices (leaf area - LA, chlorophyll - Chl) and biometric parameters (fruit diameter - FD, fruit weight - FW) were evaluated. LA values ranged from 28.24 cm^2 (V1) to 34.37 cm^2 (V5). Chlorophyll content varied between 28.24 SPAD units (V1) and 49.99 SPAD units (V9). Fruits diameter (FD) varied between 52.48 mm (V1) and 64.15 mm (V9). Fruit weight (FW) recorded values between 96.10 g (V1) and 117.32 g (V9). The regression analysis led to equations that described the variation of FD and FW in relation to LA and Chl, in statistical safety conditions ($p < 0.001$). 3D and isoquant graphs models described the distribution of FD and FW values in relation to LA and Chl. Within PCA, PC1 explained 93.304% of variance, and PC2 explained 5.6066% of variance. The cluster analysis led to the dendrogram, in statistical safety conditions, Coph.corr = 0.788. The highest level of similarity was recorded between variants V5 and V8 (SDI = 0.7787), followed by variants V7 and V8 (SDI = 1.6693), respectively by V7 and V9 (SDI = 1.8845).

Key words: *apple, biometric parameters, foliar fertilizer, model, physiological indices*

INTRODUCTION

The apple (*Malus domestica* L.) is one of the main fruit species, cultivated in various areas worldwide, by the large number of genotypes, and the high interest of apples [39].
From single trees, cultivated in gardens as a hobby, or for decorative purposes, to super-intensive plantations, in areas dedicated to apple cultivation, with computer technologies and artificial intelligence (AI) for the management of horticultural farms, apple is of great importance.
Apples are an important product in human nutrition and on the fruit market [42]. Food plays an important role in the quality of life, and apples have an important contribution in this regard [5].
Apples have a high content of minerals, vitamins, amino acids, bioactive substances, polyphenols, etc. [21]. Apples are important as fresh fruits, fresh juices [4], [20], for industrialization [6], cosmetics [44], [31], [34], pharmaceutical industry [4], [33], [20].
In relation to the destination of apple production, plantation management has an important role [16], [32], [18].
Apple quality management has been studied and evaluated in relation to different cultivated genotypes [3], [1], [8], soil type and climatic conditions [26], [7], [19], irrigation systems [13], [12], [22], fertilizers and soil or foliar fertilization [29], [43], [24], [11], [36].
Apple production has been studied in relation to various ecological, economic and social factors in order to optimize plantation management, fruit quality and fruit market [37], [30], [35], [23], [28], [45].
The study and analysis of horticultural areas, such as plantations, need to be done both on a small scale, plant organs or individual plants [38], [10], [2], [25], [14], as well as on a large scale, plots, farms, areas, etc. [15], [47], [46] in order to choose the appropriate germplasm [9], [27], [40], and the formulation of optimal farm management solutions for quality

production.
The present study evaluated the influence of foliar fertilizer resources on physiological indices and biometric parameters in apple, 'Florina' cultivar.

MATERIALS AND METHODS

The study evaluated the variation of some physiological indices and biometric parameters of apple fruit quality, in relation to foliar fertilization.
The experiment was organized within the Horticultural Center of BUASVM Timisoara, during 2012-2014. The 'Florina' apple cultivar was studied.
The plantation was organized in a semi-intensive, non-irrigated system. Soil was covered with vegetal carpet between rows with repeated mowing and maintained by herbicide on the tree rows, figure 1. Six different foliar fertilizer resources were used. Foliarel fertilizer was applied evenly on all variants. On the common Foliarel level, were applied: Biocomplex 900, Megafol, Uvafol and Waterfert. Additionally, calcium was applied in the form of calcium chloride ($CaCl_2$) and 8 fertilized variants (V2-V9) resulted, figure 1. For the comparison, a control variant was used, without fertilization (V1).

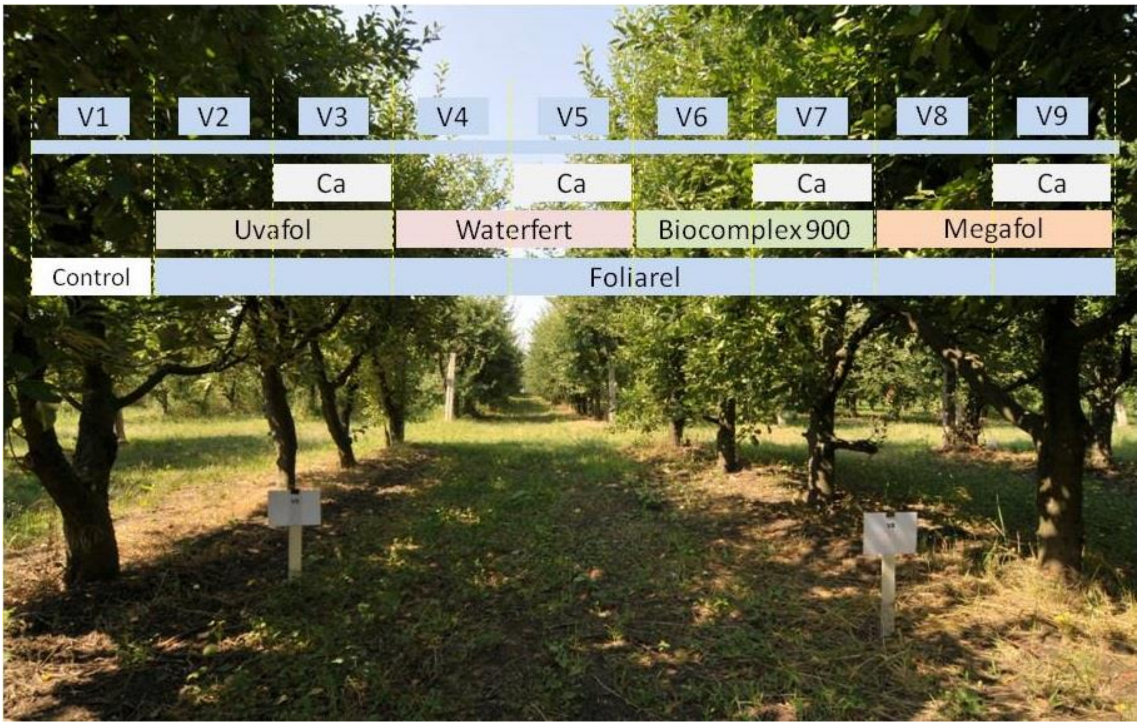

Fig. 1. Aspect from the experimental field, 'Florina' apple cultivar, and experimental variants
Source: author's image (Original).

The treatments were applied with an atomizer for the uniform distribution of the solutions. Foliar fertilizers were applied in two treatments, at the beginning of fruit formation (treatment I) and at an interval of 15 days (treatment II).
Trees vegetation condition and fruit quality parameters were evaluated, under the influence of the applied fertilization. As physiological indices leaf area - LA, and chlorophyll content – Chl were studied. The fruits were evaluated based on biometric parameters (fruit diameter - FD, fruit weight - FW).
Leaf area (LA) was determined based on leaf size (length, width), and correction coefficient (KA_F), relation (1).

$$LA = L \times w \times KA_F \qquad (1)$$

where:
LA – leaf area (cm^2);
L – leaf length (cm);
W – leaf width (cm);

KA_F – correction coefficient for 'Florina'.

The chlorophyll content (Chl) was determined by the non-destructive method with a portable chlorophyll meter (Spad 502 Plus). The diameter of the fruit (FD) was measured with an electronic calliper, with an accuracy of ± 0.001 mm. The weight of the fruit (FW) was determined by weighing with a laboratory balance, accuracy ± 0.005 g.

The increase in fruit quality was analyzed as an effect of foliar fertilizer-generated increase (FF-GI) and in relation to calcium supplementation (calcium-generated increase, Ca-GI).

The quality increase on each parameter studied (FD and FW) was reported compared to the control variant (V1), and on pairs of variants in relation to the application or not of calcium (V2/V3; V4/V5; V6/V7; V8/V9).

Appropriate mathematical and statistical tools were used to find models to describe the variation of quality parameters in relation to physiological indices (regression analysis), as well as to evaluate multiple solutions for similar results (PCA and cluster analysis).

Correlation analysis and ANOVA test were also used. To assess the safety of the data and the results obtained, the parameter p, the standard error (SE), and the coefficients r, R^2, Coph.corr., were used.

The RMSEP parameter, relation (2), was also used to assess the level of safety in predicting the values of biometric parameters based on the values of physiological indices.

$$RMSEP = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(y_j - \hat{y}_j\right)^2} \qquad (2)$$

PAST software [17], Wolfram Alpha software (2020) [41], and specific mathematical modules in EXCEL were used for data analysis and graph generation.

RESULTS AND DISCUSSIONS

The foliar fertilizer resources applied, within the 8 fertilized variants, generated a specific variation of the studied physiological indices, leaf area (LA), and chlorophyll (Chl). The LA values varied between 28.24 cm^2 for the control variant (V1) and 34.37 cm^2 for the V5 variant. The chlorophyll content varied between 28.24 SPAD units in the control variant and 49.99 SPAD units in the V9 variant (Table 1).

Fruits biometric parameters, fruit diameter (FD) and fruit weight (FW) registered a certain variation, associated with the vegetative status of the trees on the experimental variants. Fruit diameter (FD) recorded values between 52.48 mm for the control variant (V1) and 64.15 mm for the V9 variant. Fruit weight (FW) recorded values between 96.10 g for control variant (V1) and 117.32 g for variant V9 (Table 1).

Table 1. Values of physiological indices and biometric parameters in apple, 'Florina' cultivar, in relation to foliar fertilizers

Experimental variants	LA	Chl	FD	FW
	(cm^2)	(SPAD units)	(mm)	(g)
V1	28.24	44.67	52.48	96.10
V2	31.04	47.14	58.09	98.45
V3	33.23	48.73	59.09	103.63
V4	30.65	46.25	60.63	104.38
V5	34.37	48.40	62.60	113.19
V6	29.05	46.74	61.15	111.33
V7	34.34	49.23	63.85	115.48
V8	31.84	47.03	62.46	113.32
V9	33.63	49.99	64.15	117.32
SE	±0.75	±0.55	±1.20	±2.56

Source: Original data from experimental variants.

The applied foliar fertilization generated increases of fruit quality, in terms of diameter and weight, the values of the recorded increase (Δs) on each variant and index/ parameter studied, being shown in Figure 2.

Different levels of correlation were found between the physiological indices and biometric parameters studied. Very strong correlations were recorded between LA and Chl ($r = 0.900$) and between FD and FW ($r = 0.925$). Moderate correlations were recorded between FW and Chl ($r = 0.705$), between FD and LA ($r = 0.720$), and between FD and Chl ($r = 0.769$). A weak correlation was recorded between FW and LA ($r = 0.634$).

Based on the regression analysis, equations were obtained that described the variation of the biometric parameters of fruit quality in relation to the studied physiological indices.

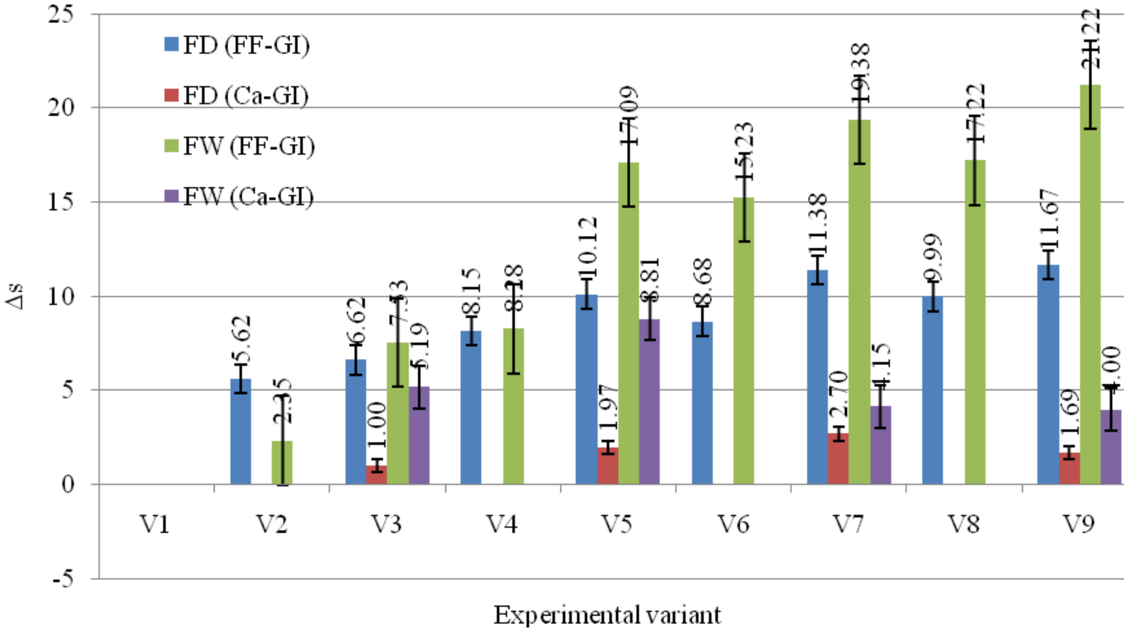

Fig. 2. The increase registered in relation to the foliar fertilization of the apple, 'Florina' apple cultivar
Source: original graph, generated based on the calculated experimental values.

The variation of the fruit diameter (FD) according to LA and Chl was described by equation (3), in conditions of statistical safety (R^2 = 0.0.999, p <0.001).

The ANOVA test confirmed the statistical safety of the values of the equation (3) parameters, as follows, p = 0.03365 for a; p = 0.0069 for b; p = 0.0077 for c; p = 0.0089 for d; p = 0.0085 for e. The graphical distribution of FD according to LA and Chl is presented in Figure 3 as a 3D model, and in Figure 4 as isoquants form.

$$FD = ax^2 + by^2 + cx + dy + exy + f \qquad (3)$$

where:
FD - fruits diameter;
x – LA – leaf area;
y – Chl – chlorophyll content;
a, b, c, d, e, f – coefficients of the equation (3);
a= 0.765196005349097;
b= 1.22091847116479;
c= 63.0043218922929;
d= -40.7376835167938;
e= -2.34095352623526;
f= 0

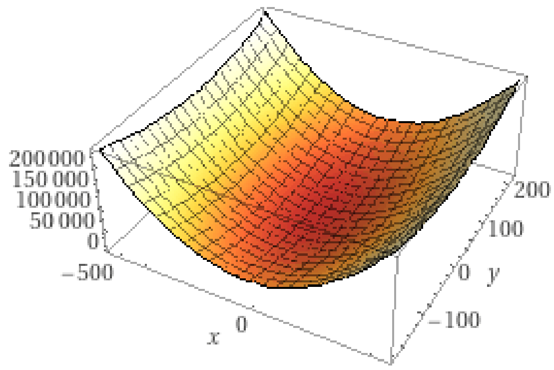

Fig. 3. 3D model of FD variation in relation to LA (x-axis) and Chl (y-axis), 'Florina' apple cultivar
Source: original graph generated based on experimental data.

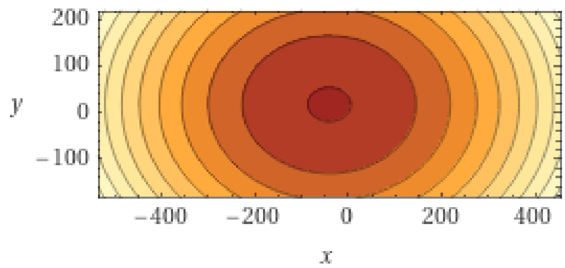

Fig. 4. Model in the form of isoquants for the distribution of FD in relation to LA (x-axix) and Chl (y-axix) in apple, 'Florina' cultivar
Source: original graph generated based on experimental data.

The variation of fruit weight (FW) according to LA and Chl was described by equation (4), in statistical safety conditions (R^2 = 0.0.998, p <0.001). The ANOVA test partially confirmed the statistical certainty of the values of the parameters of equation (4). The graphical distribution of FW in relation to LA and Chl is presented in the form of a 3D model in Fig. 5 and in the form of isoquants in Fig. 6.

$$FW = ax^2 + by^2 + cx + dy + exy + f \qquad (4)$$

where:
FW - fruits weight;
x – LA – leaf area;
y – Chl – chlorophyll content;
a, b, c, d, e, f – coefficients of the equation (4);
a= 1.8423127376365;
b= 1.84122208234375;
c= 71.5311783170931;
d= -46.3203844806745;
e= -3.96213398889279;
f= 0

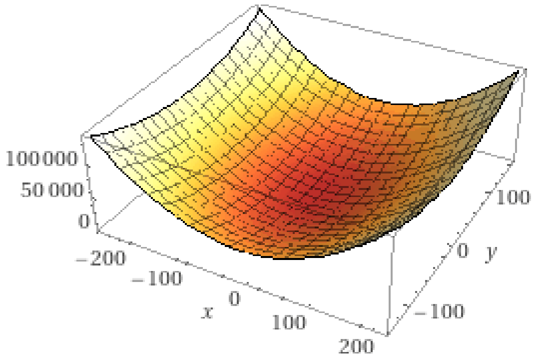

Fig. 5. 3D model of FW variation in relation to LA (x-axis) and Chl (y-axis), 'Florina' apple cultivar
Source: original graph generated based on experimental data.

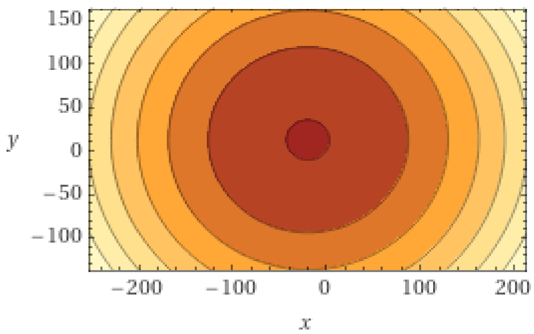

Fig. 6. Model in the form of isoquants for the distribution of FW in relation to LA (x-axix) and Chl (y-axix) in apple, 'Florina' cultivar
Source: original graph generated based on experimental data.

PCA led to the diagram in Figure 7, with variants distribution according to the indices and parameters studied. PC1 explained 93.304% of variance, and PC2 explained 5.6066% of variance.

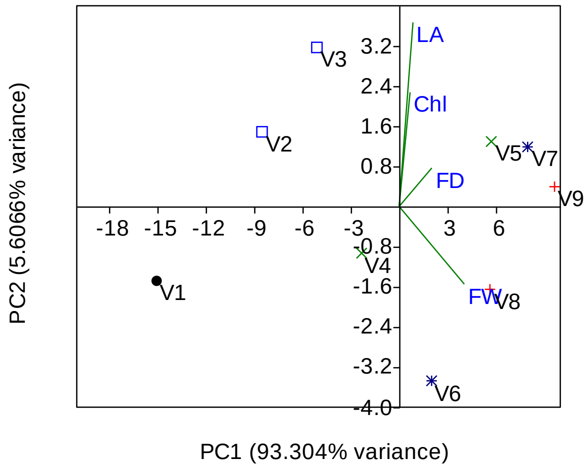

Fig. 7. PCA diagram of variant distribution in relation to physiological indices and biometric parameters in apple, 'Florina' cultivar, under the influence of foliar fertilization
Source: original graph generated based on experimental data.

The cluster analysis led to the dendrogram in Figure 8, in statistical safety conditions, Coph.corr = 0.788.

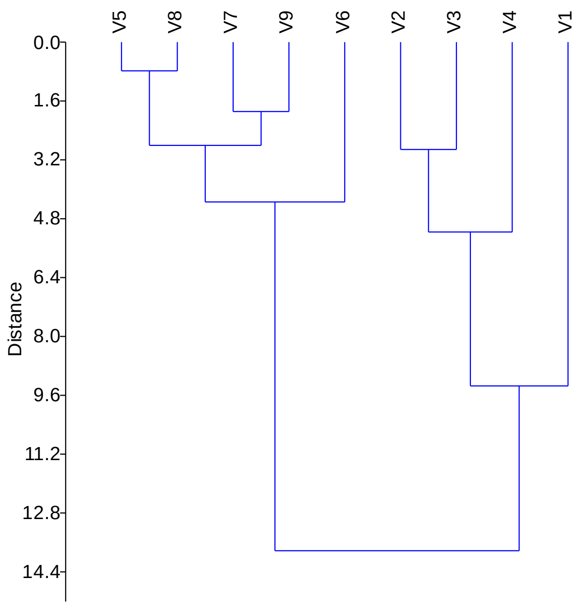

Fig. 8. Cluster diagram based on Euclidean distances, generated in relation FW and FD, 'Florina' apple cultivar
Source: original graph generated based on experimental data.

In relation to the fruits biometric parameters, the variants were grouped in two distinct clusters. A C1 cluster included variants V1 - V4, between which a high degree of similarity was found at V2 and V3 (SDI = 2.9177), and V4 was associated with them, followed by V1.

Cluster C2 included variants V5 - V9, between which different levels of similarity were registered. The highest level of similarity was recorded between variants V5 and V8 (SDI = 0.7787), followed by variants V7 and V8 (SDI = 1.6693), respectively by V7 and V9 (SDI = 1.8845), Table 2

Table 2. SDI values for experimental variants, 'Florina' apple cultivar

	V1	V2	V3	V4	V5	V6	V7	V8	V9
V1		6.4961	8.9585	12.58	19.713	17.099	21.906	20.279	23.598
V2	6.4961		2.9177	6.6011	13.862	11.491	16.056	14.511	17.853
V3	8.9585	2.9177		3.7168	10.978	8.5742	13.176	11.613	14.958
V4	12.58	6.6011	3.7168		7.264	4.9582	9.4611	7.9106	11.252
V5	19.713	13.862	10.978	7.264		2.7835	2.2003	0.77878	4.0068
V6	17.099	11.491	8.5742	4.9582	2.7835		4.8782	3.2144	6.5007
V7	21.906	16.056	13.176	9.4611	2.2003	4.8782		1.6693	1.8845
V8	20.279	14.511	11.613	7.9106	0.77878	3.2144	1.6693		3.3446
V9	23.598	17.853	14.958	11.252	4.0068	6.5007	1.8845	3.3446	

Source: original data calculated based on experimental results.

The estimation of the fruit quality parameters through equations (3) and (4) obtained from the regression analysis, was appreciated based on the RMSEP parameter; RMSEP = 1.63047 in the case of predicted FD, respectively RMSEP = 4.4560 in the case of predicted FW.
Based on the values of equations (3) and (4), the optimal values for x (LA) and y (Chl) were calculated, in relation to the fruits quality biometric parameters studied (FD and FW). Thus, in the case of FD, the values x_{opt} = 33.55 cm^2 (LA), and y_{opt} = 48.85 SPAD units (Chl) were found. In the case of FW, the values x_{opt} = 37.50 cm^2 (LA), and y_{opt} = 52.93 SPAD units (Chl) were found.
From the analysis of the values of equations (3) and (4), as well as from the 3D graphical distribution of the parameters FD and FW, it was found that the foliar surface (LA) showed a much wider variation, compared to Chl, in relation to ensuring FD and FW values, under the experimental conditions. This aspect recommends attention to the maintenance works of the trees in ensuring an optimal ratio between vegetative growth and fruiting, because the LA variation both by individual values and in the whole tree structure, contributes a lot to the variation of fruit quality parameters; a significant part of the water and nutrients being allocated to vegetative growth.
The association level of the variants in the dendrogram (Figure 8), and the values of the SDI indices (Table 2) provided information about the treatments that led to similar results, regarding the biometric parameters of fruit quality. If we take into account the availability of fertilizer products, or the costs of treatments, the farmer can choose those options that lead to similar results, in accordance with the specifics of the plantation, the destination of production (consumption, industrialization etc.), and also the market or profitability.
Such studies are important, because they offer multiple solutions, from which those the best options can be chosen, from a technical and economic point of view.

CONCLUSIONS

The foliar fertilizer resources used determined a specific variation of the physiological indices (LS and Chl) and of the biometric quality parameters (FD and FW) studied in the 'Florina' apple cultivar.
The regression analysis facilitated the obtaining of some models of the quality parameters (FD and FW) variation in relation to the physiological indices (LA and Chl),

under the influence of foliar fertilization. The obtained models are in the forms of equations, and 3D and isoquants graphic representation, in statistical safety conditions.

Among the multiple solutions obtained by foliar fertilization, the cluster analysis facilitated the identification of variants that generated similar results, with practical importance for choosing the optimal solution in relation to the fruits production system.

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PREDICTING AND ANALYZING OF TURKISH SUGAR PRICE WITH ARCH, GARCH, EGARCH AND ARIMA METHODS

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Abstract

Using GARCH(p,q) models, in this study our aim is to examine and search the characteristics of volatility of Turkish sugar price. Due to the ARCH effects on price, ARCH(q), GARCH(p,q) and EGARCH(p,q) including these effects on mean and variance equations were estimated. Normal, t-Student, and generalized error distributions with Maximum Likelihood Estimation Method were estimated for these models. Determining the optimal parameters, Marquardt's algorithm (1963) was used for maximizing the log-likelihood function. Mean absolute percentage error (MAPE), root mean square error (RMSE) and mean absolute deviation (MAD) were used to determine the fit model for making predicting. In this study, we found the best model as a GARCH (1,1) model.

Key words: *arch, garch, egarch, arima, volatility, forecasting, sugar price*

INTRODUCTION

Commodity prices has volatility over time and volatility may be defined for measuring the price varieties of financial data over time. Volatility can give a significant information when the volatility has a good interpretation. Especially, volatility is more sensitive in the financial markets than the other commodity markets. For instance, jewellery, oil, gas, agricultural commodity prices are linked with natural disasters, wars, economic crisis and unexpected meteorological conditions.

G20 Leaders Declaration at Los Cabos Summit emphasized The Action Plan on Food Price Volatility and Agriculture adopted by the Ministers of Agriculture in 2011 underlined that to feed a world population expected to exceed 9.3 billion by 2050, agricultural production will have to increase between 50 and 70 percent, and by almost 100 percent in developing countries (G20 Information Centre, 2020) [15].

G20 Leaders' Declaration at St. Petersburg Summit in 2013 they reaffirm their determination to implement all previous G20 commitments and existing initiatives including that stated in the Action Plan on Food Price Volatility and Agriculture which the G20 endorsed in 2011 G20 Information Centre, (2020) [16].

In these days, many researchers investigate the forecasting of agricultural commodity prices on different countries by using various approximations.

Aradhyula and Holt (1988) [3] applies recent developments in time-series modelling to analyse the retail prices of beef, pork, and chicken. Ex post forecast intervals generated from the GARCH processes indicate that the forecasting accuracy of the estimated models has varied widely over time with substantial volatility occurring during the 1970s and early.

Yang and Leatham (1999) examine the price discovery function for three U.S. wheat futures markets: the Chicago Board of Trade, Kansas City Board of Trade, and Minneapolis Grain Exchange [36].

Yang, Haigh, Leatham (2001) examine the effect of the recent radical agricultural liberalization policy, i.e. the 1996 FAIR Act, on agricultural commodity price volatility using GARCH models. Results of the study indicate that the agricultural liberalization policy has caused an increase in the price volatility for three major grain commodities (corn, soybeans and wheat) and little change for oats, but a decrease for cotton [37].

Apergis and Rezitis (2003) investigates volatility spillover effects across agricultural input prices, agricultural output prices and retail food prices using the technique of GARCH models. Their findings show that the volatility of both agricultural input and retail food prices exerts significant, positive spillover effects on the volatility of agricultural output prices [2].

Beckmann and Czudaj (2014) investigate the volatility spillover between various agricultural futures markets from a new perspective. Their study results provide evidence in favour of an existing short-run volatility transmission process in agricultural futures markets [5].

Zhang and Choudhry (2015) investigate the forecasting ability of six different generalized GARCH models; bivariate GARCH, BEKKGARCH, GARCH-X, BEKK-X, Q-GARCH and GARCH–GJR based on two different distributions (normal and student-t). Forecast errors based on four agricultural commodities' futures portfolio return forecasts (based on forecasted hedge ratio) are employed to evaluate the out-of-sample forecasting ability of the six GARCH models. The four commodities under investigation are two storable commodities: wheat and soybean, and two non-storable commodities: live cattle and live hogs [39].

Sanjuan-Lopez and Dawson (2017) examine the effects of speculation in the form of index trading on contemporaneous returns and volatility on corn, soybeans and wheat futures markets on the Chicago Board of Trade using multivariate generalised autoregressive conditional heteroscedasticity models and weekly data for 2006 –2014 [28].

In 2018, the crystal sugar production in Turkey was estimated to be 685,560 metric tonnes. The demand and supply of sugar relies on various factors such as domestic/foreign political implications, economic conditions, meteorological and environmental factors. Moreover, there is a high difference mark between the sugar beet at producer prices and crystal sugar at consumer prices (Turkseker, 2020) [30].

Sugar is a curious crop that due to the fact that it gives raw materials for agriculture sector. TURKSEKER beet sugar industry has 15 sugar factories that its capacity has 36% of its demand. TURKSEKER is a good and efficient organization in Turkey that it is responsible for the marketing and the production of sugar. The sugar price has been determined by the supply conditions in Turkey. Consumer prices has been steadily increasing for that reason it is very important part of economic events. Especially, household behavior in Turkey sensitive these prices and they follow all food prices in every time to buy the cheapest food for nutrition. The responsible organization in Turkey follow the sugar production and price to implementation for efficient and productive policy.

Time series analysis has been using in different areas for instance in econometrics, economics, social sciences and etc. In this paper, we aim to analyze the Turkish sugar price on a monthly base between 1994 and 2020 and ARCH, GARCH, EGARCH models and Box-Jenkins methods were used for forecasting the next years. The sugar price data was gathered from The Turkish Statistical Office's (Turkstat) database. (Turkstat, 2020) [31].

The study has four parts that first section is about the literature for sugar price. Second and third parts about the methodology of ARCH, GARCH, EGARCH and Box-Jenkins method. And, the last section has the empirical findings and discussions.

MATERIALS AND METHODS

Autoregressive Conditional Heteroskedasticity (ARCH), GARCH, EGARCH and ARIMA models particularly tested in this study. This study's contribution in literature is to determine the fit model for the sugar price data via comparing these methods.

Data

The Turkish sugar price data has about monthly data and it was taken from January 1st, 1994 to April 31st, 2020. Its number of observations is n=316. This data includes commodity price and gathered from the Turkish Statistical Institute (TurkStat) database.

Forecasting Methods

Forecasting research has been used increasingly in the world. Especially, GARCH, EGARCH, TARCH models and Box-Jenkins ARIMA model are popular methods for predicting analysis.

ARCH(Q) model

In order to test the financial series volatility, the Autoregressive Conditional Heteroscedasticity (ARCH) model was developed by Engle (1982) [14]. ARCH model has a conditional mean equation and a conditional variance equation. Before estimating GARCH models, it must test for autocorrelation of residual. After that, the variance equation has to be estimated during the process. Maximum likelihood method is used to estimation for the mean equation and the variance equation. ARCH model is an autoregressive process (AR) and written as:

The ARCH regression model is obtained by assuming that the mean of y_t is given as $x_t\beta$ a linear combination of lagged endogenous and exogenous variables included in the information set ψ_{t-1} with β a vector of unknown parameters.

Formally,

$$y_{t|}\psi_{t-1} \sim N(x_t\beta, h_t), \quad (1)$$

$$h_t = h(\varepsilon_{t-1}, \varepsilon_{t-2}, \dots, \varepsilon_{t-p}, \alpha) \quad (2)$$

$$\varepsilon_t = y_t - x_t\beta \quad (3)$$

The variance function can be further generalized to include current and lagged x's as these also enter the information set. The h function then becomes,

$$h_t = h(\varepsilon_{t-1}, \varepsilon_{t-2}, \dots, \varepsilon_{t-p}, x_t, x_{t-1}, x_{t-2}, \dots, x_{t-p}, \alpha) \quad (4)$$

or simply

$$h_t = h(\psi_{t-1}, \alpha) \quad (5)$$

σ^2 : the conditional variance of random variable.

$$\sigma_t^2 = var(u_t|u_{t-1}, u_{t-2}, \dots) = E[(u_t - E(u_t))^2 \,|u_{t-1}, u_{t-2}, \dots] \quad (6)$$

Since $E(u_t) = 0$, therefore

$$\sigma_t^2 = var(u_t|u_{t-1}, u_{t-2}, \dots) = E[u_t^2 \,|u_{t-1}, u_{t-2}, \dots] \quad (7)$$

The ARCH effect is modeled as;

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 \quad (8)$$

$$var(u_t) = \gamma_0 + \gamma_1 u_{t-1}^2 \qquad u_t \sim N(0, var(u_t)) \quad (9)$$

γ_0, γ_1 are unknown parameters.

Full model is expressed as;

$$r_t = \mu + u_t, \qquad u_t \sim N(0, \sigma_t^2) \quad (10)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 \quad (11)$$

$$\gamma_0 \geq 0, \gamma_1 \geq 0 \quad (12)$$

i) a conditional variance its value must always be strictly positive.

$$r_t = \mu + u_t, \qquad u_t \sim N(0, \sigma_t^2) \quad (13)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + \dots + \gamma_p u_{t-p}^2 \quad (14)$$

$$H_0: There\ is\ no\ ARCH\ effect \quad (15)$$

$$H_a: There\ is\ ARCH\ effect \quad (16)$$

If there is no serial correlation in the error variance, then

$$H_0: \gamma_1 = \gamma_2 = \dots = \gamma_p = 0 \quad (17)$$

$$\hat{u}_t^2 = \hat{\gamma}_0 + \hat{\gamma}_1 \hat{u}_{t-1}^2 + \hat{\gamma}_2 \hat{u}_{t-2}^2 + \dots + \hat{\gamma}_p \hat{u}_{t-p}^2 \quad (18)$$

GARCH models

The ARCH process introduced by Engle (1982) explicitly recognizes the difference between the unconditional and the conditional variance allowing the latter to change over time as a function of past errors (Bollerslev, 1986) [6].

The GARCH (p, q) process (Generalized Autoregressive Conditional Heteroskedasticity) is then given by,

$$\varepsilon_{t|}\psi_{t-1} \sim N(0, h_t), \quad (19)$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i} \quad (20)$$

$$\alpha_0 + A(L)\varepsilon_t^2 + B(L)h_t \quad (21)$$

where

$$p \geq 0, \quad q > 0 \quad (22)$$

$$\alpha_0 > 0, \quad \alpha_i \geq 0, \quad i = 1, \dots, q, \quad (23)$$

$$\beta_i \geq 0, \quad i = 1, \dots, p. \quad (24)$$

For p=0 the process reduces to the ARCH(q) process, and for p=q=0 ε_t is simply white noise. In the ARCH(q) process the conditional variance is specified as a linear function of past sample variances only, whereas the GARCH(p,q) process allows lagged conditional variances to enter as well.

The GARCH(p,q) regression model is obtained by letting the ε_t's be innovations in a linear regression,

$$\varepsilon_t = y_t - x_t' b \quad (25)$$

where y_t is the dependent variable, x_t a vector of explanatory variables, and b a vector of unknown parameters (Bollerslev, 1986).

As pointed out by Sastry Pantula and an anonymous referee, an equivalent representation of the GARCH(p,q) process is given by

$$\varepsilon_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \varepsilon_{t-j}^2 - \sum_{j=1}^{p} \beta_j v_{t-j} + v_t \quad (26)$$

and

$$v_t = \varepsilon_t^2 - h_t = (\eta_t^2 - 1)h_t \quad (27)$$

where

$$\eta_t \overset{i.i.d.}{\sim} N(0,1) \quad (28)$$

The simplest but often very useful GARCH process is of course the GARCH(1,1) process given by (1) and

$$h_t = \alpha_0 \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}, \qquad \alpha_0 > 0, \alpha_1 \geq 0, \beta_1 \geq 0 \quad (29)$$

$\alpha_1 + \beta_1 < 1$ suffices for wide-sense stationarity.

EGARCH model

Different models have been developed for testing the asymmetry of volatility. Developed by the EGARCH model by (Nelson, 1991) [24] can be written as:

$$\ln(\sigma_t^2) = \omega + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \sum_{j=1}^{q} \beta_j log \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \quad (30)$$

where

σ_t^2: the conditional variance,

$\omega, \alpha_i, \beta_j, and\ \gamma_k$ are parameters to be estimated.

In order to provide stationary, β_j parameter should be positive and < 1.

γ_k is an indicator of leverage effect that means asymmetry. This parameter must be negative and statistically significant (Dritsaki, 2018) [13].

The ARCH - GARCH Estimation

In the form of conditional heteroscedasticity, the model for the mean and variance [AR(1)-GARCH (1,1)] can be expressed as;

$$r_t = \mu + \varphi r_{t-1} + u_t, \qquad u_t \sim N(0, \sigma_t^2) \quad (31)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \lambda \sigma_{t-1}^2 \quad (32)$$

σ_t^2 is the variance of the errors.

The maximum likelihood method is used for the estimation of GARCH models. The logarithmic function of maximum likelihood is computed from the conditional densities of the prediction errors and is provided in the following form:

$$L = -\frac{1}{2} \sum_{t=1}^{n} [\ln(2\pi) + \ln(\sigma_t^2) + z_t^2] \quad (33)$$

where,

n: the number of observations,

σ_t^2: conditional variance,

$z_t^2 = \frac{\varepsilon_t^2}{\sigma_t^2}$,

$\varepsilon_t = r_t - \mu$,

r_t : the rate of return.

The Box-Jenkins Method

Forecasting is very important method to estimate the next periods that using in economics, business and industry. Holt (1957, 1963) [18] [19], Winters (1960) [33], Brown (1962) [9] and Coutie (1964) [10] used moving averages. The ARIMA abbreviation stands for autoregressive integrated moving average model. (Box and Jenkins 1976) [8] applied this methodology. ARIMA is used in time series analysis and forecasting in many studies. Such as (Yule 1927) [38], (Slutsky 1937) [29], (Walker 1931) [32], (Yaglom 1955) [35], (Libert 1984) [21], (Maberly 1986) [22], (Poulos et al. 1987) [26], (Bowerman and O'Connell 1987) [7], (Wu and Zhang 1997) [34], (Kim 2003) [20] and (Gooijer and Hyndman 2006) [17].

Evaluation of the models

MAE, MAPE, RMSE and MAD criteria are used during the forecasting to select the best model.

RMSE, MAPE and MAD statistics

There is some performance statistics such as MAPE, RMSE, MAE and MAD. MAPE were used by Alon et al. 2001 [1] and Ravindran and Warsing 2013 [27]. RMSE was stressed by Barnston 1992 [4]. Dritsaki 2018 used MSE, MAE, RMSE and MAPE.

$$MSE = \frac{\sum_{t=1}^{T}(r_t^2 - \sigma_t^2)^2}{T} \quad (34)$$

$$RMSE = \sqrt{\frac{\sum_{t=1}^{T}(r_t^2 - \sigma_t^2)^2}{T}} \quad (35)$$

$$MAPE = \frac{1}{T} \sum_{t=1}^{T} \left| \frac{r_t^2 - \sigma_t^2}{\sigma_t^2} \right| \quad (36)$$

$$MAE = \frac{1}{T} \sum_{t=1}^{T} |r_t^2 - \sigma_t^2| \quad (37)$$

In these formulas; t is time period, T is total number of observations, $y_t$is actual value, and $\hat{y}_t$ is forecasted value at time t. As a conclusion, if we have a small value for the prediction error, producing forecasted value from the model will be good.

RESULTS AND DISCUSSIONS

The data used on this model of sugar price are monthly and refer to rgprice.

The data range is from January 1994 until April 2020. It is a total of 316 observations.

All data are gathered from Turkish Statistical Institute (TurkStat). The average monthly values of sugar price and their returns are given in Figures 1 and 2, respectively. Monthly percentage return of sugar price is the first difference from natural logarithm of sugar price and is given from the following equation:

$$R_t = 100 * \ln\left(\frac{X_t}{X_{t-1}}\right) = 100 * [\ln(X_t) - \ln(X_{t-1})] \quad (38)$$

where R_t is monthly percentage return to sugar price and X_t is sugar price at time t.

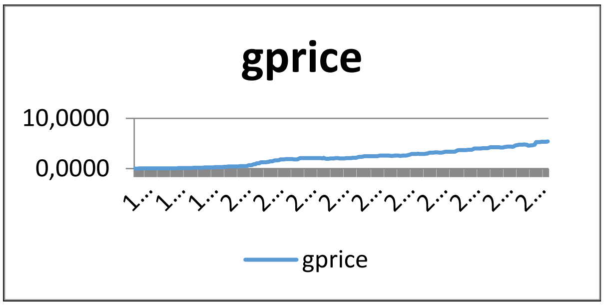

Fig. 1. Average monthly values of sugar prices
Source: Author's calculations.

We can see the nonstationary shape of the time series in the following graphics. This series is going to be examined.

This series is randomly fluctuating and indicating the observation of a global trend. In particular, after the year 2001, the time series quickly increases, and then the prices show the behavior of uptrend. Average monthly values of sugar prices are present a random walk (Figure 1).

Average monthly values of sugar prices rate are steady from Fig. 2. Thus, we can see the variance are unstable that sugar price returns show volatility.

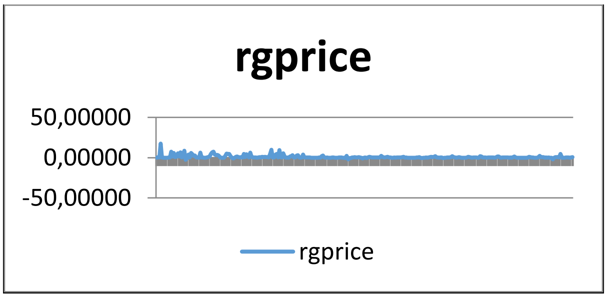

Fig. 2. Average monthly values of return of sugar prices
Source: Author's calculations.

Table 1 presents the correlograms, and we will test if there is autocorrelation on average monthly returns of sugar price, as well as the ARCH effect. This result, belong to Bollerslev (1986), features GARCH models as the most suitable for the data of sugar price rate.

Table 1. Correlogram of average monthly return of sugar price

Date: 06/23/20 Time: 19:04
Sample (adjusted): 1994M02 2020M04
Included observations: 315 after adjustments

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.474	-0.474	71.597	0.000
		2	-0.051	-0.356	72.415	0.000
		3	0.132	-0.102	78.002	0.000
		4	-0.167	-0.219	86.910	0.000
		5	0.084	-0.128	89.204	0.000
		6	-0.015	-0.126	89.279	0.000
		7	-0.079	-0.197	91.324	0.000
		8	0.112	-0.101	95.420	0.000
		9	-0.105	-0.195	99.038	0.000
		10	0.162	0.039	107.65	0.000
		11	-0.123	-0.086	112.63	0.000
		12	-0.046	-0.156	113.34	0.000
		13	0.141	-0.057	119.92	0.000
		14	-0.152	-0.165	127.60	0.000
		15	0.140	-0.012	134.08	0.000
		16	-0.025	-0.023	134.29	0.000
		17	-0.085	-0.047	136.71	0.000
		18	0.151	0.055	144.42	0.000
		19	-0.137	-0.018	150.75	0.000
		20	0.016	-0.043	150.84	0.000
		21	0.014	-0.091	150.90	0.000
		22	0.011	0.031	150.94	0.000
		23	-0.019	-0.086	151.06	0.000
		24	-0.013	-0.083	151.12	0.000
		25	0.067	-0.023	152.67	0.000
		26	-0.022	-0.023	152.84	0.000
		27	0.012	0.082	152.89	0.000
		28	-0.010	-0.004	152.92	0.000
		29	-0.073	-0.037	154.80	0.000
		30	0.121	0.082	159.96	0.000
		31	-0.090	-0.017	162.83	0.000
		32	0.026	0.041	163.06	0.000
		33	0.013	0.003	163.12	0.000
		34	-0.036	0.026	163.57	0.000
		35	0.047	0.020	164.34	0.000
		36	-0.030	0.013	164.67	0.000

Source: Author's calculations.

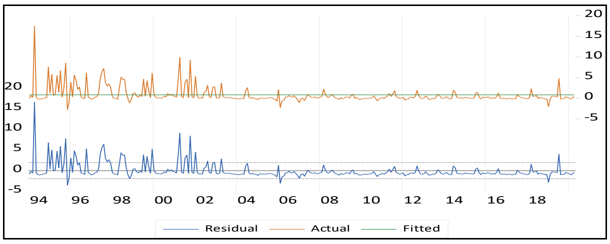

Fig. 3. Residual of sugar price
Source: Author's calculations.

The one step in the process was to create a time series plot of the data, which displayed the average monthly sugar prices for each year for the monthly from 1994 to 2020. The results of Figure 4 show that average monthly returns of the sugar price follow the normal distribution. Also, asymmetry's coefficient that is skewness shows that the distribution of sugar price returns is right asymmetric (3.666), is leptokurtic (k=22.859), and has heavy tails (Fig.4).

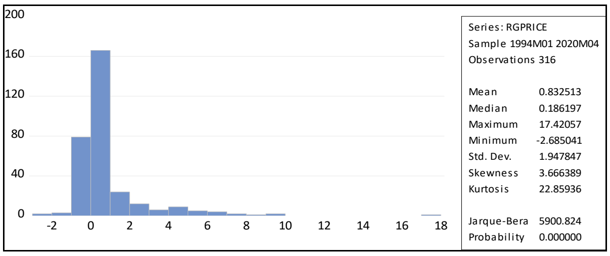

Fig. 4. Descriptive statistics and normal density graphs of average monthly return on the sugar price
Source: Author's calculations.

We test the stationarity of the average monthly returns of the sugar price using Dickey-Fuller (1979, 1981) [11] [12] and Phillips Perron (1998) [25] tests. The results in Table 2 show that the average monthly returns of the sugar price are stationary in their levels on both used tests.

Table 2. Stationarity test of average monthly returns of the sugar price

Variable	ADF		P-P	
	Constant	Constant, Trend	Constant	Constant, Trend
RGPRICE	-7.289341 (2)*	-9.321505 (3)*	-15.48088 (9)*	-16.27060 (3)*

Notes: * denotes the significant at 1%, 5% and 10% levels, significantly. The numbers in parentheses represent the lag length.
Source: Author's calculations.

ARIMA model selection for the sugar prices of Turkey

Akaike's Information Criterion (AIC) is expressed below the formula:

$$AIC = log\hat{\sigma}^2 + 2\frac{p+q}{n} \quad (39)$$

Schwarz (SBC) or Bayesian Information Criterion (BIC) is expressed below the formula:

$$BIC = log\hat{\sigma}^2 + 2\frac{p+q}{n}\log(n) \quad (40)$$

To determine the best values for the model, we use and prefer the smallest AIC or BIC values. According to literature, these two criteria are differ for some properties and the BIC criterion is preferred. Because, it has the feature that it will almost surely select the true model.

And, different ARIMA (p,d,q) results showed in Table 3. In addition to, the optimum lag length and information criterion for the ARIMA (p,d,q) for D(RGPRICE) are presented in Table 3. With respect to LogL, Akaike (AIC), Schwartz (BIC), and Hannan-Quinn (HQ) criteria, ARIMA (3,0,3) model is the most suitable as far as the mean monthly returns for the sugar price are related (Table 3).

The information criteria favor the ARIMA (3,0,3) and its results are given below in Table 4.

Table 3. LogL, AIC*, BIC and HQ test results

Model Selection Criteria Table				
Dependent Variable: D(RGPRICE)				
Model	LogL	AIC*	BIC	HQ
(3,3)(0,0)	***-620.012689***	***3.987382***	***4.082686***	***4.025459***
(2,4)(0,0)	-620.120545	3.988067	4.083370	4.026144
(2,3)(0,0)	-621.783439	3.992276	4.075666	4.025593
(4,4)(0,0)	-619.297530	3.995540	4.114669	4.043137
(4,3)(0,0)	-621.397972	4.002527	4.109743	4.045364
(3,4)(0,0)	-621.673105	4.004274	4.111490	4.047111
(4,1)(0,0)	-631.729735	4.055427	4.138817	4.088745
(0,1)(0,0)	-635.791281	4.055818	4.091556	4.070097
(0,2)(0,0)	-635.381235	4.059563	4.107215	4.078602
(1,1)(0,0)	-635.381877	4.059567	4.107219	4.078606
(4,2)(0,0)	-631.587745	4.060875	4.156178	4.098952
(1,2)(0,0)	-634.738072	4.061829	4.121394	4.085627
(0,3)(0,0)	-635.379622	4.065902	4.125467	4.089701
(2,1)(0,0)	-635.381741	4.065916	4.125480	4.089714
(3,2)(0,0)	-633.556603	4.067026	4.150417	4.100344
(0,4)(0,0)	-634.602716	4.067319	4.138796	4.095877
(1,4)(0,0)	-633.715826	4.068037	4.151427	4.101355
(2,2)(0,0)	-634.719235	4.068059	4.139536	4.096617
(1,3)(0,0)	-634.723258	4.068084	4.139562	4.096642
(3,1)(0,0)	-634.966204	4.069627	4.141104	4.098185
(4,0)(0,0)	-657.030081	4.209715	4.281192	4.238273
(3,0)(0,0)	-666.729964	4.264952	4.324517	4.288750
(2,0)(0,0)	-669.025698	4.273179	4.320831	4.292218
(1,0)(0,0)	-690.248183	4.401576	4.437315	4.415855
(0,0)(0,0)	-730.309610	4.649585	4.673411	4.659104

Source: Author's calculations.

Table 4. Estimation of ARIMA(3,0,3) model

Dependent Variable: D(RGPRICE)				
Method: ARMA Maximum Likelihood (BFGS)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.007085	0.005518	-1.283910	0.2001
AR(1)	-1.485977	0.051148	-29.05273	0.0000
AR(2)	-0.811079	0.077487	-10.46731	0.0000
AR(3)	0.112004	0.048576	2.305742	0.0218
MA(1)	0.679851	18.89401	0.035982	0.9713
MA(2)	-0.601398	16.47642	-0.036501	0.9709
MA(3)	-0.970395	54.72022	-0.017734	0.9859
SIGMASQ	2.900088	29.64561	0.097825	0.9221
R-squared	0.520144	Mean dependent var		0.001875
Adjusted R-squared	0.509202	S.D. dependent var		2.462297
S.E. of regression	1.725010	Akaike info criterion		3.987382
Sum squared resid	913.5277	Schwarz criterion		4.082686
Log likelihood	-620.0127	Hannan-Quinn criter.		4.025459
F-statistic	47.53923	Durbin-Watson stat		2.015530
Prob(F-statistic)	0.000000			
Inverted AR Roots	.11	-.80+.59i	-.80-.59i	
Inverted MA Roots	.97	-.83-.56i	-.83+.56i	

Source: Author's calculations.

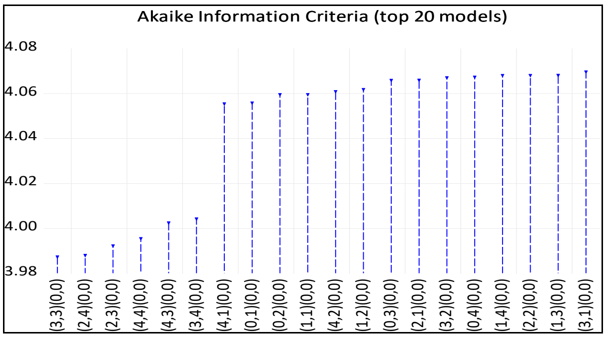

Fig. 5. Akaike Information Criteria results
Source: Author's calculations.

Empirical Results

We found the Prob. Chi-Square = 0.0084 < 0.05. And, refer to the hypothesis, we can't accept the null hypothesis. Namely, we accept the alternative hypothesis that there is ARCH effect. We can conclude that we can run the ARCH family models such as GARCH, EGARCH and so on.

$$H_0: There\ is\ no\ ARCH\ effect$$
$$H_a: There\ is\ ARCH\ effect$$

If we start to estimate ARCH(q), GARCH(p,q) and EGARCH(p,q) models, we can look into ARCH effects on the returns of the sugar price. Marquardt's algorithm (1963) [23] is used for the estimation of the parameters.

Some statistics belong to the estimated models are given in Table 5. We can look the log-likelihood (LL) value for fitting the model. If LL value has a high value, we can say that LL gives a good fit value.

The estimations of all models and the standard errors of the parameters (coefficients) together with the value of log-likelihood function, as well as the normality test, autocorrelation test, and conditional heteroscedasticity test in Table 5.

If we decide the most suitable value, we can look some statistics such as significance of coefficients, LL value, autocorrelation and heteroscedasticity. In here, The ARIMA(3,0,3)-GARCH(1,1) model for GED is the fitted distribution according to these statistics. In this model, whole coefficients are significant at 5% level, LL value has the highest value, no autocorrelation and heteroscedasticity. As a conclusion, this model is fitted for predicting (Table 5).

Table 5. ARIMA(3,0,3)-ARCH(1), ARIMA(3,0,3)-GARCH(1,1), and ARIMA(3,0,3)-EARCH(1,1) results

ARIMA (3,0,3)-ARCH(1)			
Parameter	Normal	t-Student	GED
ω	3.220(0.000)	376.63(0.999)	1.166(0.000)
α_1	0.217(0.000)	2415.93(0.999)	3.978(0.062)
		DOF=2.000(0.000)	GED=0.373(0.000)
Log-likelihood	-654.38	-403.93	**-389.60**
ARIMA (3,0,3)-GARCH(1,1)			
ω	0.016(0.000)	181.14(0.998)	0.008(0.000)
α_1	0.053(0.000)	1107.68(0.998)	-0.013(0.088)
β_1	0.924(0.000)	0.009(0.003)	0.989(0.000)
		DOF=2.000(0.000)	GED=0.4900(0.000)
Log-likelihood	-512.06	-402.38	**-373.82**
ARIMA (3,0,3)-EGARCH(1,1)			
ω	-0.117(0.000)	-0.128(0.003)	-0.003(0.889)
α_1	0.161(0.000)	1.365(0.036)	0.071(0.278)
β_1	-0.223(0.000)	-0.643(0.131)	-0.157(0.005)
γ_1	1.035(0.000)	1.000(0.000)	1.066(0.000)
		DOF=2.011(0.000)	GED=0.464(0.000)
Log-likelihood	-500.64	-403.41	**-373.30**
Notes: Value in parentheses denotes the p-values			

Source: Author's calculations.

ARIMA(3,0,3)-EGARCH(1,1) model with the GED distribution isn't good for forecasting. Because, coefficients are not significant, β_1 coefficient is negative and less than 1 indicating that the stationarity of the model. Moreover, γ_1 coefficient is positive and not significant statistically that showing the stationarity of the model. As a result, we can't use this model for predicting (Table 5).

Forecasting

At this point, for the predicting of ARIMA(3,0,3)-GARCH(1,1) model on the returns of sugar price, dynamic and static procedures are used. During the dynamic estimation, the lags of dependent variable and ARMA terms are used for estimation. That is, this procedure is implemented by n-step ahead forecasting. The other procedure is static. In this step, we use the actual values belong to dependent variable. Its name of procedure is one-step ahead forecast. Using the dynamic and static forecast, the evaluation of forecasting the returns of sugar price is implemented and presented, respectively in Figure 5.

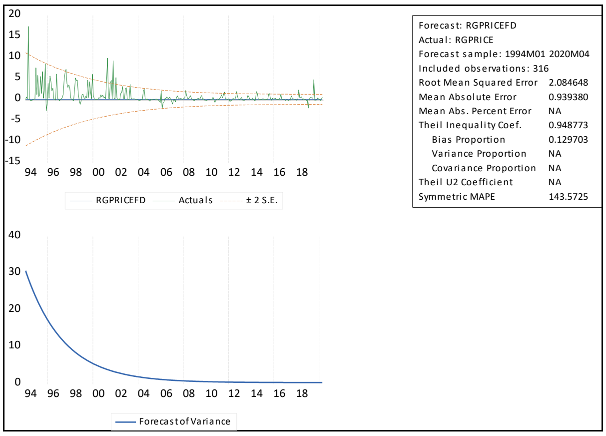

Fig. 6. Dynamic forecast of sugar price (GARCH)
Source: Author's calculations.

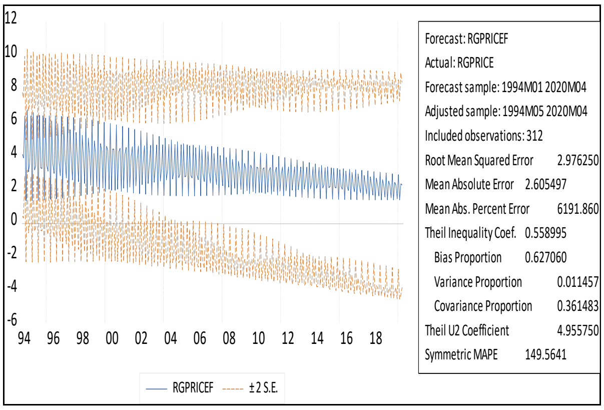

Fig. 7. Dynamic forecast of sugar price (ARIMA)
Source: Author's calculations.

Especially, some indicators are given in here for intance the determined model is complying with the past data, the fitted values link with the scatter of the actual data are good. There are some indicators such as the RMSE, MAE and MAPE are low relative to other models, the adjusted R^2 is high. As a conclusion, residuals are white noise (Table 6).

Table 6. The test accuracies of the forecasting m GARCH and ARIMA methods for sugar prices

Methods	The criteria		
	RMSE	MAPE	MAE
GARCH	2.085*	NA*	0.939*
ARIMA	2.976	6191.86	2.605
*GARCH is the best model for making forecasts			

Source: Author's calculations.

CONCLUSIONS

This paper emphasizes on the creative of a model for the Turkish sugar price. When sugar price can give volatility, GARCH models are convenience for using as a model. Moreover, ARIMA(3,0,3)-ARCH(1), ARIMA(3,0,3)-GARCH(1,1) and ARIMA(3,0,3)-EGARCH(1,1) models were estimated for registering symmetry effect's volatility on sugar price. The estimation of ARIMA(3,0,3)-EGARCH(1,1) model is used for finding the leverage effect. That is, positive shocks cause for the lower volatility. As a conclusion, By using the dynamic process, ARIMA(3,0,3)-GARCH(1,1) model is gathered. According to results of this study, we can say that GARCH model has a good estimation to predict the sugar prices.

In order to identify the ARIMA model for a time series, we calculated the different ARIMA models. In this study, first of all sugar prices are taken by logarithmized and used the first order difference. This method is the best way to select the ARIMA model.

During the evaluation, important statistical tests were used. Especially, the significance of the coefficients and used to test the residuals were taken. To evaluate the fit of the ARIMA models, The Akaike information criterion (AIC) and the Bayes information criterion (BIC) are used. The R^2 and Adjusted R^2 were evaluated. In order to determine the best ARIMA model, these criteria are used. The autocorrelation and partial autocorrelation give the impression that the residuals estimated from the ARIMA (3,0,3) are approximately white noise. The mean absolute percentage error (MAPE), root mean square error (RMSE) and mean absolute deviation (MAD) are used for selecting the best model forecasting.

Due to all criteria values for the GARCH (1,1) model are the lowest and fitted values is the best model in this study by comparing these criteria.

We believe that the research methodology and the results given in this paper can be useful for the strategy setting of Turkish agricultural economists, economists and government authorities.

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ANALYSIS OF THE EFFICIENCY IN PRODUCTION OF TOMATOES AMONG AGRICULTURAL ESTABLISHMENTS: DATA ENVELOPMENT ANALYSIS AND STOCHASTIC FRONTIER ANALYSIS

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Abstract

Technical efficiency of tomato producers in Ankara was evaluated using Data Envelopment Analysis and Stochastic Production Frontier methods. Using Stratified Random Sampling method 77 tomato producers were selected and structured questionnaire was used to collect data from the selected farmers. The main tomato production problems faced by tomato producers are diseases representing 22.4%, low labour force 20.0%, cost of inputs 17.7% and access to irrigation water 1.9%. The main marketing problems faced by farmers are transportation cost of tomatoes to sales point %39.9 and low selling of tomatoes 38.6%. Technical efficiency was found to be 55.55% under stochastic production frontier while under Data Envelopment Analysis was found to be 86.43%. Stochastic Frontier Analysis separates causes of changes in output into managerial and chance hence lower efficiency score compared to data envelopment analysis approach which does not. The results of Stochastic Production Frontier indicate that all factors of production that include labour, land, seedling, animal manure, chemical fertilizer, pesticides, irrigation and tractor expenditure where all found to be statistically significant in influencing production on the other hand formal education of the farmer, use of agricultural credit and membership to agricultural organisation were found to be statistically significant in influencing technical efficiency scores.

Key words: *efficiency, stochastic frontier analysis, data envelopment analysis, tomatoes production*

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is one of the most important vegetables in the world. It contributes to a healthy and balanced diet. Tomatoes are rich in minerals, vitamins, important amino acids, sugars and dietary fiber. Tomatoes contain a lot of vitamins B and C, iron and phosphorus (Shankara et al. 2005) [9]. The vitamin A content in yellow tomatoes is higher than in red tomatoes, but red tomatoes contain lycopene, an antioxidant that can contribute to protection against carcinogens. Tomatoes are consumed in fresh (table) and processed (paste) forms. Tomato is one of the processed products, tomato juice, ketchup, tomato paste, peeled, tomato puree. Tomato demand and trade in the world is constantly growing. In 2017, it was estimated that world tomato production was 241 million tons, export and import trade was 81 million tons and 5 million tons, respectively (FAOSTAT 2017) [5]. This figure represents 36% of tomatoes traded in the international market, while the remaining 64% represents consumer consumption and domestic trade. In addition, this figure shows the economic importance of tomatoes in a country's foreign currency earnings and income earnings of tomato producers. The main activities involving tomato production are listed as soil preparation, seedling planting, fertilization, irrigation, pesticide, weed and disease control and harvesting operations (Shankara et al. 2005) [9]. Tomato (*Lycopersicon esculentum*) is one of the vegetables grown worldwide (Shankara et al. 2005) [9]. According to continents, tomato production is estimated to be 111 million in Asia, 23 million in Europe, 20 million in Africa, 13 million in North America, 6 million in South America and 500 thousand in Australia (FAOSTAT 2018) [6]. The countries where tomatoes are produced the most in the world are China 12 million tons, India 1 million 900 thousand tons, USA 1 million 300 thousand tons, Turkey 1 million

200 thousand tons, Egypt 662 thousand tons, Iran 665 thousand tons and other countries 6 million tons (FAOSTAT 2018) [6]. Turkey's highest tomato producing provinces Antalya 2 million 500 thousand tons, Mersin 1 million 300 thousand tons, Muğla 700 thousand tons, Bursa 340 thousand tons, Çanakkale 309 thousand tons, Hatay 62 thousand tons, Tokat 353 thousand and other provinces 3 million 400 thousand tons (Turkstat 2019) [10].

In this study, a research has been carried out for the problems related to tomato production activities in Ankara Province. The study focuses on tomato diseases, production cost, profit, yield and marketing. According to the reviewed literature, none of the previous studies focused on the analysis of the cost, income and profit efficiency of tomato growing agricultural enterprises. Therefore, this study focuses on the evaluation of technical efficiency, which is a component of the cost effectiveness of tomato growers in Ankara, and the problems experienced in tomato production and marketing using Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) methods.

MATERIALS AND METHODS

Material

Data were obtained from enterprises producing tomato in Ankara province through a questionnaire. The questionnaire forms were filled in by going to sample tomato producers and interviewing them face to face. In addition to the primary data obtained, the findings of previous studies on the subject, published and the records of different organizations, and second data were used.

Data Analysis

SPSS, DEAP and R package programs were used in data analysis.

Methods

Sampling

Within the scope of the study, there are 394 tomato enterprises in Ankara Province Ayaş district. Tomato growers of 5 villages included in the study were selected because they produce intensive tomatoes. The total tomato cultivated area of these villages is 2,713.44 decares, and the average land is 9,120 decares. While the first layer allocated to the production of tomatoes was 0.15-9.15 decares, the second layer was allocated 10.15-50.15 decares for the production of tomatoes. Neyman method was used to determine the total sample volume (n). Using this method, the total sample volume was determined to be n = 77.

Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA)

Technical efficiency is the ability of a firm to avoid waste by using as few inputs as required by its technology and production (Coelli et al. 2005) [2]. Allocation activity is the firm's ability to combine inputs and/or outputs in optimal proportions in light of prevailing prices. There are two approaches to estimating technical effectiveness; Parametric and nonparametric approaches (Fare et al. 1985) [7]. Parametric approaches such as stochastic boundaries are to predict production functions using econometric techniques. Nonparametric approaches such as Data Envelopment Analysis are used in linear programming techniques for estimation of effectiveness (Cooper et al. 2007) [4]. In this study, Data Envelopment Analysis and Stochastic Frontier Analysis technique were used to predict the efficiency in tomato production. Output directional data envelopment and stochastic production limit are used to analyze the optimum amount of output that can be achieved with the current input level and technology. Output oriented data envelopment and stochastic production limit were used to analyze the scale of the business.

Data Envelopment Analysis (DEA) (maximization LP problem)

The Banker-Chaenes-Cooper (BCC) data envelopment model considers underproduction and the size of the scale process as sources of inefficiency. This is called the output-direction BCC data envelopment model and is expressed as follows:

$$\mathrm{Max}\ \theta + \varepsilon\left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right)$$

S.t.

$$\theta y_0 - Y_i\lambda + S_r^+ = 0$$

$$X_i\lambda + S_i^- = x_0$$

$$\sum_{i=1}^{n} \lambda_i = 1$$

Maximum output achievable with current technology level = θ * vector of output quantities (Yi)

$$\lambda.\theta.S_r^{+}.S_i^{-} \geq 0$$

θ = Effectiveness points ranging from 0 to 1
S_r^{+}= output scarcity (loose) due to output mix
S_i^{-}= over input (loose)
λ= Lamda
X_i= Vector of input quantities
Y_i = Vector of output quantities (Cooper et al. 2007) [4].

Stochastic frontier analysis (maximization problem)

The data envelopment analysis technique provides the analysis of the use of resources, the maximum amount of output that can be achieved with current input and technology levels. However, it does not show the factors that contribute to the source of changes in efficiency between businesses. On the other hand, stochastic production frontier technique provides analysis of the sources of efficiency changes (Fare et al. 1985) [7]. For this reason, stochastic probability frontier technique was also used to analyze the sources of variation in possible activities among tomato farmers in Ayaş district.

Selection of tomato production function

Estimation of the stochastic production limit requires the definition and selection of the appropriate production function. Common production function models Linear, Cobb-Douglas, Quadratic, Normalized quadratic, Translog, Generalized Leontief, Elasticity of Substitution Constant etc. (Battese and Coelli 2005) [1]. But commonly used are Cobb-Douglas and Translog. In this study, Cobb-Douglas and Translog production function was evaluated using log odds ratio test. For Cobb-Douglas, LR = 2 (least square - Cobb-Douglas stochastic frontier analysis). For Translog, LR = 2 (least square - Translog stochastic frontier analysis). The function of Cobb-Douglas was determined to be suitable for the production of tomatoes in Ayaş district. For this reason, the Cobb-Douglas function was used to analyze the technical efficiency of tomato producers in Ayaş district.

The model is specified as follows:

$$lny_i = lnf(x_i;\beta) + (v_i - u_i)$$

b= vector of technological parameters
ln = natural logarithm
v_i= white noise error term (iid~N(0. σ^2)
u_i= The term ineffectiveness (semi-normal, gamma, exponential or truncated normal distributed) is chosen as the semi-normal distribution ineffectiveness.
x_i= Vector of input quantities
y_i = Vector of output quantities (Coelli et al. 2005) [2].

Variable selection for tomato production function

Production is the process of combining and coordinating inputs (production resources or production factors) in the creation of a good or service (Colman and Young 1989) [3].

The production process of tomatoes requires the following inputs (Shankara et al. 2005) [9]. Workforce (working days), land (decare), seedling amount (piece), chemical fertilizer (kg), animal fertilizer (ton), pesticide (lt), Tractor (expenses) and irrigation (total irrigation times throughout the season), these inputs have been the selection criteria for the variables used in the analysis of production efficiency in both SFA and DEA methods.

RESULTS AND DISCUSSIONS

In this section, efficiency results of Stochastic Frontier Analysis and Data Envelopment Analysis are discussed.

Variables used in Stochastic Frontier Analysis and Data Envelopment Analysis

The statistical values of the variables used in the Stochastic Frontier and Data Envelopment technical efficiency analysis are presented in Table 1.

Table 1. Variables used in Cobb-Douglas model and Data Envelopment Analysis

Variables	Mean	Minimum	Maximum
Total tomato production quantity (kg)	59,487.01	1,000	300,000
Preparation of land throughout the season using a tractor (how many times)	2.81	2	5
Irrigation throughout the season (how many times)	21.58	10	40
Number of days family workforce and foreign workforce worked in tomato production	66.16	45	96
Land allocated for tomato production (decare)	15.49	1	60
The amount of seedlings used (number)	13,272.07	450	50,000
Chemical fertilizers used (kg)	883.84	0	10,000
Animal fertilizer used (ton)	36.55	0	400
Pesticide used (liter)	9.86	1	25

Source: Authors' calculation.

Continuous variables used in the analysis of variability affecting the technical efficiency level among farmers are given in Table 2.

Table 2. Variables used in the inneficiency model

Variables	Mean	Minimum	Maximum
Age of the business owner	54.79	34	72
Number of people in the family	3.06	2	6
The total number of years the farmer has grown tomatoes	25.58	6	45

Source: Author's calculations.

Analysis of technical efficiency with the stochastic frontier analysis

It includes the selection of the appropriate production function, the estimation of the selected production function, and the analysis of the factors affecting changes in the efficiency level of tomato farmers.

Selection of production functional form; odds ratio test

Commonly used types of production functions are translog and Cobb-Douglas production function, so both are considered here. Translog and Cobb-Douglas production is compared to stochastic frontier function versus non-stochastic frontier functions. First, the double error translog generation is compared with the single error translog generation using the stochastic margin, probability ratio test. This was done to test the significance of the variance of the ineffectiveness error term. Test results show that the variance of a component of ineffectiveness is not significant at an error rate of 5% (Table 3).

Table 3. Comparison of the double error translog stochastic generation function with the single error translog generation function using the probability ratio test

Model	#df	Log likelihood value	#df	Ki-square value	Pr > ki-square
First model	46	-28,051			
Second model	47	-28,051	1	0	1
Significance values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

Source: Authors' calculation.

This demonstrated that the translog production function was not a suitable functional form. The signs of some coefficients of the translog production stochastic frontier function are reversed, which is another indication that the translog stochastic frontier function is not a suitable model. Log likelihood test and hypothesis are stated as follows.

LR = 2 (model 1 - model 2).

H_o: Model 1: Single error translog generation stochastic limit (No inefficiency)

H_1: Model 2: Double error component translog generation stochastic limit (inefficiency present)

Second, the double error components are compared with the single error Cobb-Douglas production function using the Cobb-Douglas production stochastic boundary function log likelihood ratio test. Log likelihood test results showed that ineffectiveness error components were significant at 0.1% error rate (Table 4). This shows the existence of inefficiency among tomato producers in Ayaş district. Also, the signs of the coefficients of the Cobb-Douglas production stochastic boundary function appeared as expected, which is an additional indication of the good model fit for the data. The log likelihood ratio test and the hypothesis are stated as follows.

LR = 2 (model 1 - model 2).

H_o: Model 1: Single error Cobb-Douglas production stochastic limit function (no inefficiency)
H_1: Model 2: Double error components Cobb-Douglas production stochastic boundary function (inefficiency exists)

Table 4. Comparison of double error Cobb-Douglas production stochastic limit and single error Cobb-Douglas production function using probability ratio test

Model	#df	Log likelihood ratio	#df	Ki-square value	Pr > ki-square
First model	10	-64.624			
Second model	11	-55.815	1	17.618	0.000 ***
Significance values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

Source: Authors' calculation.

The chi-square test was also performed for the inefficiency error term in the Cobb-Douglas production stochastic limit. According to the results, the variance of an ineffective error term constitutes 99% of the total variation and is statistically significant at an error rate of 0.1% (Table 4). This led to the rejection of the null hypothesis of no inefficiency in the data. Therefore, it has become appropriate to include explanatory variables for the inefficiency error term in the model.
As a reminder, the hypothesis for the Cobb-Douglas production stochastic limit function and the inefficiency error term is expressed as follows.
Cobb-Douglas production stochastic limit function:
$lny_i = lnf(x_i;\beta) + (v_i - u_i)$
v_i= white noise error term (iid~N(0, σ_{vi}^2)
u_i = inefficiency term is semi-normal (iid~N(0, σ_{ui}^2)
$\gamma = \frac{\sigma_{ui}}{\sigma_{vi}+\sigma_{ui}}$
Ho: $\gamma = 0$ there is no ineffectiveness
H1: $\gamma > 0$ there is ineffectiveness

This is a test of variance that monitors the chi-square distribution.

Table 5. Chi-square test of inefficiency variance components of Cobb-Douglas production stochastic boundary

Gamma	Estimated gamma value	Standard error	z-value	Pr(>|z|)
γ	0.999	0.00	18,221,462.85	0.000 ***
Significance values '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Source: Authors' calculation.

Estimation of the efficiency effect of the Cobb-Douglas production stochastic frontier analysis model

The combined results of the Cobb-Douglas production and inefficiency functions are shown in Table 6, respectively. The sum of all the coefficients of the Cobb-Douglas production stochastic boundary function is equal to 1.67. The fact that this total is more than one means that tomato production in Ayaş district provides increasing returns to scale. It means that farmers can increase their level of efficiency and production by increasing the size of their business. The coefficients of all Cobb-Douglas production stochastic boundary function were statistically significant and with expected signs (Table 6). The use of tractor expenditures as an input was considered as the appropriate variable, so a negative sign emerged. This indicates that a 1% increase in the use of inputs will result in a percent increase in tomato production up to the recommended or optimal ratio according to the magnitude of their coefficients. For example, a 1% increase in the use of family and foreign labor provides a 0.677% increase in tomato production, keeping all other inputs constant. On the other hand, a 1% increase in tractor expenditures will cause a 0.553% decrease in tomato production.

There are two basic approaches to estimating the inefficiency model; they are two-stage and one-stage. For the two-stage approach, technical efficiency scores are estimated in the first stage and limited dependent regressions such as the least square regression or the Tobit model are used to evaluate the variables that affect the changes in the efficiency scores in the second stage. For the one-step approach, the inefficiency model is substituted in the stochastic boundary function and estimated simultaneously (Kumbhakar and Lovell 2000) [8].

In this study, a one-step approach was used in the estimation of environment or situation variables affecting technical efficiency among tomato farmers in Ayaş district. The results of the inefficiency model are presented in Table 6 along with the results of the Cobb-Douglas production stochastic boundary function.

Table 6. Cobb-Douglas production efficiency effect stochastic frontier analysis model results

Variables	Variables in natural log form	Coefficients	Estimated coefficients	Z value	Pr(>|z|)	Significance value
Production function	Intercept	b_0	6.387	9.985	0.000	***
Number of family and foreign labor days	lnx_1	b_1	0.677	3.810	0.000	***
Tomato planting land	lnx_2	b_2	0.573	16.618	0.000	***
Total amount of seedlings used (pieces)	lnx_3	b_3	0.239	33.919	0.000	***
Total chemical fertilizer used (kg)	lnx_4	b_4	0.102	6.018	0.000	***
Total used animal manure (tonnes)	lnx_5	b_5	0.111	4.126	0.000	***
Total pesticide used (lt)	lnx_6	b_6	0.145	16.981	0.000	***
Tractor cost (TL)	lnx_7	b_7	-0.553	-8.349	0.000	***
How many times irrigation is done (Number)	lnx_8	b_8	0.253	2.665	0.008	**
Inefficiency function	Z (intercept)	δ_0	-2.074	-1.997	0.046	*
Age of the owner of the business	Z1	δ_1	0.033	1.504	0.133	
Educational status of the owner of the business	Z2 secondary school	δ_2	1.271	2.779	0.005	**
Educational status of the owner of the business	Z2 high school	δ_3	-0.424	-0.976	0.329	
Educational status of the owner of the business	Z2 bachelor	δ_4	-1.039	-1.046	0.296	
Years the owner of the business spent in tomato production	Z3	δ_5	-0.032	-1.180	0.238	
Number of family members	Z4	δ_6	-0.008	-0.060	0.952	
Credit utilization status of the business owner	Z5 (no)	δ_7	0.612	1.725	0.085	,
Status of the owner of the business as a member of the cooperative	Z6 (no)	δ_8	1.133	3.080	0.002	**
Sigma square	sigmaSq	δ^2	0.846	12.268	0.000	***
Gamma	Gamma	γ	0.999	18,221,462.858	0.000	***
Log likelihood value: -45,16988						
Significant value: ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘,’ 0.1 ‘’1						

Source: Authors' calculation.

Testing the significance of all the coefficients of the inefficiency model

The statistical significance of all coefficients in the inefficiency model was tested using the Log likelihood ratio test.

The test results showed that all coefficients were statistically significant in influencing the changes in activity level among tomato farmers (Table 7).
This led to the rejection of the null hypothesis. The log likelihood test is expressed as follows:
LR = 2 (model 1 - model 2).

Model 1: as all explanatory variables to Zi have the effect $lnf(x_i;\beta)+[(v_i-f(\gamma,z_i)+\epsilon_i]$

Model 2: as all explanatory variables to Zi have no effect $lnf(x_i;\beta)+[v_i-f(\gamma_0)+\epsilon_i]$

Ho: $\gamma_1 = \cdots = \gamma_6 = 0$
H1: $\gamma_1 \dots \gamma_6$ does not equal at least zero

Table 7. Log odds ratio test for the effect of all inefficiency coefficients

Model	#df	Log ratio value	#df	ki-square value	Pr > ki-square
First model	20	-45.170			
Second model	12	-54.231	8	18.122	0.020 *

Source: Authors' calculation.

Evaluation of efficiency scores

Technical efficiency average of tomato producers in Ayaş district is 55.55% (Table 8). This is to keep all other factors affecting production such as diseases, input costs, profitability constant. It means that there is a possibility of increasing output by 44.45% by better use of existing inputs of tomato producers in Ayaş district.

Table 8. Summary statistics of efficiency points

Statistical parameters	Efficiency scores %
Mean	55.55
Median	54.00
Mod	100
Minimum	7.00
Maximum	100.00

Source: Authors' calculation

Considering that tomato producers are not fully efficient, the calculation of the actual amount of tomatoes they will produce if they use their inputs correctly is given below.
Calculation of technical efficiency score:

$$TE_i = \exp(-u_i) = \frac{y_i}{y_i^*} = \frac{y_i}{f(x_i;\beta)+(v_i-f(\gamma.z_i)+\epsilon_i)}$$

$TE_i =$ Technical efficiency
Exp= Exponential
$y_i =$ Actual output vector (amount of tomatoes) (Kg)
$y_i^* =$ Vector (amount of tomato) of maximum outputs achievable with current technology and input level (Kg).

Maximum achievable output average (kg):

$$average\ maximum\ output = \sum (y_i^*)/n$$
$$= \sum \left(\frac{y_i}{TE_i}\right)/n$$

Average of poor output (kg):
$low\ output = \sum(y_i^* - y_i)/n$
$n =$ Total number of tomato producers (sample volume)
If tomato producers had used their inputs properly, they would have obtained an average of 95.235 kg of tomatoes compared to an average of 59.487 kg realized. It shows that the average amount of loss is 35.748 kg (Table 9).

Table 9. Realized and realizable production quantity distribution

Output	Mean (kg)	Median (kg)	Minimum(kg)	Maximum(kg)
y_i^*	95,235	61,268	71,136	468,235
y_i	59,487	30,000	1,000	300,000
$y_i^* - y_i$	35,748	24,308.36	13.14	268,234

Source: Authors' calculation.

Factors affecting changes in efficiency scores

The majority of tomato producers in Ayas district, representing 18.18% of the total population, have a technical efficiency of 41-50%, the second majority representing 15.58%, technical efficiency is in the range of 91-100%, the rest is 18.18%. It is distributed above and below (Table 10 and figure 1). Given these changes in the level of technical efficiency among tomato producers, the variables that affect the environment in which tomato production takes place are; formal education, use of agricultural credits, membership in agricultural organizations, experience in tomato production and age of tomato producers were evaluated.

Formal education level, use of agricultural credit and membership in agricultural organization were statistically significant among all environmental variables used to explain changes in the level of technical efficiency among tomato producers, while the age of the farmer and experience in tomato production were statistically insignificant.

Table 10. Distribution of efficiency points

Efficiency groups (%)	Frequency (Number of establishments)	Frequency (Number of establishments) (%)
1-10	5	6.49
11-20	4	5.19
21-30	5	6.49
31-40	8	10.39
41-50	14	18.18
51-60	9	11.69
61-70	9	11.69
71-80	5	6.49
81-90	6	7.79
91-100	12	15.58
Total	77	100.00

Source: Authors' calculation.

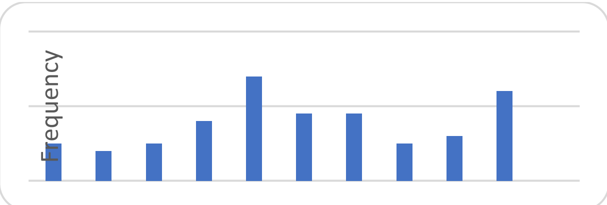

Fig. 1. Distribution of efficiency points (SFA)
Source: Own results.

Data envelopment approach output oriented (maximization LP problem)

In this section, the technical efficiency results of data envelopment are presented and compared with the results of stochastic frontier analysis. The results of the stochastic frontier analysis show that the production function of tomato producers in Ayaş district exhibits an increasing return to scale. Therefore, in the comparison of effectiveness scores, Data Envelopment analysis was used for the analysis of technical effectiveness according to the varying scale for the output.

Analysis of changes in efficiency scores

The average efficiency score of tomato producers was determined as 86.43%, indicating that producers are likely to increase their output by 13.57% without needing additional inputs while keeping all other factors affecting output (Table 11).

The majority of tomato producers have technical efficiency in the range of (91-100%) (Table 12 and Figure 2).

Table 11. Summary statistics of efficiency points

Statistical parameters	Efficiency points%
Mean	86.43
Median	100.00
Mod	100.00
Minimum	32.50
Maximum	100.00

Source: Authors' calculation.

Table 12. Distribution of efficiency points

Efficiency groups %	Number of establishments	Number of establishments (%)
31-40	4	5.19
41-50	2	2.60
51-60	4	5.19
61-70	7	9.09
71-80	5	6.49
81-90	7	9.09
91-100	48	62.34
Total	77	100.00

Source: Authors' calculation.

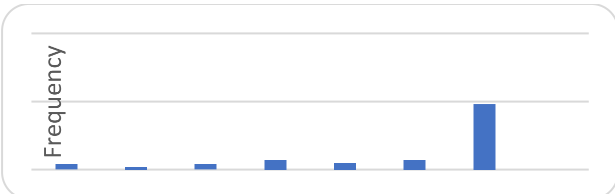

Fig. 2. Distribution of efficiency points (DEA)
Source: Own results.

Considering that tomato producers are not fully technically efficient, the actual average amount of output they can achieve if they use their inputs properly is calculated as follows.

Maximum output (kg) achievable with current technology level:

$$y_i^* = \left(\frac{y_i}{\theta} + S_r^+\right)$$

$y_i^* =$ Vector of achievable maximum outputs

$\theta = vector\ of\ efficiency\ scores\ as\ fractions$

y_i = vector of output quantities
S_r^+= output shortage due to output mix (loose)
Average maximum achievable output (kg)
$average\ maximum\ output = \sum(y_i^*)/n = \sum\left(\frac{y_i}{\theta} + S_r^+\right)/n$
Low output average (kg)
$Low\ output = \sum(y_i^* - y_i)/n$
n = Total number of tomato producers

If the producers had used their inputs appropriately, the average output of tomatoes would have reached 68,536.37 kg, which is 9,049.36 kg greater than the actual production (Table 13).

Table 13. Distribution of realized and realizable production amount

Output	Mean (kg)	Median (kg)	Minimum (kg)	Maximum(kg)
y_i^*	68,536.37	36,945.36	1,000	300,000
y_i	59,487	30,000	1,000	300,000
$y_i^* - y_i$	9,049.36	6,945.36	0	67,318.67

Source: Own results.

Scale effectiveness: Data Envelopment Analysis

If an enterprise is of optimal size, if the resource used in its production increases by one percent (1%), the production amount increases by one percent (1%), this means that the production resource and the production amount are one-to-one scale efficiency (Cooper et al. 2007) [7]. It is calculated according to the formula below.

$$\text{Scale effectiveness} = \frac{Fixed\ return\ technical\ efficiency\ score\ of\ each\ farmer}{Variable\ return\ technical\ efficiency\ score\ of\ each\ farmer} * 100$$

The majority of tomato producers operate under increasing returns to scale representing 59.94%, while the second majority operating under fixed returns to scale representing 29.87% and operating under decreasing returns to scale representing at least 10.39% showing enterprises (Table 14).

According to the results, 29.87% of the tomato producers are scale efficient, that is, they operate in the optimum size of the tomato plant, while 70.13% of the producers are scale ineffective (Table 14). 70.13% of producers state that they should not only increase their technical efficiency but also change their tomato plant size. 10.39% of those with scale ineffective work more than the optimum tomato business size, so they need to reduce the size of the tomato business to the optimum level to become scale efficient. Those working above optimal have 98% efficiency of scale, so they need to downsize their tomato business by 2% to become scale efficient. Of those with scale inefficiency, 59.94% work less than the optimum size of the tomato plant, so they need to increase the size of the tomato plant to its optimum level to become scale efficient. Sub-optimal employees have a 70% scale efficiency, so they need to expand their tomato business by 30% to become scale efficiency.

Table 14. Data Envelopment scale distribution

State of return to scale	% Average effectiveness score	Number of establishments	%
Fixed	100	23	29.87
Decreasing	98	8	10.39
Increasing	70	46	59.74
Total	86.43	77	100.00

Source: Own results.

Comparison of stochastic production and data envelopment analysis approaches

The average technical efficiency from the data envelopment analysis was 86.43%, while the average technical efficiency from the stochastic frontier analysis was 55.56%, which made a difference of 30.87% (Table 15). The average technical efficiency from data envelopment analysis is higher than that from stochastic frontier analysis. The sources of variation in tomato production are divided into two. First of all, the factors affecting the amount of production out of the control of the producers, for example, some of the producers did not have any diseases in their fields during the season as luck, but some of them unluckily had harmful diseases in their fields.

Secondly, the factors that affect the production amount that can be controlled by the producers. For example, some of them use production resources well, some do not use them well, and good users can obtain higher production amounts than those who do not use them well. Because the data envelopment approach does not separate the chance of changes in tomato production and the effect from the use of appropriate resources. Stochastic frontier analysis, on the other hand, distinguishes the effect from the chance of changes in tomato production and the appropriate use of inputs. Data envelopment analysis is given higher technical efficiency than stochastic boundary analysis, since the chances of changes in tomato production and the use of appropriate resources do not separate the coming effect.

Table 15. Comparison of technical efficiency score of stochastic production limit and data envelopment analysis

Statistical parameters	Efficiency Score %	
	Stochastic Production Limit	Data Envelopment Analysis
Mean	55.56	86.43
Median	54.00	100.00
Mod	100.00	100.00
Minimum	7.00	32.50
Maximum	100.00	100.00

Source: Own results.

CONCLUSIONS

The production function selection process was carried out using the log likelihood test. According to the results of the log likelihood test, it was concluded that the Cobb-Douglas production stochastic boundary function is an appropriate function of the production process of tomato producers in Ayaş district. The one-stage Cobb-Douglas production stochastic boundary function was used to estimate the environmental factors that affect changes in technical efficiency. It was concluded that all inputs used in tomato production in Ayaş district were statistically significant in affecting the changes in the production amount of tomatoes. These are labor (days of working in family and foreign tomato production during the season), the amount of land allocated for tomato cultivation (decare), the number of seedlings (pieces), chemical fertilizers (kg), animal fertilizers (tons), pesticides (lt), tractor expenses (TL) and irrigation (irrigated times during the season) were concluded.

It was concluded that the factors affecting the changes in the agricultural efficiency of tomato producers, these are formal education, membership in agricultural organizations and use of agricultural credits, are statistically significant in influencing the appropriate use of tomato inputs by tomato producers. Technical activities were found to be statistically significant in influencing the changes, as they provided formal education, tomato producers, tomato production technologies, the importance of developing technologies for agriculture and the correct use of technologies, etc. Therefore, in general, those with higher formal education levels have higher technical efficiency than those with formal education levels. Agricultural organizations, tomato growers, the resources used in tomato production or general agricultural production have been found to be statistically significant in influencing the changes in their technical efficiency, as they provide wholesale purchases, access to information of advanced agricultural production, use of common agricultural machinery, etc. Therefore, those who are members of agricultural organizations have higher technical efficiency than those who are not members of agricultural organizations. Agricultural credits were statistically significant in influencing changes in their technical efficiency as tomato producers did not purchase advanced agricultural equipment and advanced inputs etc. Therefore, those who use agricultural credits have higher technical efficiency than those who do not use technical activities.

The average technical efficiency of tomato producers in Ayaş district was found to be 55.56% using stochastic frontier analysis approach and 86.43% using data envelopment analysis approach. According to the Stochastic Frontier Analysis approach, if tomato producers had used their inputs properly, they would have produced an average of 95,235 kg of tomatoes compared to an average of 59,487 kg realized. The average amount of loss was found to be 35,748 kg. On the other hand, with the data weakening analysis, if the producers had used their inputs appropriately, the average output of tomatoes would have reached 68,536,37 kg, which was 9,049.36 kg greater than the actual production. According to the Stochastic Frontier Analysis approach, since the sum of the coefficients (elasticities) of the whole model of production is equal to 1.67, which is more than one, it is determined that there is an increasing return to scale. It is concluded that tomato producers work under the increasing return production function. On the other hand, when using the Data Envelopment Analysis method, 59.74% of tomato producers are under increasing returns to scale, while 40.26% are working under constant and decreasing returns to scale. Overall, it was concluded that the majority of tomato producers operate under increasing returns to scale. According to the two approaches, it has been determined that the tomato enterprises in Ayaş are operating under increasing returns. Therefore, since tomato producers cannot increase scale efficiency, their businesses need to grow. The main problems encountered in tomato production are tomato diseases 22.4%, insufficient labor force 20%, high input costs 17.2%, access to water 16.9%, ineffectiveness of pesticides 13.1%. It was concluded that there were problems. Among the problems encountered in tomato marketing, 61.4% high transportation and low tomato price 38.6% were concluded. Tomato producers in Ayaş district should use the appropriate (optimal) combination of inputs that they do not use in tomato production, since they cannot increase the amount of tomato production and do not have technical efficiency. Tomato producers in Ayaş district should enlarge their tomato businesses in order to increase scale efficiency. In order to increase technical efficiency, tomato producers in Ayaş district should be advised that they do not have formal education, do not belong to agricultural organizations and do not use agricultural credits. In order to reduce tomato diseases, tomato producers in Ayaş should consult with experts in tomato diseases, do good weed control, pay attention to irrigation and other management practices. In order for the pesticides to be effective, the tomato producers in Ayaş must follow the written instructions for each pesticide, use clean water, spray at the right time, use the right pesticide for the identified insects (insect), and use pesticides that have not expired. In order to solve the problem of insufficient workforce in the agricultural sector in Ayaş district, social (sports, etc.), economic (good salaries for agricultural workers, suitable and flexible agricultural loan programs, banking services, insurances, etc.), education and health sectors (accessible schools and hospitals). Demand for agricultural products should be created through rural development programs. If the demand for agricultural products (tomato production) increases, the workforce in the agricultural sector (tomato production) may increase because other people have started to produce agricultural products. In order to solve the problem of high input cost and difficulties in accessing water in Ayaş district, it should be recommended to purchase tomatoes in bulk through agricultural organizations (agricultural cooperatives). In order to solve the problem of high transportation and low price of tomatoes in Ayaş district, it is necessary to direct tomato producers to contract farming. Tomato producers should also establish agricultural products marketing organizations that can assist farmers in providing transportation and marketing information.

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LOCAL ACTION GROUPS AND RURAL DEVELOPMENT IN BULGARIA– CHALLENGES AND PROSPECTS

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Abstract

Over the last decade, local action groups (LAGs) in Bulgaria have become key organizations supporting the implementation of projects important for rural development. Prerequisites for this are the unique characteristics of the LEADER/CLLD approach, which allow empowerment of the population, capacity building combined with providing access to financial resources, as well as building trust and accumulation of social capital. Since the beginning of the application of the approach in the country, LAGs have been facing some difficulties, but at the same time the opportunities for attracting funds to support a wide range of initiatives at the local level are expanding. In this regard, the aim of this study is based on the analyses of the activities of LAGs in the country, to outline the challenges facing these organizations and to reveal their potential for sustainable development of rural areas. The case study method is applied. The results of the study show a significant potential of LAGs to accelerate the socio-economic processes in rural areas.

Key words: *bottom-up approach, entrepreneurship, social capital, sustainability*

INTRODUCTION

Community-led local development (CLLD) is an approach that complements activities and measures for achieving sustainable results in rural areas. The latter is possible through the specific characteristics of CLLD / LEADER and, accordingly, through its bottom-up implementation, which allows the participation of all stakeholders in the local decision-making process, capacity building and increasing the level of social capital [3, 6, 10, 14].

In addition, CLLD / LEADER helps to address important challenges in the application and development of business initiatives in rural areas [8, 9], including lack of access to financial resources [1]. According to the European Commission for 2020, nearly 10% of SMEs in the EU experience such difficulties and identify access to resources as the most important in carrying out their activities [5].

A number of authors examining sustainable development conclude that in order to overcome poverty and social exclusion in rural areas, it is necessary to implement integrated projects and programs that combine the following two elements: 1) access to financial resources and 2) raising the level of human and social capital [7, 11, 13].

An earlier own study reveals that the implementation of the approach in Bulgaria in the first programming period 2007-2013 is accompanied by a number of difficulties, some of which were related to the financial stability of the LAGs, and others referred to the application of the Community-Led Local Development Strategy and the balanced spending of the strategy's budget [12]. The efforts made by the participants in the process for overcoming the identified difficulties lead to the successful application of the approach and the achievement of enviable results.

In this regard, the aim of this study is, based on the analysis of the activities of LAGs working in Bulgaria, to identify challenges that could potentially hinder the achievement of the desired results and to outline the potential of these organizations to achieve sustainable rural development in the country.

The article is structured as follows: First, the methodological approach of the research is presented. Second, the difficulties encountered by the local action groups in carrying out their activities and implementing the Community-led Local Development Strategies are systematised and analysed. Third, the potential of these organizations to contribute to sustainable results in rural areas has been revealed. On this basis, conclusions and recommendations have been made to improve the activities of the LAGs, as well as with regard to policies in the field.

MATERIALS AND METHODS

The following methods for collecting, processing and analysing information were applied within the research: in-depth interviews, documentary analysis, case study. The study was conducted in the period March-June 2021 and covers the activities for 2020 of 44 Local Action Groups from a total of 64 LAGs [15] operating in the country.

The data used for the study were collected from two groups of sources: 1) electronic databases, including The Commercial Register of the Registry Agency [2], The Bulgarian NGO's Information Portal [16], The European Network for Rural Development [4] and others, as well as 2) independently collected information. The information obtained from the electronic databases on the activities of the LAGs, in turn, was complemented by in-depth interviews with key experts in the field.

RESULTS AND DISCUSSIONS

The results of the analysis of the documentation of the LAGs reveal that 52.3% of them do not report any difficulties during the study period, both in relation to the management of the organization and in terms of their activities under the Community-Led Local Development Strategies.

The challenges reported by the remaining 47.7% of these NGOs can be systematized into three main groups (Fig.1). They are generally related to: 1) the management of the organization itself; 2) the Strategy realisation and 3) the impact of COVID-19 on the implementation of the activities.

The first group includes difficulties regarding the activities and management of the LAG. Some of the surveyed organizations, which stated the existence of challenges in 2020, point out that the relationship between the approval of applications for payment of running costs and the State Fund Agriculture (SFA) approval of LAG procedures for project evaluation creates serious difficulties for the financial stability of the respective organisations. The latter is a prerequisite for the LAG to seek support from local authorities or businesses, as well as to take out loans to ensure the proper functioning of the organization, including the payment of staff salaries. Another measure taken to overcome this problem is to cover the costs of the appraisers' payments at the expense of the organization in order to avoid waiting for the approval of the completed procedures and for the LAG to receive an interim payment. The organizations which used the loan emphasize that the interest on the loans remains at their expense. The above leads to the departure of employees, which would further complicate the implementation of activities. These LAGs, who have faced the need to fill their team, often experience difficulties in hiring people who meet the requirements for a position.

In the second group, concerning the application of the Strategy for Community-Led Local Development, the challenges are manifested for both the LAG and the beneficiaries in the following two main directions: 1) delay by the SFA in reviewing and approving the procedures conducted by the LAG for the provision of grants and 2) delays in concluding contracts with beneficiaries. The problem with the extended process of verification of procedures by the SFA was identified as significant in 65% of a total of twenty-one organizations that reported difficulties during the study period.

Only 30% of the respective LAGs identify the pandemic and the resulting restrictive measures as an important obstacle to the application of the activities planned during the period. The most common challenges in this group concern the holding of face-to-face events, including information meetings, conferences, training, festivals and other celebrations, as well as in connection with the implementation of activities for the exchange of experience on the territory of the country and abroad.

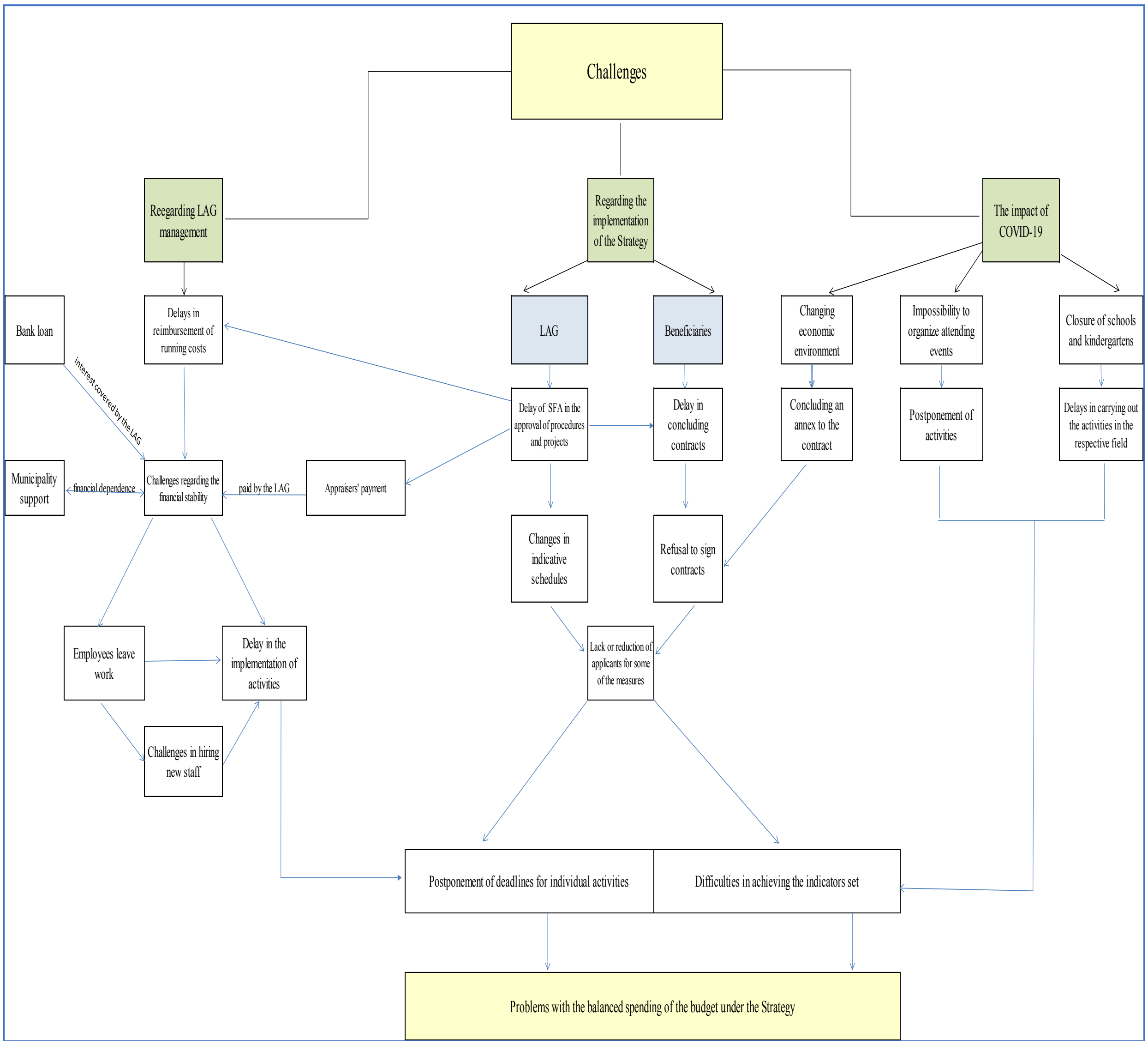

Fig. 1. Challenges for the LAGs in 2020 - interconnections
Source: Own research.

Two of the Local Action Groups state that they have encountered difficulties in the application of the measures of the Strategy under the Operational Program "Science and Education for Smart Growth" due to the closure of kindergartens and schools for a certain period of time (Fig 2).

The study revealed that the surveyed organizations which reported challenges in 2020 are taking continuous action to overcome them, including communication with state agencies, application of joint actions, etc (Box 1).

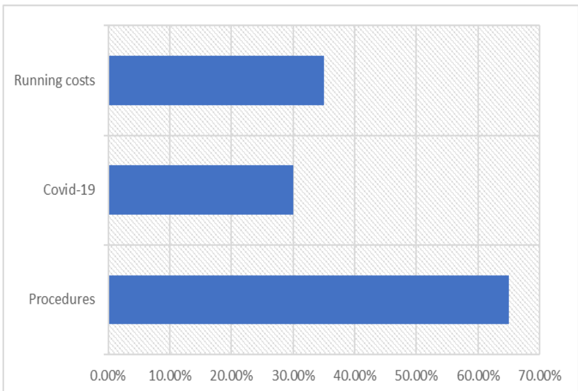

Fig. 2. Importance of the identified problems for 2020
Source: Own research.

In general, the LAG team did not have any serious and insurmountable difficulties. The team of the association is active in eliminating difficulties and ambiguities by preparing written questions to all institutions and governing bodies involved in the CLLD approach and actively participates in the activities organized at the National level and the LAG Association.

The examination of the applications for payment of the expenses under sub-measure 19.4. is bound by the verification of the procedures for acceptance and evaluation of projects under sub-measure 19.2

Box 1. Challenges in 2020
Source: LAGs' Report, [2]

It is important to emphasize that even some of those LAGs who indicated difficulties did not report a problem in communicating with Government Agencies of different programs.
Each of the identified difficulties poses potential risks to the balanced spending of the strategy's budget. Based on the experience with the application of the approach in Bulgaria and given that some of these problems were observed in the previous programming period 2007-2013, it can be assumed that the actions taken and addressing them in the current year will help to achieve the set goals.
Regarding the place and role of LAGs in sustainable development processes, a number of researchers find that these organizations have significant potential to complement the top-down measures applied, and through bottom-up actions they are able to contribute to overcoming the main problems faced by rural areas, including tackling poverty and depopulation in these areas [6, 10]. The latter is possible thanks to the integrated approach, which combines access to resources with the empowerment of the population.
The results of the study show that CLLD helps to increase the level of human capital, as well as to expand contacts and cooperation at the local level. At the same time, an earlier own study found a positive relationship between the level of social capital and the results achieved in the application of integrated approaches to the socio-economic development of rural areas [13]. On this basis, it can be stressed that Local Action Groups play an important role in achieving sustainable results in the country's rural areas.

CONCLUSIONS

Based on the study, the following conclusions and recommendations can be made:
-Local Action Groups in Bulgaria face a number of challenges in 2020. The latter can be systematized as follows: 1) related to the management of the organization; 2) difficulties which directly refers to the implementation of the Community-Led Local Development Strategy; and 3) difficulties arising from pandemic restrictions.
-The analysis of the data revealed that the share of organizations that do not report difficulties in the respective year is higher, including such connected to the epidemiological situation in the country. A significant part of the remaining LAGs (65%) identifies the long process of review and approval of LAG procedures by the SFA and the delays in concluding contracts with the beneficiaries as significant problems concerning the overall activity of the organisation. The latter have an important impact on those LAGs that do not implement multi-fund strategies, as the surveyed organizations do not indicate serious difficulties in the measures funded by the other funds available for CLLD.
-Restrictions related to COVID-19 lead to postponement of planned events and visits, such as experience and good practices exchange, as well as in the implementation of measures and activities concerning kindergartens and schools due to their closing for a certain period of time.
-The problems identified during the study period are related to the balanced spending of the budget of the strategy, as some of the beneficiaries are discouraged and refuse to sign a contract, and for some measures, there are no candidates.
-Despite the challenges, Local Action Groups and the approach contribute significantly to increasing the capacity and level of social

capital of local communities. On this basis, as well as in connection with the results of an earlier own study revealing that higher levels of social capital contribute to expanding the scope of beneficiaries, it can be concluded that these organizations have significant potential to achieve sustainable rural development.

-The main recommendation in regard to the policies in the field is to optimize the processes of verification of the RA of the RDP, to look for opportunities to reduce the regulatory burden and to have greater flexibility regarding the contracts of the beneficiaries in connection with the changes in the economic situation.

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EVALUATING THE POTENTIAL OF ORGANIC LAND USE IN UKRAINE

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Abstract

The paper analyzed the state and development trends of organic land use in Ukraine and determined its place in the European sector of organic agriculture. To assess the endogenous and exogenous factors of the development of organic land use in Ukraine, the method of SWOT analysis was used. It has been determined that the effective development of a model of organic farming is impossible without a comprehensive understanding of the situation about the potential of agricultural land use for the possibility of producing organic products. Methodological approaches to evaluation the potential of organic land use is proposed, based on the use of an integral index, which is characterized by a set of indicators for four main components: land-resource potential, agro-production potential, environmental safety and market infrastructure. In order to compare different-quality and different-dimensional indicators, it is proposed to interpret their values by normalizing, that is, to make the transition from absolute values to normalized ones. On the basis of the developed methodological approach, an evaluating of the potential for the development of organic land use in the regions of Ukraine was carried out. Such an evaluating makes it possible to differentiate regions (territories) depending on the integral index and to rank them as far as possible and potential for the development of organic land use. In turn, ranking territories according to the potential of organic land use helps to identify the most promising of them for investment in the development of organic production.

Key words**:** *evaluating, potential, organic, land use, agricultural, territory*

INTRODUCTION

One of the trends in the development of the world sector of the agricultural economy is the rapid development of organic agriculture. The latest data of Research Institute of Organic Agriculture FiBL shows that organic farmland grew in many countries, and the total organic area increased “to more than 72 million hectares, representing 1.5 percent of agricultural land worldwide, managed by more than three million producers” [22]. In particular, in Europe in 2019, the area of organic agricultural land in 1 year increased by 5.9% (0.9 million hectares) to 16.5 million hectares. At the same time, in the context of countries, the largest growth was shown by France, Ukraine and Spain (Fig. 1).

The main impetus for the spread of organic agriculture in Ukraine, on the one hand, was the global trend towards an increase in demand for organic products, and on the other hand, the awareness of the need to preserve the natural environment, greening economic activities and popularizing a healthy lifestyle [1; 17; 19].

Noting the objective nature of the organization of the organic agricultural production system, it should be said that the formation of an agricultural economy focused on the production of organic products should be realized and acceptable to the majority of citizens, especially landowners and land users.

Considering the significant land-resource potential of Ukraine, where in the near future there will be a full-fledged land market with the possibility of buying and selling agricultural land, and due to the high global demand for organic products, national and foreign investors are increasingly showing interest in the development of organic land use in Ukraine.

However, it should be noted that the Ukrainian model of organic land use is significantly different from the world, including the European one. If in European countries the cost of production increases significantly after the transition to organic farming, then in Ukraine the increase in this indicator is moderate, due to the high natural soil fertility. This is confirmed by the practical experience of domestic agricultural enterprises that have switched to organic farming technology [3; 4; 5; 8; 13; 21].

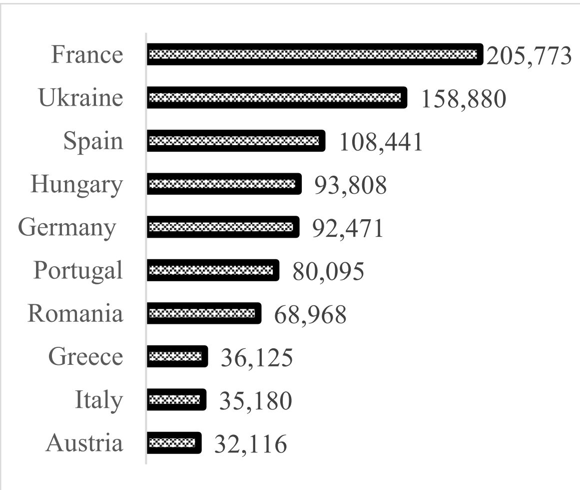

Fig. 1. The ten European countries with the highest increase of organic land, hectares
Source: FiBL survey 2021 [22].

It is traditionally believed that the potential for the development of organic production on agricultural land depends on three main components: economic (development of the material and technical base, availability of natural resources), environmental (compliance of existing resources, ecosystems and production technologies with environmental requirements) and social (the population's ability to pay and their perception of the concept of green production and environmental friendliness of products) [9-11].

V. Kyporenko and A. Vdovychenko notes that the development of organic production in Ukraine is slowed down by certain factors, namely: “economic risks (associated with a decrease in profitability during the transition period); ecological (the presence of a significant amount of contaminated and depleted land that cannot be used for the needs of organic production); legal (insufficient level of regulation of the sphere of production, certification and sale of organic products), informational (low level of information support to consumers about the benefits of organic products and distrust of its producers ”[7].

Scialabba N., Hattam C. believe that “the determination of the suitability of organic agriculture should include agroecological, economic, social and institutional considerations” [14].

Given the controversy and insufficient validity of approaches to the evaluation potential and prospects for the development of organic agroland use, the development of principles and methods for such an assessment requires further scientific substantiation. The relevance of the above is confirmed by the presence of a specific institutional environment in the Ukrainian organic sector of the economy.

MATERIALS AND METHODS

The formation of organic farming is completely determined by the current influence on this sector of endogenous factors (natural and climatic conditions, resources, market conditions, and so on) and exogenous factors (institutional environment, social and political characteristics, the general state of the state's economic system) [2; 10]. To assess the endogenous and exogenous factors of the development of organic land use in Ukraine, the method of SWOT analysis was used (Fig. 2). In order for the SWOT analysis to give an objective picture, we conducted an expert survey of organic market operators.

To study the potential for the development of organic land use in Ukraine, it is necessary to analyze its constituent parts. This will reveal the potential role of the organic sector in the market of each region of Ukraine, which will contribute to its most efficient functioning.

How a particular region is suitable for the production or consumption of organic products depends on a number of characteristics.

STRENGTHS	WEAKNESS
– the growing role of organic agriculture and a positive trend in demand for organic products abroad; – low chemicalization of agriculture; – the presence of a significant amount of potentially suitable land; – favorable climatic and natural conditions; – ensuring high quality and safety of products; – the presence of an unemployed rural population interested in the development of the industry; – existing experience in organic farming by domestic farms	– underdeveloped institutional environment; – lack of national certification and labeling bodies; – high prime cost and product price with a low shelf life; – poor development of animal husbandry; – low level of provision of promotion and retail of organic products and promotion of healthy food; – undeveloped domestic market for organic products; – low paying capacity of the population; – low availability of borrowed financial resources
OPPORTUNITY	**THREAT**
– low competition on the domestic – organic market; – dissemination of experience of foreign producers of organic products; – growing environmental awareness of the population; – preservation of traditions and national culture; – preservation of the natural environment; – combination of organic agriculture with related areas of natural resources, including recreation and tourism; – development of auxiliary areas; – access to foreign markets.	– inconsistent and inadequate development of the regulatory framework for organic producers; – inadequate government support for organic agriculture (information, financial, marketing); – insufficient provision of scientific research on development issues and environmental and economic justification; – instability of the economic and political situation in the country; – a decrease in the level of purchasing power of the population; – underdevelopment of the agricultural land market.

Fig. 2. SWOT analysis of the organic land use sector in Ukraine
Source: author's elaboration.

We propose to determine the potential of organic land use by the combination of four main components: land-resource potential, agroproduction potential, environmental safety and market infrastructure. Each of these components can be calculated by calculating indicators within certain criterion groups (Table 1).

The weight of each indicator and components (criterion) was determined by expert judgment. For this, a written survey of specialists and scientists in the field of land use was carried out in order to systematize objective data on the level of influence of certain indicators on the development of organic agricultural land use [6; 15].

In order to eliminate the difference in the dimensions of the given indicators, rationing was carried out.

The rationing procedure involves the transformation of the values of all indicators in comparison with the optimal value (the best among the analyzed ones), while the normalized indicator is in the range from 0 to

1, and the maximum proximity to one indicates the level of optimality of the actual indicator [16; 18].

Table 1. List of components and indicators for assessing the potential of organic land use

Components and indicators	The threshold values
Land-resource potential	**35**
Total area of agricultural land	8
Agricultural assimilation of the territory	6
Ecological and agrochemical assessment of lands	7
Humus content in the soil	7
Agroclimatic potential	7
Agro-production potential	**21**
Gross agricultural output	8
Resource provision of agricultural producers	7
The level of economic activity of the rural population	6
Environmental safety	**32**
Pesticide load	8
Chemical load	8
The level of land erosion	6
Intensity of land erosion	3
The area of agricultural lands contaminated with radionuclides	7
Market infrastructure	**12**
Capacity of the intraregional market for organic products	8
Level of logistic service	4

Source: author's elaboration.

To calculate the integral indicator (index) for assessing the potential of organic land use (I_{pol}), the sum of the normalized values of the set of indicators included in them is determined, adjusted in accordance with their weight:

$$I_{pol} = \sum_{i=1}^{n} x_i \times gx_i \times 100, \qquad (1)$$

x_i – normalized value of the i-th indicator;
gx_i – weighting coefficient of the i-th indicator;
n – the number of indicators used in calculating the integral index.

The proposed methodological approach to the evaluation of the potential of organic land use permit to objectively evaluate the potential use of agricultural land for organic farming at the regional or country level. By adapting the set of indicators proposed within the framework of certain criteria to the activities of economic entities, it is also possible to determine the potential of organic land use for specific agricultural producers.

RESULTS AND DISCUSSIONS

Ukraine has huge potential in the organic sector, the analysis of which allows us to conclude that the country in the near future can significantly expand its influence on the organic food market. Firstly, one of these opportunities is that Ukraine has a huge resource of agricultural land (42.7 million hectares) [20].
In addition, Ukraine occupies one of the leading places in Europe in terms of agricultural land area [12; 20]. As of 2019, Ukraine ranks 12th among European countries in terms of the area of agricultural land used for organic farming (Table 2).

Table 2. Organic agricultural land by European countries, 2019 (TOP-25)

№	Country	Hectares
1	Spain	2,354,916
2	France	2,240,797
3	Italy	1,993,225
4	Germany	1,613,785
5	Russian Federation	674,370
6	Austria	669,921
7	Sweden	613,964
8	Czech Republic	540,986
9	Greece	528,752
10	Turkey	518,435
11	Poland	507,637
12	**Ukraine**	**467,980**
13	United Kingdom	459,275
14	Romania	395,228
15	Finland	306,484
16	Hungary	303,190
17	Portugal	293,213
18	Latvia	289,796
19	Lithuania	242,118
20	Estonia	220,737
21	Slovakia	197,565
22	Switzerland	172,713
23	Bulgaria	117,779
24	Croatia	108,127
25	Belgium	93,119

Source: formed by the author according to FiBL survey 2021 [22].

However, if we take into account the share of organic land use in the total area of agricultural land, the situation changes dramatically (Table 3).

Table 3. Organic shares of total agricultural land by European countries, 2019 (TOP-35)

№	Country	Organic share, %
1	Liechtenstein	41.0
2	Austria	26.1
3	Estonia	22.3
4	Sweden	20.4
5	Switzerland	16.5
6	Czech Republic	15.4
7	Italy	15.2
8	Latvia	14.8
9	Finland	13.5
10	Denmark	10.9
11	Slovenia	10.3
12	Slovakia	10.3
13	Germany	9.7
14	Spain	9.7
15	Greece	8.7
16	Portugal	8.2
17	Lithuania	8.1
18	France	7.7
19	Croatia	7.2
20	Belgium	6.9
21	Hungary	5.7
22	Cyprus	5.0
23	Norway	4.6
24	Luxembourg	4.4
25	Netherlands	3.7
26	Poland	3.5
27	Romania	2.9
28	United Kingdom	2.6
29	Bulgaria	2.3
30	Ireland	1.6
31	Turkey	1.4
32	Moldova	1.2
33	**Ukraine**	**1.1**
34	Serbia	0.6
35	Malta	0.5

Source: formed by the author according to FiBL survey 2021 [22].

Ukraine, with an indicator of the share of organic land use of 1.1% in this area, already occupies the 33rd position. This indicates a huge potential for the development of the organic sector in Ukraine.

In general, Ukraine ranks first in the Eastern European region in terms of certified organic arable land, specializing mainly in the production of cereals, legumes and oilseeds. The number of domestic organic farms is growing every year, of which today there are about 617. In addition to the growth in the area and the number of farms engaged in the production of organic products, over the past three years, the domestic market has been consistently filled with its own organic products due to the establishment of domestic processing of organic raw materials. The domestic market for organic products in Ukraine was estimated in 2019 at close to 20 million euros.

As for the indicators of export of organic products from Ukraine, in 2019 it was estimated at about 160 million euros. At the same time, 85% of exported products were supplied to the countries of Europe.

Table 4. Organic agricultural land and organic shares of total agricultural land by Ukrainian region

№	Region	Hectares	Organic share, %
1	Herson	84,540	4.16
2	Kyiv	60,423	3.37
3	Odesa	49,608	1.87
4	Cherkasy	41,428	2.79
5	Zaporizhia	40,433	1.76
6	Zhytomyr	37,623	2.38
7	Poltava	25,755	1.16
8	Rivne	20,403	2.13
9	Dnipropetrovsk	19,111	0.74
10	Lviv	15,104	1.17
11	Kirovohrad	14,478	0.70
12	Khmelnytskyi	12,928	0.81
13	Chernihiv	11,650	0.55
14	Ternopil	10,278	0.96
15	Mykolayiv	9,430	0.46
16	Kharkiv	4,578	0.19
17	Volyn	4,564	0.42
18	Vinnytsia	3,559	0.17
19	Transcarpathian	1,166	0.25
20	Ivano-Frankivsk	576	0.09
21	Chernivtsi	191	0.04
22	Sumy	85	0.005
23	Donetsk *	69	0.003
24	Luhansk *	0	0.00
	Ukraine	**467,980**	1,10

* Data without taking into account a part of the territory of the region.
Source: author's elaboration.

In 2019, Ukraine ranked 2nd out of 123 countries in terms of the volume of imported organic products in the EU, up two steps from the previous year.

Analysis of the current state of organic land use in Ukraine in the regional context shows a significant differentiation of the country's regions depending on the total area of organic agricultural land and the share of organic land in the total structure of agricultural land (Table 4).

In particular, Kherson is the region with the largest area of organic agricultural land (84,540 hectares) and the share of these lands among the total area of agricultural land use (4.16). In such regions as Ivano-Frankivsk, Chernivtsi, Sumy, Donetsk and Lugansk, organic agriculture is practically absent.

However, the key indicators of land use in the context of regions have been investigated, within the framework of studying possible trends in their development, systematization and comparison, do not allow reflecting a holistic view of the possible potential of organic land use, which is necessary for the development and adoption of an integrated decision. In this aspect, a detailed component-wise study should be carried out, followed by generalization and systematization of the output data according to the corresponding integral index, which determines the key indicators of the potential of organic land use, taking into account their optimal values.

Using the proposed method of assessment based on the results of calculations, the indicators of the potential of organic land use in the regions of Ukraine are characterized with due completeness. The value of the integral index and its main components are reflected in Table 5.

Table 5. The results of calculating the integral index of the potential of organic land use in the regions of Ukraine

№	Region	The value of the indicators of the main components of potential of organic land use				Integral index of potential of organic land use
		Land-resource potential	Agro-production potential	Environmental safety	Market infra-structure	
1	Kyiv	87.8	94.3	81.8	97.1	88.4
2	Odesa	86.0	83.3	81.1	96.9	85.2
3	Cherkasy	81.3	88.7	85.8	80.6	84.2
4	Dnipropetrovsk	88.0	90.3	75.7	83.6	84.0
5	Herson	79.4	84.6	85.1	90.8	83.7
6	Kirovohrad	88.6	81.3	73.7	83.6	81.7
7	Kharkiv	86.4	87.1	68.3	91.4	81.4
8	Mykolayiv	81.3	74.5	80.7	92.8	81.1
9	Chernihiv	78.3	81.6	85.4	76.5	81.0
10	Zaporizhia	82.0	78.3	78.0	77.5	79.4
11	Ivano-Frankivsk	73.8	63.5	89.6	90.8	78.7
12	Poltava	80.2	90.1	65.4	88.7	78.6
13	Vinnytsia	75.3	93.8	61.6	81.2	75.5
14	Sumy	81.0	65.8	69.7	78.5	73.9
15	Ternopil	80.6	67.8	66.3	79.6	73.2
16	Donetsk *	82.7	76.8	56.4	77.5	72.4
17	Khmelnytskyi	76.1	81.3	60.0	77.5	72.2
18	Lviv	74.6	70.6	66.2	79.6	71.7
19	Luhansk *	72.3	70.3	67.7	77.5	71.0
20	Transcarpathian	62.5	53.5	80.4	87.7	69.4
21	Chernivtsi	75.6	70.3	57.9	78.5	69.2
22	Rivne	69.3	69.2	65.5	77.5	69.0
23	Volyn	57.5	70.3	72.2	76.5	67.2
24	Zhytomyr	61.6	62.5	60.4	80.6	63.7

* Data without taking into account a part of the territory of the region.
Source: author's elaboration.

Analysis of the Table 5 showed that among the regions of Ukraine the Kyiv region is characterized by the greatest potential for organic land use (final estimate 86.3). The potential indicator in Odesa (85.2), Cherkasy (84.2), Dnipropetrovsk (84.0) and

Herson (83.7) regions is somewhat lower. At the same time, several regions of Ukraine have a low level of potential for the development of organic production in their territories, namely: Zhytomyr and Volyn.

It should also be noted that certain regions have rather high values of indicators simultaneously for several components, but due to the indicators of market infrastructure (for example, Chernihiv), in general, they have a lower potential for the development of organic land use than the leaders.

The results of the analysis of Table 5 in individual regions reflect a significant difference in the values of the main components of the potential for the development of organic land use, which indicates the imbalance of these four components and the need to take into account the peculiarities in the development of the organic sector of the regional economy.

CONCLUSIONS

Thus, when assessing the potential for the development of organic land use, it makes sense to use indices that characterize its value from production and consumer positions, and make it possible to identify territories depending on their potential role in this segment of the economy.

In general, the proposed methodological approaches to evaluation the potential of organic land use, based on the use of an integral index, include a set of assessment criteria and indicators, an algorithm for their normalization in accordance with optimal values.

They make it possible to differentiate regions (territories) depending on the integral index and to rank them as far as possible and potential for the development of organic land use. In turn, the ranking of territories (regions) by the potential of organic land use helps to identify the most promising of them for investment in the development of organic production and ensuring the effective functioning of producers of organic agricultural products.

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EVOLUTIONARY CYCLE OF *CYDALIMA PERSPECTALIS* WALK. UNDER THE INFLUENCE OF CLIMATE CONDITIONS IN CRAIOVA AREA

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Abstract

The aim of the paper is to highlight the link between climatic conditions and the developmental stages of the species Cydalima perspectalis. If the temperature is low the evolution in days of the development stages increase and vice versa. For the population studied in 2020, the first flight of adults took place on May 18, and the last on October 14. It is clear that it completed 2 generations and the amount of effective temperature for the first generation is 646.7°C and for the second generation it was 628.3°C. The amount of effective temperature (degrees-days)in the period 2019-2020 for the egg stage varies between 62.8°C in 2020 and 48.6°C in 2019, for the larval stage is between 444.8°C (2020) and 403.4°C (2019) and for the pupae stage the values are between 139.1°C (2020) and 74.1°C (2019).Under the natural influence of climatic factors, the number of generations of the species Cydalima perspectalis in the Craiova area varies from one year to another, this suggests that this species is directly dependent on temperature.

Key words*: *life cycle, temperatures, Cydalima perspectalis

INTRODUCTION

Cydalima perspectalis Walk. belongs to the order Lepidoptera, family Crambidae, native from the Asian Continent [14]. In Europe it managed to colonize most of the countries: Germany [5], the Netherlands [19,] France [9], Switzerland [16], Austria [28], Romania [13], Belgium [8], Italy [4], Hungary [34], Turkey [12], Czech Republic [33] and Slovenia [30].
The most recent reports are from Malta [1], Northern Macedonia [21], Gibraltar [26], Lithuania [25], Kosovo [10] and Belarus [31], in 2018 it was reported in the USA in Ontario [23]. In the European countries this pest completes two generation [11], [15], [20], to three generations per year [16],[29], [22], [3], [2]. In years with a warmer climate, species *Cydalima perspectalis* can develop a fourth generation [16], [6], [7].
In Galicia, the number of annual generations has been found to fluctuate depending on climatic conditions, completing two generations in 2014 and 2015, three generations in 2016 and up to five generations in 2017 [27].
In Romania a different number of generations are reported depending on the area, in Cluj this species completes two generations/year, [24], and in Craiova three generations/year [32]. Research on the ecology of the box tree moth has been conducted worldwide by the following authors: [18], [35], [17], [36], [20].
Studies conducted in Japan [18] on laboratory populations reported a different duration of development of *Cydalima* eggs at different temperatures, so it was shown that with increasing temperature, the development (in days) decreases, thus at a temperature of 15°C egg development period lasts fifteen days, at 20°C lasts seven days, at 25°C lasts four days, at 30°C lasts three days.
In the areas of origin, full development for the second and third generations of the same year takes place in 25 days at a temperature of 25°C [18], and in northern China the second and third generations of the same year completed their development within 25 days at a temperature of 27°C [35].
The developmental period for the pupae stage of the *Cydalima* species is 38 days at a constant temperature of 15°C, 17 days at 20°C, 10 days at 25°C and 7 days at 30°C

[18], and for the preoviposition period were 5.5 days at 15°C and 3.2 days at 20°C, 2.3 days at 25°C and 2.2 days at 30°C [18].

The lifespan of females is 8.02 ± 0.18 days and 8.69 ± 0.12 days for males [36].

For the population of the species *Cydalima perspectalis* studied in Switzerland, the minimum temperature for the development of the stages was: 10.91°C and 48-54°C the amount of effective temperature for the egg stage, 8.38°C and 322.58°C the amount for the stage of larva and 11.5°C and 133.33°C the amount of effective temperature for the pupae stage, and for the first generation the effective temperature is 518°C, and for the second generation is 430°C [20].

In the Garrotxa area, *Cydalima perspectalis* develops 3 generations, so they calculated the amount of effective temperature (degree-days) for each stage of development according to generation.

The amount of effective temperature for the preoviposition period is 36.3°C, for the egg stage it is 59.5°C, the larval stage is 449.0°C, and the pupae stage is 148.4°C, these values correspond to the first generation. For the second generation for each stage of development we have the following values, 42.2°C for the preoviposition period, 58.6°C for the egg stage, for the larval stage was 404.7°C and for the pupae stage was 145.1°C

The amount of effective temperature for the preoviposition period of the third generation was 41.1°C, for the egg stage it was 54.2°C, for the larval stage was 401.3°C, and for the pupae stage was 95.7°C.

The amount of effective temperature for the first generation is 693.2°C, for the second generation 650.6°C, and for the third generation the value of the actual amount of temperature is 592.3°C [2].

MATERIALS AND METHODS

The purpose of the research is to show how climatic conditions influences the development of *Cydalima perspectalis*, by following the evolutionary cycle and development period (in days), each stage was staggered in correlation with the average temperature. The researches were carried out in field conditions, in the Al. Buia Botanical Garden from Craiova in 2020. For the monitoring of each stage of development, we took samples from field and counting of the larvae was made weekly. Accurate identification of the flight period of adults of the species *Cydalima perspectalis* was performed using pheromone traps (Photo 1).

Photo 1. Mounting pheromone traps
Source: Own experiment. Original.

RESULTS AND DISCUSSIONS

The data obtained with the help of pheromone traps, made it possible to determine the flight period of the species *Cydalima perspectalis* in Craiova, the first adults being caught on May 18, and the last adults were on October 14.

The flight of the adults of the hibernating generation, was staggered between May 18th and June 25th, the peak of the flight period was on June 10th.

After a period of inactivity of about 3 and a half weeks, a second flight period begins on July 20, corresponding to the first generation and lasts until August 24. The maximum of the flight period was between July 29 and August 12.

The third flight period starts on September 7 and lasts until October 14, the maximum flight curve being between September 15 and 23.

The flight curve of adults of the species *Cydalima perspectalis* during 2020 shows three peaks of activity, specific to the hibernating generation (May 18-June 25), the first generation (July 20-August 25) and the second generation (September 7 and October 14) (Fig.1).

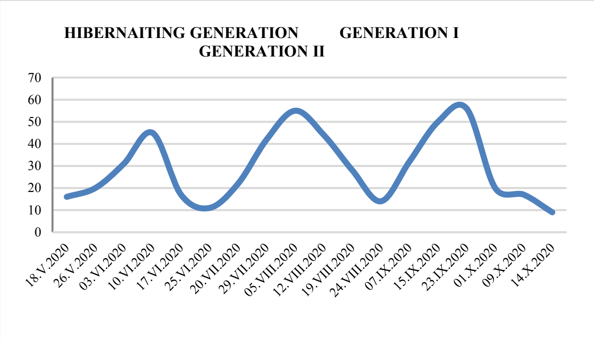

Fig. 1. Flight phenology of *Cydalima perspectalis* in 2020
Source: Own results.

Most of the larvae came out of diapause in the second decade of March, being at the 4th age of larval development and evolved over a period of 50 days until the appearance of the first pupae in the field (Photo. 2).

Photo 2. The beginning of hibernating larvae activity
Source: Original.

The pupae stage of the hibernating generation lasted 17 days until the appearance of the first adults, at a temperature of 16.9°C.

The eggs of the first generation were observed in the third decade of May and their development lasted 15 days at an average temperature of 15.1°C. The larvae were observed on June 6 and their development lasted over a period of 31 days at an average temperature of 22.3°C, the first pupae were observed on July 7 and developed over a period of 13 days at an average temperature of 22.2°C, and the first adults appeared on July 20.

The second generation appeared on July 24, the eggs of this generation developed for 5 days at an average temperature of 22.2°C, after this period appeared the first larvae that developed for 27 days at an average temperature of 24.6°C. For the pupae stage the average temperature was 22.7°C, and the evolution of this stage was 12 days. The adults of the second generation appeared on September 7.

For the third generation, the eggs developed over a period of 4 days at an average temperature of 24°C, and from September 15 the larvae evolved.

The data mentioned above represent the minimum duration from which each stage of each generation of species *Cydalima perspectalis* evolved. During the research it was observed that the larvae of the winter generation are affected by the constant temperature changes from May to April, some of them were found dead in the last decade of March (5.9°C) and the first decade of April (8.8°C), then the lowest values of the development period of the hibernating larvae were registered.

During 2020, the species *Cydalima perspectalis* developed two complete generations, and the third is partial. In 2019 in the same area it has developed 3 generation and the fourth was partial, in this case temperature was the main cause of the differences of generation from a year to another.

However, third-generation larvae, even if they completed their cycle, would not survive as a pupae stage due to the low temperature recorded after the third decade of October (11.6°C) and November (5.5°C).

So for the two generations completed in 2020 by the box tree moth, the amount of effective temperature for the egg stages of the first generation was 62.8°C, for larva stage was 444.8°C and for the pupae stage was 139.1°C is 646.7°C, and for the second generation the amount of effective temperature is 628.3°C, the data are presented in Table 1 and for the data already published for the year 2019, the amount of effective temperature is presented in Table 2.

Table 1. The amount of effective temperature (degree-days) in 2020 for the development stages of *Cydalima perspectalis*

DEVELOPMENT STAGES	AMOUNT OF EFFECTIVE TEMPERATURE 2020	1ST GENERATION	2ND GENERATION
EGG		*62.8°C*	*56.5°C*
LARVA		*444.8°C*	*437.4°C*
PUPAE		*139.1°C*	*134.4°C*
TOTAL CYCLE		*646.7°C*	*628.3°C*

Source: Own results.

Table 2. The amount of effective temperature (degree-days) in 2019 for the development stages of *Cydalima perspectalis*

DEVELOPMENT STAGES	AMOUNT OF EFFECTIVE TEMPERATURE 2019	1ST GENERATION	2ND GENERATION	3RD GENERATION
EGG		*53°C*	*51.5°C*	*48.6°C*
LARVA		*431.8°C*	*426.1°C*	*403.4°C*
PUPAE		*137.5°C*	*135°C*	*74.1°C*
TOTAL CYCLE		*622.3°C*	*612.6°C*	*526.1°C*

Source: Own results.

The amount of effective temperature for 2019 for the three generations completed in this area, the values for the egg stage are: 53°C for the first generation, 51.5°C for the second generation and 48.6°C for the third generation. The amount of effective temperature for the larval stage was beetwen 431.8°C and 403.4°C and or the pupae stage variated beetwen 137.5°C for the first generation, 135°C for the second generation and 74.1°C for the third generation.

These variations are encountered due to climatic conditions, if in 2019 there were 3 complete generations, and the fourth partial, in 2020 we have 2 complete generations, and the third partial, under the influence of temperatures in the area. This tells us that the development of the species *Cydalima perspectalis* depends entirely on temperature and then on food.

CONCLUSIONS

Temperature is the main climatic factor that can influence the development of the box tree moth from a year to another. If the temperature is low the evolution in days of the development stages increase and vice versa.

For the population studied in 2020, the first flight of adults took place on May 18, and the last on October 14.

In 2019 we have 3 generation and the fourth generation is partial and in 2020 this species completed 2 generation and the third is partial, in this case under natural climatic condition the life cycle of the speciei Cydalima perspectalis can variated from a year to another.

The amount of effective temperature (degrees-days) for the egg stage varies between 62.8°C in 2020 and 48.6°C in 2019, for the larval stage is between 444.8°C (2020) and 403.4°C (2019) and for the pupae stage the values are between 139.1°C (2020) and 74.1°C (2019).

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INNOVATION FOR SUSTAINABLE WATER SECTOR

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Abstract

Challenges regarding the sustainable management of the water sector require the diffusion of innovative technologies and the implementation of innovative solutions. The aim of the article is to make a SWOT analysis based on the assessment of the possibilities of innovations to contribute to sustainability in the water sector and the analysis of the problems for their implementation. This allows being outlined recommendations for improving the process of innovation implementation in the sector. The methodological framework of the study includes: 1. Theoretical review of the implementation of innovations in the water sector 2. Methodology for the study of sustainable management of the water sector through the implementation of innovations 3. Study of the problems and the possibilities for achieving sustainability through the implementation of innovations based on a survey among experts 4. Conclusion on the implementation of innovations in the water sector and recommendations for process improvement. The results in the article are part of a study related to the sustainable management of the water sector in Bulgaria.

Key words: *sustainability, water sector, innovation*

INTRODUCTION

Challenges in terms of low quality and quantity of water, adverse effects on public health and biodiversity, disruption of ecosystem services, water scarcity and drought, floods, which cause major economic losses and sometimes deaths, require the use and diffusion of new, region-adapted, innovative solutions [2]. Innovations have been present at every stage of human development, and over time they have changed their shape and appearance, but have always been a driving force and a factor for development [5]. Innovation in the water sector can be not only new sustainable technologies but also new partnerships in the field of public administration, research, and industry, new business models, and new forms of water management that are not only innovative but can also stimulate and support technological innovation. In addition, innovation does not need to be entirely new technology or concept, but new combinations and innovative ideas for improvements in modern technologies and systems, all of which must play a role in sustainable water management [3].

The implementation of innovative solutions to address the challenges in the water sector and support the development of innovations and their market diffusion leads to the accumulation of significant economic opportunities [9]. Innovation in the water sector is associated not only with the creation of new products or services, but also with the improvement of existing ways of managing water resources at a lower or the same price but with higher quality.

The scientific literature describes many barriers in front of the innovation in the water sector. Constrains for the diffusion of innovation include the widespread unwillingness of stakeholders in the water sector to test and use new technologies [3]. This is partly due to high investments in existing, long-lasting technologies because the maintenance or upgrading of this equipment requires a large part of current budgets [8]. Other barriers include the high cost of new technologies. As a result, different member states have different specificities and any company that launches a new technology may find that the cost of its certification is too high for some countries [3].

In some countries, consumers are required to pay to connect to the network system, so there is no incentive for consumers to test new technology. Uncertainty about the ownership and management of water companies' assets can also slow down the spread of innovation. Effective water pricing can stimulate the uptake of innovations if it reflects real financial, environmental, and resource costs [7]. Many pricing policies still suffer from difficulties in defining and limiting a consumer group.

The main factors for the development of innovation are costs, technology, and stakeholders. When the costs associated with the application of cleaner technology are high, the old technological regimes are maintained [1]. Therefore, the transition from polluting to clean technologies is highly dependent on the economic situation of the country. At the same time, the introduction of innovations requires new ecologically oriented knowledge and infrastructure.

Technological opportunities play an important role in the implementation of innovations in the water sector. Improving technological capabilities through research and development stimulates the development of innovation [6].

Innovations require a wide range of knowledge, as their implementation often requires institutional changes, adoption of specific management systems, application of complex regulations, and others [4]. In this regard, the different intensity of innovation and especially eco-innovation, and their effectiveness in different countries depend on the level of development of research and development, the availability of the necessary qualified staff, the development of cooperation, networks etc. [6].

MATERIALS AND METHODS

The aim of the article is to make a SWOT analysis based on the assessment of the possibilities of innovations to contribute to sustainability in the water sector and the analysis of the problems for their implementation. This allows being outlined recommendations for improving the process of innovation implementation in the sector.

The results in the article are part of a study related to the sustainable management of the water sector in Bulgaria [10].

The methodological framework of the study includes:

1. Theoretical review of the implementation of innovations in the water sector
2. Methodology for the study of sustainable management of the water sector through the implementation of innovations
3. Study of the problems and the possibilities for achieving sustainability through the implementation of innovations based on a survey among experts
4. Conclusion on the implementation of innovations in the water sector and recommendations for the process improvement.

The analysis is based on a survey conducted with experts at the national level on the possibilities for achieving sustainable management in the water sector through the introduction of innovations. The participants in the study are experts from municipal administrations who are well acquainted and qualified in the field of policies and instruments for achieving sustainable water sector management, risk management in the water sector, and innovation. 20 experts with the necessary competence on the researched issues participated in the survey. The survey was conducted in the period November 2019 - January 2020.

The tool used in the article is the SWOT analysis. It is applied to analyze achieving a sustainable water sector in Bulgaria through innovation. To determine the main elements in the development of the SWOT diagram for the purposes of the article, research questions are set regarding the strengths and weaknesses, opportunities, and threats.

The research questions for the different elements of SWOT analysis are as follows:

Strengths

-How can we use our strengths to achieve sustainability in the water sector through innovation?

-Which are the advantages of implementing innovations in the water sector?

-How does the implementation of innovations in the water sector contribute to its sustainability?
-How will we use the specifics of implementing innovations in the water sector as a strength to achieve sustainability?

Weaknesses

-How can weaknesses in the implementation of innovations in the water sector be reduced or eliminated before they become a threat?
-What could be improved in the implementation of innovations in the sector and how?
-Which factors (internal and external) are considered as weaknesses in the implementation of innovations in the sector?

Opportunities

-What could be the opportunities for innovation in the water sector and how can existing ones be better used to overcome weaknesses and / or threats?
-Which are the good opportunities (short-term, long-term)? Which of the good opportunities are easily feasible and which can only be realized by changing the external environment?
-Are there any potential opportunities to contribute to sustainable management in the water sector? How can they be reached?
-Are there any potential opportunities to contribute to the dynamization of the process of innovation in the water sector? How can they be reached?

Threats

-What are the main constraints aimed at introducing innovations in the water sector in the short term?
-What are the main constraints aimed at implementing innovations in the water sector in the long term?
-Will the change of the external environment constrain the introduction of innovations in the water sector?
-What are the possible threats arising from the external environment in the implementation of innovations in the water sector?
-Which threats arise from the lack of innovation in the water sector?

The questions used in the questionnaire for the purposes of this article are related to the assessment of the challenges and barriers to the implementation of innovations, as well as the factors for the implementation of innovations in the water sector (Table 1).

Table 1. Assessment of the challenges, barriers, and factors for the implementation of innovations in the water sector

Challenges	Barriers	Factors
• Poor quality of water resources. • Lack of water resources. • Adverse effect on public health. • Adverse effects on biodiversity. • Obstruction of the provision of ecosystem services. • Drought. • Flood.	• Unwillingness of stakeholders in the water sector to use new technologies. • Serious investments in existing, long-lasting technologies. • High cost of new technologies. • Uncertainty regarding the ownership and management of water companies' assets. • Difficult access to funding sources. • Lack of need for innovation.	• The value of the costs incurred for innovation. • Technology requirements. • The requirements set in the legislation. • The desire of stakeholders.

Source: Own conception.

RESULTS AND DISCUSSIONS

The assessment of the achievement of a sustainable water sector through innovation was realized through questions included in the expert survey. Innovations are assessed as important for overcoming the challenges in the water sector. They have a high (50%) and very high significance (30%) for improving the quality of water resources. They are also important for overcoming their shortage, as 20% define them as those of high significance and 70% as very high. The importance of innovation for overcoming the adverse effects on public health due to quantitative and qualitative problems of water resources is defined as high by more than half of the respondents (Table 2). 25% consider this significance as low, and 10% believe that it is missing. The opinion on the importance of innovation in overcoming the adverse effects on biodiversity differ, and in general, it can be defined as average. Such assessments were given by more than one third of the respondents, 30% consider that the importance is high, 25% that it is low, and 10% share a view that it is missing. More than half of the respondents define the importance of innovation for the provision of ecosystem services as high and very high, and 25% define it as average.

Table 2. Assessment of the importance of innovation to overcome the main challenges in the water sector, %

Challenges	1	2	3	4	5
Poor quality of water resources	0	0	20	50	30
Lack of water resources	0	5	5	20	70
Adverse effect on public health	5	10	30	45	10
Adverse effects on biodiversity	10	25	35	15	15
Obstruction of the provision of ecosystem services	5	15	25	40	15
Drought	0	0	30	40	30
Floods	5	5	25	45	20

1 - lack of significance; 2 - low significance; 3 - average significance; 4 - high significance; 5 - very high significance
Source: own research [10] .

Only 15% consider it is low and 5% think it is missing. Innovation is important for overcoming drought problems. 30% describe this importance as a medium, 40 % as high, and the remaining 30% as very high. Innovation activity is also important for overcoming floods and 90% of the experts indicate high scores in general.

The barriers to the implementation of innovations in the water sector proposed in the questionnaire are assessed as serious (Table 3). The high cost of new technologies is defined as a serious (40%) and very serious (30%) problem, and difficult access to sources of funding as a serious constrain for 30% of the experts and very serious for 40% of them. Uncertainty regarding the ownership and management of the assets of water companies is also a barrier, which is assessed as an average - 25%, serious - 30% and, very serious - 30% of the respondents. Lack of need for innovation and unwillingness of water supply to use new technologies are not defined as very serious barriers in front of the innovation. They are defined as barriers with average scores. Serious investments in existing long-term technologies receive mixed assessments if they are constrained or not. Experts define them as: very serious - 15%; serious - 25%; medium - 30%; small barrier - 20% and they are no barrier for 10%.

Table 3. Assessment of the main barriers in front of the implementation of innovations in the water sector, %

Barriers	1	2	3	4	5
The unwillingness of stakeholders in the water sector to use new technologies	10	30	40	5	5
Serious investments in existing, long-lasting technologies	10	20	30	25	15
High cost of new technologies.	5	10	15	40	30
Uncertainty regarding the ownership and management of water companies' assets	0	15	25	30	30
Difficult access to funding sources	0	0	30	30	40
Lack of need for innovation	10	20	45	25	0

1 - It is not a barrier; 2 - Small barrier; 3 - Medium barrier; 4 - Serious barrier; 5 - A very serious barrier
Source: own research [10] .

Many of the factors included in the survey for the development of innovation in the water sector receive a high score (Table 4). Technology requirements (75%) and stakeholder willingness (70) are identified as definitely important factors for more than half of the respondents. The value of the costs incurred for innovation and the requirements set in the legislation are definitely important factors for the development of innovation in the water sector for 45% of the surveyed experts. The value of the costs incurred for innovation is rather an important factor for the development of innovation in the sector for 55% experts. The requirements set in the legislation are an important factor for 40% of the respondents and the willingness of the stakeholders for 25% of them are identified as rather important factors. No factor is defined as one that is not important at all or rather unimportant. Only 5% of the experts identify technology requirements and legal requirements as rather unimportant factors.

Table 4. Assessment of the main factors for the development of innovations in the water sector, %

Factors	1	2	3	4	5
The value of the costs incurred for innovation	0	0	0	55	45
Technology requirements	0	5	5	15	75
The requirements set in the legislation	5	5	5	40	45
The desire of stakeholders	0	0	5	25	70

- Not important at all; 2 - Rather not important; 3 - No opinion; 4 - Rather important; 5 - Definitely important;
Source: own research [10].

SWOT analysis of the implementation of innovations in the water sector

Strengths due to the implementation of innovations in the water sector are overcoming the shortage of water resources and improving the quality of water resources (Table 5 and Table 6).

Table 5. SWOT analysis of the implementation of innovations in the water sector in Bulgaria, (Strengths and Opportunities)

STRENGTHS
• Overcoming the shortage of water resources. • Improving the quality of water resources. • Availability of highly qualified staff for implementation of innovations in the sector. • High added value. • Financial assistance under the operational programs. • Overcoming the adverse effects on public health due to quantitative and qualitative problems of water resources.
OPPORTUNITIES
• Provision of ecosystem services. • Overcoming drought problems. • The requirements regarding the technologies set in the legislation. • Climate change. • The risk of floods. • The level of development of research and development. • Level of development of cooperation networks. • Efficient water pricing.

Source: own research.

The availability of highly qualified staff for the implementation of innovations in the sector and financial assistance under the operational programs are also defined as strengths.

The strengths of the implementation of innovations in the sector is the overcoming of the adverse effects on public health due to quantitative and qualitative problems of water resources.

The implementation of innovations in the water sector leads to the creation of high added value, as it benefits from the investment of innovative components from other sectors (IT, construction, infrastructure).

A weakness in the sector is the serious investments in existing, long-term technologies for the operation and maintenance of water infrastructure, which affects the dynamics of the process of implementing innovations.

Table 6. SWOT analysis of the implementation of innovations in the water sector in Bulgaria, (Weaknesses and Threats)

WEAKNESSES
• Uncertainty regarding the ownership and management of water companies' assets. • Serious investments in existing, long-lasting technologies. • Unwillingness of the stakeholders in water sector to use new technologies. • Strong dependence on other sectors and the innovations developed in them. • High cost of new technologies.
THREATS
• Difficult access to funding sources. • Lack of need for innovation and unwillingness of water supply to use new technologies. • Unwillingness of stakeholders. • The value of the costs incurred for innovation. • Lack of awareness. • Change of the legislation in the water sector. • Lack of technical assistance for implementation of innovations.

Source: own research.

The unwillingness of the stakeholders in the water sector to test new technologies is defined as a weakness precisely because the serious investments in existing, long-term technologies and the maintenance of water infrastructure requires serious funding. Uncertainty regarding the ownership and asset management of water companies leads to the limited implementation of innovative solutions in the water sector.

The implementation of innovations in the water sector is highly dependent on the development of innovations in other sectors such as IT, construction, specialized equipment, and others. Challenges facing the water sector such as drought, climate change, flood risk can be identified as an opportunity to stimulate innovative solutions in the water sector, as the problems are expected to deepen. The implementation of innovative solutions to address the challenges in the water sector and support the development of innovations and their market diffusion will increase the value of ecosystem services. The efficient pricing of water and its connection with the innovations in the sector is an opportunity to dynamize the process. An opportunity for innovation is to stimulate the development of cooperation networks, as innovation processes are carried out through the interaction between multiple users and stakeholders (water users), research centers and governmental, and local authorities.

Threats to dynamize implementation of innovation in the water sector are associated with difficult access to sources of funding and the value of the costs incurred for innovation. At the same time, the lack of need for innovation and the unwillingness of stakeholders in the water sector to use new technologies is a threat. Lack of information and technical assistance for the implementation of innovations is also identified as one of the barriers in front of the implementation of innovations in the water sector.

CONCLUSIONS

Based on the theoretical review and analysis of the opportunities, and barriers to the implementation of innovations to achieve a sustainable water sector, the following conclusions could be summarized:

-Water innovation can be both new sustainable technologies and new partnerships, business models, forms of water management, combinations and innovative ideas for improvements in modern technologies and systems, all of which must play a role in sustainable water management.

-The innovations are assessed as significant for overcoming the challenges in the water sector in terms of improving the quality of water resources, overcoming the shortage of water quantities, the adverse effects on public health due to quantitative and qualitative problems of water resources, for providing of ecosystems.

-Definitely important factors for the development of innovation in the water sector are determined by the requirements in terms of technology and the willingness of stakeholders. The value of the costs incurred for innovation and the requirements set in the legislation are definitely important factors for the development of innovation in the water sector.

-The barriers to the implementation of innovations in the water sector proposed in the survey are assessed as serious. High costs of new technologies are defined as serious constrain, difficult access to funding sources, uncertainty regarding ownership and asset management of water companies are identified as very serious barriers in front of the implementation of innovation.

The following recommendations can be given to dynamize the process of implementing innovations to achieve a sustainable water sector:

-One of the weaknesses defined in the SWOT analysis is the uncertainty of ownership and asset management of water companies. In this regard, the recommendations of the EIP Water Working Group on creating a network between buyers can be taken into account. In this way, groups can exchange information on best practices.

-Coordination and joint decision-making between stakeholders is also needed to develop and implement innovative technologies.

-Stakeholders need to understand that innovation is the main source of competitive advantage and in this regard, it is necessary to apply models for developing innovative strategies for innovation in the water sector, which are consistent with the needs of society, institutions, and the environment.

-Grants, financial incentives, and pricing strategies can help for buying innovation.

-The lack of need for innovation from stakeholders and the unwillingness of stakeholders in the water sector to use new technologies can be overcome by implementing one initiative recommended from the Union in the field of innovation, included in the Europe 2020 strategy, which is to create European partnerships for innovation. They will accelerate the spread of innovation in the water sector.

-The main weaknesses and threats are the value of the costs incurred for innovation and the high cost of new technologies, as well as the difficult access to funding sources. They could be overcome through new funding approaches. In the strategy paper for water innovation [9] is proposed the creation of a common structure at the European level to build an interface between funding institutions and industry, which stimulates innovation and improves knowledge of access to finance. It is also proposed to improve access to finance for small and medium-sized enterprises and to build frameworks and tools to stimulate public sector innovation in priority areas, based on a review of best practices in public procurement.

-Lack of awareness of stakeholders can be overcome by applying a dissemination approach. Many innovations are relatively new (renewable energy, electro mobility) and are more dependent on external sources of information and research compared to already established innovations. In this regard, universities and other research institutions play a significant role in the development and implementation of innovation in the water sector. These institutions can also contribute to the provision of highly qualified professionals with education in new scientific fields.

-Good legislation can stimulate environmental technologies and lead to challenges such as insufficient research capacity, inadequate functioning of the research system, weaknesses in information and training.

As conclusion, challenges regarding sustainable management in the water sector require increasing the diffusion of innovative technologies and the implementation of innovative solutions that take into account the specifics of the regions. This will give competitive advantages for both businesses and regions.

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CONSUMER BEHAVIOR AND AGRICULTURAL CONSUMER MARKET

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Abstract

The fact that the market is the main trading instrument influencing the development of the national economy makes it necessary to analyze the lessons of all the factors that will affect its development. Consumer markets have a significant share of daily demand.Therefore, the article analyzes the behavior of consumers of agricultural products. It describes many factors that affect consumer behavior. The study argues that consumer behavior is not only affected by price and income factors. There are dozens of external factors that affect consumer behavior. Studies show that many factors can influence consumer choices, from social factors to psychological factors. The article graphically describes consumer behavior under the influence of these factors. The article also provides information on per capita consumption and market prices of agricultural products in Azerbaijan. Proposals have been put forward to stimulate the development of consumer markets in Azerbaijan.

Key words: *behavior of consumers, agricultural products, consumer choices, income, pricing policy*

INTRODUCTION

Since inception, society has been in constant contact with nature to meet the products of daily needs. Society has been influenced by nature in order to meet the demand for food. Society tried to shape nature as he wished in order to meet of the needs. There is only one economic goal behind this. This is related to meeting society's demand for food and non-food products. Thus, the strengthening of mutual relations and the growing productivity of labor eventually led to the creation and development of new types of shopping centers. However, it is undeniable that there are some differences between past and present consumers. Thus, although the main purpose of consumers in the primary market is to meet only the demand for essential food products, these behaviors are different in the modern consumer [2]. Changes in the socio-economic interests of modern consumers have also affected their behavior towards food and non-food products. As the market accelerates the development of the national economy, increasing the sales share of the market is always in the spotlight. The market also provides related industries with both raw materials and other means of production.The market is also interacting with the industries that produce the means of production [4]. Therefore, all the factors affecting the development of the market should be kept in focus, and by influencing these factors, the development of the market should not be delayed. For this purpose, the article examines the factors influencing the economic interests and choices of consumers in the consumer goods market. Attention was paid to the possibility of a positive impact of these factors on the market of agricultural consumer products in Azerbaijan.

MATERIALS AND METHODS

The article analyzes the factors affecting the amount of goods consumed by the consumer in the market. Attention was paid to the economic and social impact of the factors.Attention was drawn to changes in consumer demand under the influence of both price and non-price factors. In addition, non-price factors and psychological factors that determine consumer behavior were identified. The article also provides information on self-sufficiency opportunities in the agricultural market of Azerbaijan and compares it at the international level. For this purpose, mathematical, statistical, analysis, synthesis, logical methods were widely used. The tables created in the article are based on Microsoft Excell 2010 version.The graphs in the article are based on economic theory. The tables containing statistical data in the article are based on the data of the State Statistics Committee of the Republic of Azerbaijan.

RESULTS AND DISCUSSIONS

The market of agricultural consumer goods provides the realization of the majority of products with a high share in daily consumption. Especially at a time when economic crises are replacing each other in the world, the impact of the pandemic on the economy is expanding, and the population is constantly growing, it is necessary to reliably meet consumer demand for food. It is known that the agricultural consumer market is affected by changes in fuel and equipment of production. This leads to more or less fluctuations in commodity prices in the consumer market. Changes in market prices of goods lead to a reduction in the volume of products consumed by low-income people. Such consumers are encouraged over time to consume a close substitute for those products. However, substitute products often do not have the same quality as previous products. As a result, in the face of high prices, the consumer is forced to consume low quality products [6]. For this purpose, state regulatory tools are widely used in our country to prevent such cases. The validity of the agricultural seasonality factor can cause the market to have an abundance in different seasons of the year by product groups, and a shortage in other seasons. For this reason, seasonal fluctuations in product prices are observed in the market [2]. To this end, an in-depth analysis of these and other factors affecting the market becomes necessary. Here, the state intervenes in the market over time, causing the restoration of lost economic benefits for producers and consumers. In general, there are factors in agricultural bases that affect consumer behavior to one degree or another. In the agricultural consumer goods market, the following economic and social factors can influence the desires of consumers to consume goods:

-the price of the commodity;
-quality of goods;
-whether there is a substitute for the goods;
-whether necessary or unnecessary;
-price and income sensitivity of the commodity;
-close to the market;
-advertising, marketing activities;
-tastes, age group, family composition, climate, education, etc.

As noted in economic theory, a decrease in the price of a product causes the consumer to buy more of that product. Figure 1 shows the impact of declining vegetable prices on consumer preferences.

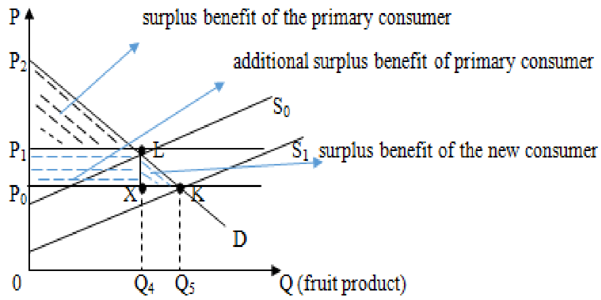

Fig. 1. Change of consumer surplus in the consumer market
Source:[6].

As we see when the price of fruit falls from p_1 to p_0, its consumption increases by q_4-q_5 (Fig. 1). Thus, under the influence of price reductions, there is an increase in consumer behavior, and this occurs in two different volumes. In the first case, this increase is reflected in the change in previous consumer demand against the background of declining prices. In this case, the primary consumer receives additional benefits [8]. This volume corresponds to the area of the square Sp_1, p_0, x, l (Fig. 1). In another case, declining prices are explained by the entry of new consumers into the market. The additional benefits of new consumers correspond to the area ΔSl, x, k. It is known that fruit products are consumed more in the winter due to vitamin deficiency in the consumer goods market.
An increase in the price of a particular x product in the market has two effects on the consumer: income and replacement effect. Therefore, the price and revenue effects

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separatelyshows (Fig. 2). The consumer buys fruits and vegetables. The reduction in the price of vegetables allows the consumer with a stable income to buy more than vegetables. More precisely, the consumer with income gains at point f_0 on the product x and y consumed at px, py prices. That is, it achieves maximum efficiency at the point where the indifference curve (ic) touches the budget line. In this case, there is a decrease in the price of product x, which increases the real income of the consumer. Thus, according to the new income of the consumer, the budget line changes from y_1,x_1 to y_1,x_2. As it is known, a new optimal point for the consumer is formed in the emerging budget line (f_1). When we look at the newly formed optimal point for the consumer, we see that the amount consumed on the product x increases from x_0 to $x`_1$, and this is the overall effect [6].

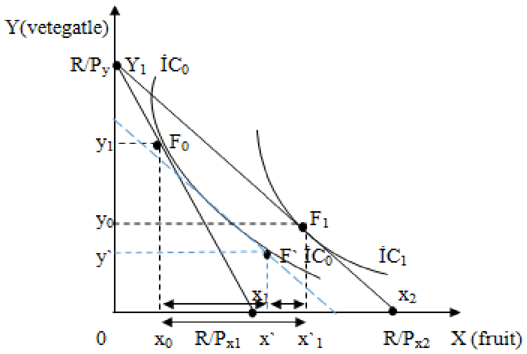

Fig. 2. Change in consumer behavior
Source: [2].

The behavior of the consumer as a result of the total price effect corresponds to the distance in the range $x`_1$-$x_0$ shown (Fig 2.) In the consumer market, the total effect is equal to the sum of the substitution ($x`$-x_0) and income effects ($x`_1$-$x`$).Thus, the income effect forms a new budget line for fruit and vegetable production and an indifference curve (ic_1), which reflects the volume of higher benefits. However, the product substitution effect causes the same indifference curve to move.

As noted, the impact of commodity price and revenue expectations on consumer behavior is high.Other factors influencing consumer behavior are related to social factors.Among such factors, the age group of the population, family composition, education, advertising and many other factors to some extent affect consumer behavior [5]. Thus, the behavior of the older consumer is significantly different from the younger generation. People in this age group tend to eat healthier foods. Sustainable goods are preferred in their consumption. The opposite is observed in the younger generation [7]. Another factor influencing this was the advertising factor.This factor affects consumers to varying degrees depending on the age group and desire of the product's consumers.It stimulates the increase of the volume of goods to be consumed. After looking at important information about the impact of several social and economic factors on consumer behavior, it is important to look at the current situation in the national market, which affects consumer behavior.

Statistical figures shows the change in agricultural production in Azerbaijan over the past five years (Table 1). The change in the volume of basic agricultural products in 2020 compared to 2016 is calculated and noted in the last column. Looking at statistical figures production has increased significantly in various areas over the last five years compared to previous years. Among them, the production of potatoes, vegetables, fruits, grapes, tobacco, meat and eggs has increased significantly [10]. During this period, only a decrease in sugar beet production was observed, which is due to a comparative advantage. Thus, at a time when domestic production is expensive, the import of this product is considered more economically effective. When you look at the level of local self-sufficiency in these products, you can see that this volume is higher than in any previous year. Thus, ensuring consumption at the expense of local production solves such an important issue as food security. It is important to meet food security at the expense of increasing production over the years, to ensure the economic interests of consumers in the market. In particular, the location of the territory of Azerbaijan in the temperate climate zone allows production to be carried out twice a year. This provides consumers with access to a wide range of products in all seasons. The partial disappearance of the seasonal principle due to climatic reserves, as a result, prevents sharp fluctuations in market prices. This situation also eliminates the need to import various types of products. It allows the Azerbaijani consumer to buy the required quantity and quality of products. This also allows foreign currency to remain inside the country. it is also important for the development of the national economy.

Table 1. Dynamics of the main types of livestock products (thousand tons)

Products	2016	2017	2018	2019	2020	2020/2016 %
Cereals, (corn)	3,065.1	2,928.8	3,309.2	3,538.5	3,257.1	6.2
Potato	902.4	913.9	898.9	1,004.2	1,037.6	14.9
Sugar beet	312.6	410.1	277.2	218.5	253.3	-18.9
Vegetables	1,270.6	1,405.6	1,521.9	1,714.7	1,738.9	26.8
Fruits and berries	882.8	954.8	1,010.8	1,099.7	1,133.1	28.3
Grapes	136.5	152.8	167.6	201.8	208.0	52.3
Tea	1.02	0.78	0.87	0.93	0.93	9.6
Tobacco	3.6	5.3	6.3	6	6.9	91.6
Meat	523.8	540.5	556.6	573.3	591.1	12.8
Milk	2,009.1	2,024.1	2,080.4	2,150.8	2,192.5	9.1
Egss	1,609.8	1,714.0	1,676.2	1,827.1	1,906.2	18.4

Source: The State Statistical Committee of the Republic of Azerbaijan.

If we pay attention, the needs of the country's population are fully met for many products (Table 1). There is an average dependence of 20-30% on imports only for grain products. However, from 2021, the involvement of new agricultural lands in production will ensure that a significant part of the supply is paid for by local production. Dependence on imports in this area will be eliminated or partially existing.In addition, there is a dependence on imports of 10-20 per cent of beef.This will meet the demand in the near future through the cultivation of new breeds by industrial methods.There is an effective government policy in this area that will meet the needs of consumers.This is the main goal of the state program "On reliable food supply of the population in the Republic of Azerbaijan in 2008-2015."Thus, the production of the main types of agricultural products produced in the required amount in our country helps consumers to make more optimal decisions [3].It fully meets their demand for food and non-food products.The main factor influencing consumer behavior is the volume and quality of products produced in the domestic market.To do this, it is important to pay attention to the current situation in the domestic market of Azerbaijani food products through an international comparison of products produced in the domestic market [9].Thus, Azerbaijan's domestic production, which is growing in a short period of time, is able to meet the high level of domestic demand for key products. Important economic decisions taken to eliminate dependence on imports are bearing fruit in a short time. For this purpose, figures compares the production of agricultural products in the CIS countries (Table 2). These countries were economically close. These countries, which have a recent history in the CIS, in fact have a similar development. Countries in transition have similarities in many areas, especially in the agricultural sector. There are many similarities between the behavior of consumers in the countries included in this group. For more than seventy years, there has been both economic and social closeness between people living together in the same economic space. Thus, food and non-food products produced in a single economic space have become available to citizens of all countries of the union. This has led to a closeness between producer behavior over time. This can also be linked to joint economic decisions [1]. Here, the establishment of stable prices for products had a significant impact on consumer preferences. The state used this tool to determine the maximum and minimum price limits for products produced. This can be seen in the figures in the table. Statistical figures is reflected in the article to give an idea of the agrarian consumer market. The data here show how the physical weight of production in the CIS countries has changed in recent years.

Table 2. Physical volume index of agricultural production, in comparable prices (As a percentage of the previous year)

Years / Country	Azerbaijan	Ukraine	Uzbekistan	Tajikistan	Russia	Moldova	Kyrgyzstan	Kazakhstan	Belarus
2017	104.2	97.8	101.2	106.8	103.1	109.1	102.4	103.0	104.2
2018	104.6	108.1	100.2	104.0	99.8	102.5	102.7	103.5	96.7
2019	107.2	101.1	102.5	107.1	104.0	98.1	102.6	100.9	102.9

Source: The State Statistical Committee of the Republic of Azerbaijan.

Figures show that there is no significant difference in the production of agricultural products in these countries (Table 2). The volume of production here has increased with each passing year due to the introduction of new technologies. This proves that consumers in those countries do not face severe market imbalances. As production does not fall sharply, consumers do not face high prices. This shows that the consumer does not face the lost economic benefits. Thus, if we pay attention, the growth of agricultural products in the Republic of Azerbaijan in 2019 was higher.

Table 3. Consumer price index international comparison

Country	2017	2018	2019
Azerbaijan	12.936	2.269	2.611
Georgia	6.035	2.615	4.853
Russia	3.683	2.878	4.47
Moldova	6.57	3.04	4.838
Kyrgyzstan	3.175	1.543	1.134
Belarus	6.032	4.872	5.598
Ukraine	14.438	10.952	7.887

Source: The State Statistical Committee of the Republic of Azerbaijan, International Monetary Fund, International Financial Statistics and data files.

This was achieved by bringing new species to the country. This has led to significant increases in both crop production and livestock. Large farms have been established, which has led to an increase in production compared to last year.As there are not many differences between countries in the consumer market, there are no sharp differences in prices between them. Thus, the customs agreement and joint economic decisions have always been in the center of attention in this area. As know economic development in the CIS similar. The main factor determining consumer behavior, changes in the level of prices (Table 3). Here it is important to pay attention to price fluctuations over the years. At the same time, figures show how the consumer price index changes in the domestic market [12].

It turns out that the price change in the domestic market in 2017 was close between Ukraine and Azerbaijan. This figure decreased in 2018 due to the impact of economic decisions made in the Republic of Azerbaijan. In 2017, this may be explained by the decline in fuel prices on world markets. Currently, this situation is best regulated by the development of other non-oil sectors.In 2019, this situation was ensured at the best level by making optimal decisions. Unlike many CIS countries, the economy quickly established in line with the economic requirements of the pandemic. Restoring its territorial integrity in a short period of time, Azerbaijan has made decisions aimed at improving the supply of the population in the consumer market. This has led to a general level of prices being lower than world market prices due to the abundance in the consumer goods market.

Despite widespread fluctuations in world market prices, this situation continued in 2020. As mention that food products prices in the Republic of Azerbaijan in 2020 did not increase significantly compared to last year. Thus, according to the State Statistics

Committee, the consumer price index in 2020 compared to 2019 was 102.8 percent. It was 105 percent for food, beverages and tobacco products, and 101.3 percent for non-food products. In December 2020, the consumer price index was 100.8% compared to the previous month, 102.6% compared to December of the previous year. In January-February 2021, 6 billion 27.9 million manat worth of food products, including 3 billion 205 million manat worth of food products and 2 billion 822.9 million manat worth of non-food products were sold to consumers in the retail trade network [11]. According to the State Statistics Committee, compared to the same period last year, retail trade turnover increased by 1.3 percent in real terms, including 4.9 percent for non-food products, and increased by 2 percent for food, beverages and tobacco products. The reason for the decline in non-food products is due to the long-term expectations of consumers due to such a change in consumer behavior due to the pandemic [10]. In addition, if we pay attention to the average monthly salary, the average monthly salary in Azerbaijan is significantly higher than the level of consumer spending. With such a salary, the provision for the consumer basket is paid in full. The remaining funds allow to be allocated and collected in the social sphere.

CONCLUSIONS

The information provided in the article on consumer behavior actually shows that there are dozens of factors that affect consumer choices. These factors are related not only to the price and income factors, but also to the influence of non-economic factors. The article clearly states that consumer choices are influenced by many such economic, social and psychological factors. How these decisions are optimized is illustrated in the graphs. The article also contains important information about agricultural production in Azerbaijan. It contains extensive information about the self-sufficiency of the local market. Thus, paying attention to the information contained in the article, the factors influencing the development of the agricultural consumer market can be listed as follows:

-to pay attention to the correct assessment of the volume of consumer demand;

-increase market self-sufficiency opportunities;

-improving the competitiveness of the products;

-reducing the role of intermediaries in the market;

-creation of products according to the budgets of different market participants;

-comparative analysis of international market prices;

In addition to the above, it is important for the state to partially intervene in the market in order to protect the economic interests of consumers. This can affect the level of self-sufficiency of the market.

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INVESTIGATION OF THE TENDENCIES OF DAIRY MARKET DEVELOPMENT IN UKRAINE AND COMPETITIVE CAPACITY OF DOMESTIC AND POLISH PRODUCERS AT THE MARKET

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Abstract

The analysis confirms poor scientific interest to the study of dairy markets, examination of the level of competitive capacity of commodities from the consumers' position, determination of the directions of competitive capacity improvement. Purpose of the article is to analyze the tendencies of at the dairy products market in Ukraine, to determine impact of export-import transactions at the market, to study consumer preferences and competitive positions of commodities of Ukrainian and Polish producers, to substantiate directions of their increase. In their work, the authors used the methods of statistical analysis for examination of the tendencies of dairy market development in Ukraine; interviewing through the Internet – to study consumer preferences, and factors, influencing their choice; testing of hypotheses – for scientific substantiation of the factors, influencing the choice; expert estimates – for determination of the score of some indicators of cheese quality; complex method for assessment of competitive capacity of commodities. The initial data include statistical data, state standards, and scientific publications. Analysis of Ukraine's dairy market confirms negative tendencies concerning reduction of most products output. Moreover, one observes growth of imported dairy products. The investigations suggest that competitive capacity of cheese of Polish producers can be increased at Ukraine's market by activation of their communication and extension of his/her sale network. The demand for Ukrainian commodities can be improved by reduced application of conserving agents, stimulation of sale and pricing optimization.

Key words: *market of dairy products in Ukraine, import of dairy products, consumer preferences, competitive capacity of cheeses*

INTRODUCTION

The market of dairy products takes an important position in support for a balanced diet of people, supply of essential nutrients, and establishment of food safety of the country. The above-mentioned facts suggest timeliness of the presented problem and necessity to examine its current conditions. For the recent years, indicators of the market of dairy products in Ukraine have been influenced by two crises, which have occurred in the milk-processing branch of Ukraine, particularly, financial-economic crisis and the crisis of the resource-based industry, which has contributed to intensification of the first. The last factor has caused growth of the volume of imported dairy products in Ukraine. However, Ukraine has considerable marketing capabilities to improve the internal supply of the products for population and to increase the export of national dairy products under conditions of sufficient reconsideration of the approaches to formation of competitive capacity of those products.

The purpose of the research is to make analysis of the tendencies of dairy market development in Ukraine, to determine impact of export-import transactions in the field on the market, to study consumer preferences and competitive positions of the commodities of foreign and Ukrainian producers, and to argue directions of their improvement.

To write the article the authors have collected and analyzed the secondary marketing information using the methods of statistical analysis, primary information by interviewing through the Internet. The obtained results have been analyzed using the method of determination of nonmonotonic dependence between the parameters and matrix of break frequencies and testing of the hypotheses, examining of competitive capacity of cheeses on the ground of a complex method and calculation of the integral index of competitive capacity of the commodities.

To reach the set goal the authors of the research have analyzed the existing scientific literature concerning determination of the tendencies of dairy market development in different countries, creation of demand and supply for the products, and have made investigations of the competitive positions of some brands with consideration of consumer preferences and directions of their strengthening.

The next step was to define characteristics of the methods of investigation, to argue choice of the methodology for its performance and analysis of results, definitions of hypotheses, which have been tested in the process of collection and analysis of primary marketing information about consumer preferences of dairy products in Ukraine. Such steps supplied scientifically argued results concerning assessment of competitive capacity of cheese of Ukrainian and Polish enterprises at the market of Ukraine. The article also examines tendencies of development of dairy products market in Ukraine. The obtained results of the research make the information basis for making conclusions concerning directions to raise competitive capacity of some kinds of cheese of Polish and Ukrainian producers at the market of Ukraine. It will make a positive effect on the conjuncture of that product market.

The review of literary sources demonstrates a great gap concerning investigation of the tendencies of development of dairy products market in some countries, and concerning creation of demand and supply for those products, determination of competitive positions of some brands, and study of consumer preferences. In the process of the research of the dairy products market, the scientists pay considerable attention to management of dairy products quality and instruments for its assessment with the focus on use of scientifically argued methodology of the analysis. For example, application of the methodology of FMEA analysis (Failure Mode and Effects Analysis) results in improvement of quality of the processes in dairy industry and helps to avoid mistakes at the early stages of production, to define a discrepancy concerning products quality and reasons of their appearance [1, 5].

One should note that quality of the produced commodities should meet the legally approved standards, regardless of the enterprise size, by keeping to the principles of the system of quality management and it is the results of corporative processes [10].

In the dairy branch, control for safety of products is focused on consumers and their perception of the safety guaranties. Thus, the enterprises are in permanent search for new channels to communicate information to consumers and hold their attention concerning the supplied products [13, 20].

Under conditions of the extended introduction of information technologies by enterprises, it is necessary to apply the communication strategies in the Internet with the use of key efficiency indices (KEI). It will help the dairy enterprises to estimate their personal status and the chosen marketing strategy [6, 18]. It is also important to study creation of consumer preferences of dairy products of a definite producer. In that aspect, the authors of the work specify creation of a core market. Such investigations will contribute to increase of the level of efficiency of the products sale referring to the results of market researches [8, 11].

Some authors suggest that the Internet and other digital mass media transform the marketing by means of intellectual growth, and consumers obtain additional opportunities while making a choice of suppliers and a price proposal. Milk-processing enterprises get the opportunities to strengthen their personal competitive positions. Thus, examining the quality of dairy products, it is not enough just

to use personal technologies to improve the quality and methodology of its estimation, but to apply the advanced methods of Internet-marketing by determining the needs and expectations of consumers from the proposed products; by generation of the obtained information from consumers; by projecting of quality models, which can explain the value of determined criteria and future proposals [9, 14].
The authors of the research consider that scientifically based methodology for analysis of dairy products quality secures its appropriate level and assists formation of consumers' loyalty through the digital mass media, including the Internet.
The authors of the work agree to the idea of scientists, who claim that milk-processing enterprises stay under a high risk, caused by the global warming and other natural changes, application of transgenic modifiers, decline in demand for products, high requirements to certification and standardization of products, their safety, etc. along with setting of a competitive price, which, on one hand, requires from the producer to look for cheaper raw materials, and, on the other hand – their correspondence to the set quality parameters [2, 7].
However, in spite of the great number of available investigations, there is only primary comprehension of the processes of development of dairy products market and competitive positions of brands on it. The present article aims to explain the real nature of development of the market of dairy products in Ukraine and the key parameters of its competitive capacity from the position of consumers.

MATERIALS AND METHODS

For analysis of the tendencies of development of dairy products market in Ukraine, the authors of the research used the method of statistical analysis, particularly for determination of the rates of growth of some indicators of the market, a share of Polish products in the structure of import and export of some dairy products in Ukraine.
To study consumer preferences concerning some kinds of dairy products of domestic and Polish producers, the following hypotheses were suggested, particularly:
-consumption of dairy products of Ukrainian and Polish producers correlates with the demographic characteristics of consumers;
-importance of the factors of the dairy products purchase does not correlate with the choice of Ukrainian and Polish producers.
In February-March 2019, the questionnaire was made to test the hypotheses with application of the Google Forms service and a random sampling with the size, defined by the formula [3]:

$$n = \frac{t^2 \cdot v^2}{v_x^2}\ , \qquad (1)$$

Where:
t – is t-statistics of Student, which corresponds to the set level of safety,
v^2 – is a ratio of variation of a feature;
v_x^2 – is a ratio of variation of a deviation.
A minimum amount of the sampling constituted 307 people. The set deviation in the results, which were obtained while completing the sampling, constituted 5%. However, the ratio of variation was considered in the figure of 20%.
To test the hypotheses on the base of collected primary marketing information, the scientists used the Pearson criterion [12].
To apply the criterion χ^2 (the Pearson criterion) it is necessary to compare frequencies of observation of a definite feature (f_{ci}) with the expected frequencies (f_{oj}), which are determined in the matrix of break frequencies.
The criterion χ^2 is calculated by the formula:

$$\chi^2 = \sum_{i=1}^{4} \frac{(f_{ci} - f_{oi})^2}{f_{oi}}. \qquad (2)$$

In case the criterion χ^2 marks some relation, it is also true for the sampling and for the general aggregate.
The made questionnaire determines the factors, which are important for consumers in Ukraine while choosing some kinds of dairy products. However, it is needed to consider a possible sampling error.

The questionnaire provides the information for determination of the indicators of significance for calculation of the indices of competitive capacity of cheese of Ukrainian and Polish producers.
Analysis of the level of competitive capacity of some brands of cheese of Ukrainian and Polish producers required application of the method of calculation of the integral indicators of competitive capacity. However, estimating some quality parameters of cheese, which do not have numerical expression, and using the method of expert estimates, the work supplies a score of assessment, which has some elements of subjectivism.

RESULTS AND DISCUSSIONS

Tendencies of production and consumption of milk and dairy products in Ukraine

Tendencies of development of the market of dairy products in Ukraine can be determined by analyzing statistical information, obtained from official sources, particularly from the site of the State Statistics Service of Ukraine.
According to the official data, a considerable reduction of milk production in Ukraine in the recent years has caused fall of production of some dairy products.
For better understanding of the above-mentioned process, Fig. 1 presents dynamics of production of some kinds of dairy products in Ukraine for the period 2011-2019.

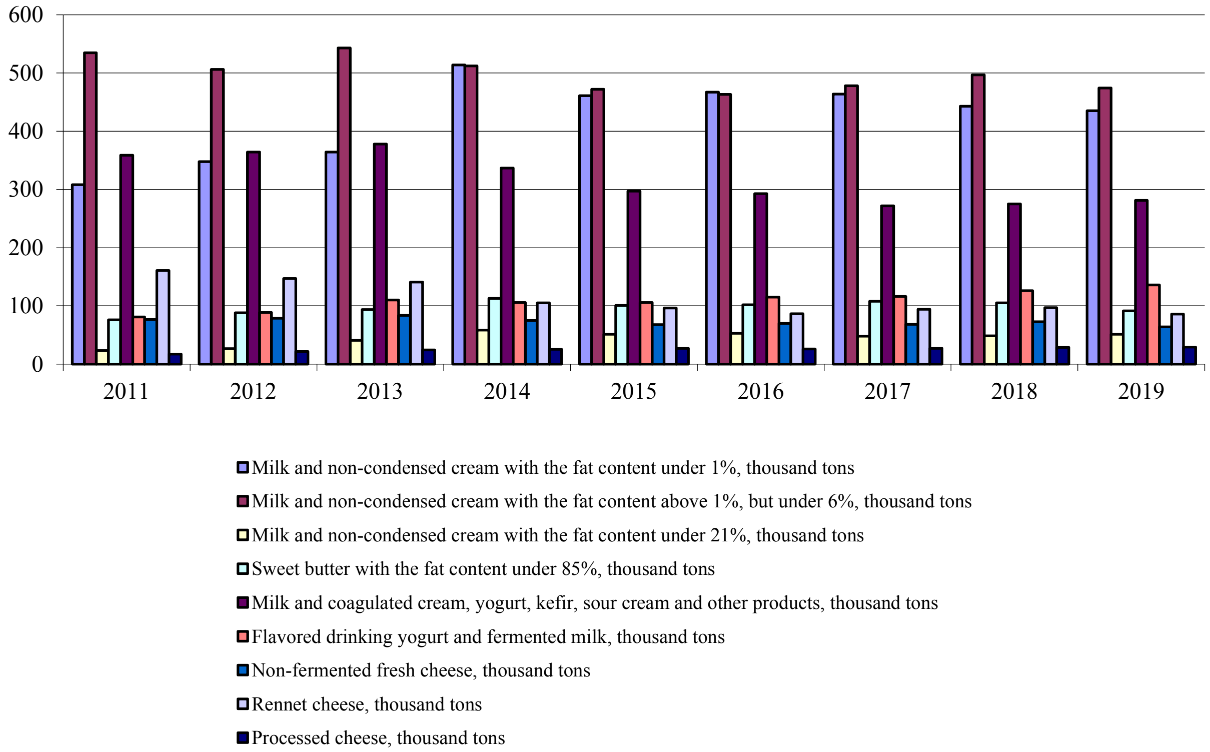

Fig. 1. Dynamics of production of some kinds of dairy products in Ukraine in 2011-2019.
Source: completed on the basis of [17].

Analysis of the Fig. 2 confirms that the outcome of milk production and most kinds of dairy products in kind in Ukraine (but for processed cheese, liquid yogurts and flavored fermented milk, fermented milk products, milk and cream with the fat content above 21%) demonstrates the tendency to decline.

Dynamics of the amount of consumption of milk and dairy products in the period 2010-2013 per one person in milk equivalent demonstrated the tendency to growth, and in 2014-2020 – the tendency to decline (Fig. 2). It was negative for development of milk-processing enterprises of Ukraine and creation of demand for those products.

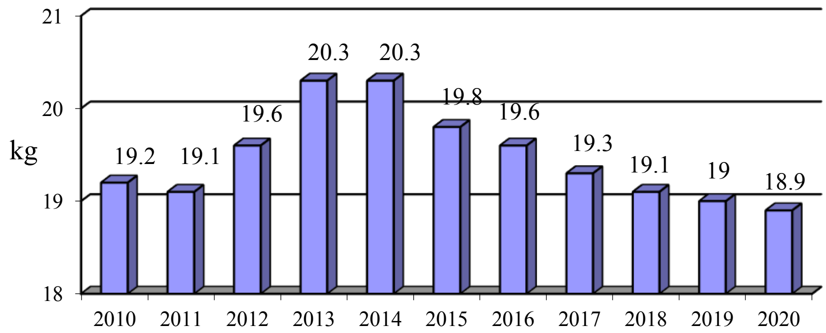

Fig. 2. Consumption of milk and dairy products per one person calculated as the amount of milk consumed monthly
Source: completed on the basis of [16].

To increase the volume of consumption of factory-produced dairy products, to multiply the volume of supplies of domestic products to foreign markets, it is necessary to make active promotion of the products at the market, and to improve the quality of domestic products.

The peculiarity of management of the products quality at milk-processing enterprises is that quality of the products greatly depends on quality of the primary product, i.e. milk.

Recently, Ukraine's government has performed the measures concerning brining of the national standards of milk quality to the European level, because they are expected by the contract of association with the EU. Since January 1, 2019, Ukraine has approved a new standard concerning security of milk quality, i.e. DSTU 3662:2018 "Primary cow milk. Technical conditions" [4] and struck down the previous one.

The negative effect on the quality of primary product for milk-processing enterprises of Ukraine is done by the fact that almost 70-80% of milk is produced at private peasants' farms and thus, the milk is stored in the system of rural points of collection and they are of lower quality.

Lack of the required amount of primary products of good quality for production of dairy products creates preconditions for growth of their import in Ukraine.

Tendencies of export and import of dairy products (totally and Poland)

Conjuncture of the dairy products market in Ukraine is considerably influenced by export-import transactions in the branch (Table 1).

Table 1. Tendencies of export and import of dairy products, tons

Kind of products		Export					Import				
		2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Milk and non-condensed cream	Total	10,489.3	14,061.5	20,815	25,206.4	18,641.6	586.4	836.5	1,326	3,598.1	12,969
	Poland	0.4 (0.004%)	319.7 (2.27%)	1279 (6.14%)	971.3 (3.85%)	0.91 (0.005 %)	49.8 (8.49%)	192 (22.95%)	505 (38.08%)	2736.6 (76.06%)	9648.5 (74.4%)
Fermented dairy products	Total	2,853.8	3,711	5,470	24,145.3	5,694.4	2,587.3	3,611.7	4,857	3,185.5	9,920.6
	Poland	0.05 (0.002%)	1.2 (0.03%)	488 (8.92%)	420 (1.74%)	557.1 (9.78%)	632.8 (24.46%)	1198.6 (33.19%)	2078 (42.78%)	1271.1 (39.9%)	5716.9 (57.6%)
Milk whey	Total	23,871.8	31,937	31,943	6,063.6	26,904	728.7	1,383.3	2,097	6,167	5,062.5
	Poland	0 (0%)	340 (1.06%)	340 (1.06%)	959.9 (15.8%)	260 (0.97%)	83.2 (11.42)	160.1 (11.57%)	820 (39.1%)	2,933 (47.56%)	2,084.8 (41.2%)
Sweet butter and other fats, produced of milk	Total	12,032.4	30,421.9	30,383	18,283.4	11,229.1	1,083	751.4	1,099	3,405.9	10,012.4
	Poland	0.06 (0.0005 %)	3.3 (0.011%)	6.07 (0.02%)	0.042 (0.0002%)	0.024 (0.0002%)	63 (5.82%)	0.1 (0.013%)	2.07 (0.19%)	569.3 (16.71%)	5,234 (52.3%)
Cheese	Total	8,050.8	9,050.7	8,343	7,171.1	6,358.2	7,058.4	10,010.2	13,722	23,723.5	46,767.2
	Poland	0.3 (0.004%)	53.5 (0.59%)	19.2 (0.23%)	0.043 (0.0006%)	0.029 (0.0005%)	2,707.4 (38.36%)	3,952.3 (38.48%)	5,015 (36.55%)	9,822.9 (41.41%)	22,479.5 (48.1%)

Source: [15].

In Ukraine, the volume of import is lower than the amount of export concerning such groups of dairy products as milk and non-condensed cream, whey, sweet butter. However, it is higher concerning fermented products and cheese. Analysis of the Table 1 confirms that in the structure of dairy products import, a considerable share is taken by Poland. Thus, in the future, it is necessary to study consumer preferences in Ukraine concerning some groups of dairy products and their producers by the Internet questionnaire.

Study of consumer preferences concerning some kinds of dairy products of domestic and Polish production.

The questionnaire has been completed by 312 respondents, including 67.3% - women, 32.7% - men. Distribution of the respondents by age and income is presented at the Fig. 3.

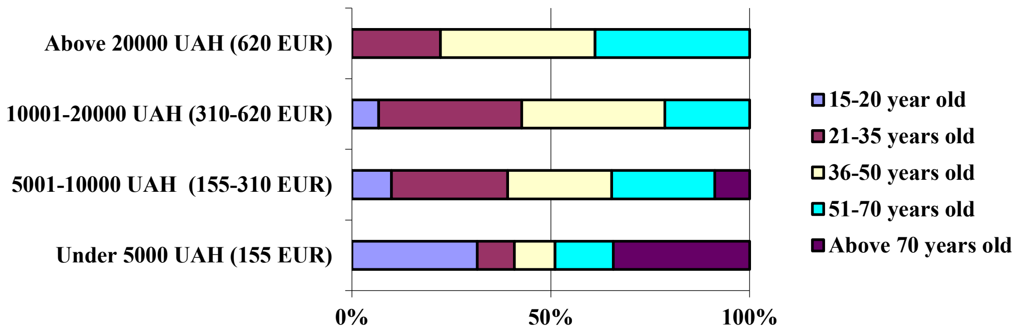

Fig. 3. Distribution of respondents according to the age and income
Source: developed by the authors.

Among Ukrainian consumers, the most popular dairy products include milk (65.1%), cheese (64.7%) and sour cream (61.5%). The least popular products include fermented dairy products (38.1%). Milk of Ukrainian producers is preferred by 80.1% of consumers, while milk of Polish producers – by 10.9%. Fermented dairy products of Ukrainian producers are preferred by 84% of consumers, while fermented dairy products of Polish producers – by 10.3%. Cheese of Ukrainian producers is preferred by 62.8%, and cheese of Polish producers – 22.8%.

To study whether there is any difference between the demographic characteristics of respondents, who prefer Polish and Ukrainian producers of dairy products and to check the first hypothesis, the authors of the work have calculated the criterion χ^2 (Table 2).

Table 2. Testing of the hypotheses concerning dependences of consumption of dairy products of Ukrainian and Polish producers on demographic and social-economic characteristics of consumers

Kinds of relations	χ^2	χ^2_{cr}	Result
Relation between the sex of respondents and choice of milk of Polish and Ukrainian producers	0.021	3.8	Relation is not confirmed
Relation between the age of respondents and choice of milk of Polish and Ukrainian producers	7.26	7.8	Relation is not confirmed
Relation between the income of respondents and choice of milk of Polish and Ukrainian producers	5.95	6.0	Relation is not confirmed
Relation between the sex of respondents and choice of fermented dairy products of Polish and Ukrainian producers	0.24	3.8	Relation is not confirmed
Relation between the age of respondents and choice of fermented products of Polish and Ukrainian producers	6.82	7.8	Relation is not confirmed
Relation between the income of respondents and choice of fermented dairy products of Polish and Ukrainian producers	1.33	6.0	Relation is not confirmed
Relation between the sex of respondents and choice of cheese of Polish and Ukrainian producers	0.22	3.8	Relation is not confirmed
Relation between the age of respondents and choice of cheese of Polish and Ukrainian producers	4.07	7.8	Relation is not confirmed
Relation between the income of respondents and choice of cheese of Polish and Ukrainian producers	4.13	6.0	Relation is not confirmed

Source: developed by the authors.

Thus, the hypothesis about a dependence of consumption of dairy products of Ukrainian and Polish producers on demographic and social-economic characteristics of consumers is not confirmed.

Table 3 supplies results of the research concerning the most important factors, influencing the choice of dairy products.

Table 3. Results of investigations concerning the most important factors influencing the choice of dairy product, %

Factors	Kind of products		
	Milk	Fermented dairy products	Cheese
Price	54.8	59.3	63.5
Content of the product	36.5	42.9	50.3
Standard compliance	28.8	31.1	33.7
Fat content	46.2	42.9	20.2
Energy content	13.1	15.4	9.9
Availability in retail networks	25.6	23.1	25.3
Brand awareness	31.4	28.2	26
Design of packaging	6.4	5.4	
Capacity of packaging	12.8	10.9	
Material of packaging	11.9	9.6	
Shelf life	42	35.9	34.9
Advertisement and sale promotion	7.7	8.3	7.7
Convenience of packaging while consuming the product		10.6	
Packing of the product			20.8
Period of the product maturing			12.5

Source: developed by the authors.

The most important factors, influencing the choice of milk, include its price (54.8%), fat content (46.2%) and shelf life (42%). The least attention is paid by consumers to the design of packaging (6.4%), advertisement and sale promotion (7.7%).

The most important factors, influencing the choice of fermented dairy products, include their price (59.3%), content of the product and fat content (42.9% for each). The least attention is paid by consumers to the design of packaging (5.4%), advertisement and sale promotion (8.3%).

The most important factors, influencing the choice of cheese, include its price (63.5%) and content of the product (50.3%). The least attention is paid by consumers to advertisement and sale promotions (7.7%), and energy content (9.9%).

Similar to the previous case, to test the hypothesis, which says that significance of the factors of dairy products choice does not correlate with the choice of Ukrainian and Polish producers, the authors of the research have calculated the criterion χ^2 (Table 4).

Table 4. Testing of the hypotheses concerning the relation of significance of the factors of dairy product purchase and choice of Ukrainian and Polish producers

Kinds of relations	χ^2	χ^2_{cr}	Result
Relation between significance of the factors of milk purchase and choice of milk of Polish and Ukrainian producers	9.14	12.6	Relation is not confirmed
Relation between significance of the factors of purchase of fermented dairy products and choice of those products of Polish and Ukrainian producers	22.31	14.1	Relation is confirmed
Relation between significance of the factors of cheese purchase and choice of the cheese of Polish and Ukrainian producers	11.71	12.6	Relation is not confirmed

Source: developed by the authors.

According to the results of testing of the second hypothesis, one can affirm that the relation between significance of the factors of dairy products purchase and the choice of their Polish or Ukrainian producers is observed only for fermented dairy products.

Recently, in the structure of dairy products of Ukraine, the share of Polish cheese has greatly increased (Table 1).

Thus, it is important to point competitive capacity of Ukrainian and Polish cheese at the market of Ukraine.

However, significance of some parameters of quality is determined on the base of collected primary marketing information.

Assessment of competitive capacity of cheese of domestic and Polish producers at the market of Ukraine

At the Ukrainian cheese market, the most popular are the following brands [6], particularly "Zvenyhora" (23.64%); "Klub syru" (23.64%); "Komo" (21.62%); "Shostka" (21.62%); Hlobino (18.18%); "Pyriatyn" (14.55%); Président (10.91%).

Competitive capacity of the cheese of the most popular brands of Ukrainian and Polish producers is examined by the parameters with the significance presented in the Table 5.

The kinds of cheese, particularly "Staryi hollandets", produced by the brand "Komo", "Nuar" of the brand "Klub syru", "Dobrodar" of the brand "Zveny Hora" and "Korolivskyi" of the brand SierpC, are compared in the Table 6.

Table 5. Significance of quality parameters of cheese

Parameters for assessment of competitive capacity	Number of advantages	Sign.
Content of the product	157	0.208
Standard compliance	105	0.139
Fat content	63	0.084
Energy content	31	0.041
Availability in retail networks	79	0.105
Brand awareness	81	0.108
Packing of the product	65	0.086
Period of the product maturing	39	0.052
Shelf life	109	0.145
Performance of communication measures	24	0.032

Source: developed by the authors.

Table 6. Parameters for assessment of competitive capacity

	Significance	"Staryi hollandets" of the brand "Komo", Ukraine	"Nuar" of the brand "Klub syru", Ukraine	"Dobrodar" of the brand "Zveny Hora", Ukraine	"Korolivskyi" of the brand "SierpC", Poland
Content of the product, (score)	0.208	Milk, salt, sodium chloride, annatto colorant, ferments, conserving agents of potassium nitride, natamycin (8)	Milk, salt, sodium chloride, annatto colorant, ferments conserving agent of potassium nitride, natamycin, enzyme preparation (8)	Milk, salt, sodium chloride, ferments, annatto colorant, enzyme preparation (9)	Milk, ferments, chlorine calcium, enzyme rennet, salt, annatto colorant (9).
Standard compliance, (score)	0.139	TS U 15.5-32049199-005-2005 (8)	TS U 15.5-24220539-001-2004 (8)	TS U 15.5-00447818-001-2004 (8)	TS U 15.5-35442481-002-2008 (8)
Fat content, %	0.084	45	45	50	45
Energy content per 100 g of the product, kcal	0.041	334	349	327	359
Availability in retail network, score	0.105	9	9	10	8
Brand awareness, score	0.108	10	10	9	7
Number of variants of the product packing, units.	0.086	3	2	2	2
Period of maturing, (score)	0.052	2 months (8)	1,5 months (7)	Not mentioned (5)	Not mentioned (5)
Maximum shelf life, days	0.145	120	240	120	150
Performance of communication measures, score	0.032	7	8	9	4
Average price for a kilo in a retail network, UAH (EUR)	-	344 (10.63)	305 (9.42)	339 (10.47)	299 (9.24)

Source: developed by the authors.

The authors of the work have made assessment of the competitive capacity of cheese "Korolivskyi" of the brand SierpC of Polish production comparing to the cheese "Staryi hollandets" of the brand "Komo", "Nuar", produced by "Klub syru" and "Dobrodar" of the brand "Zveny Hora" of Ukrainian producers (Table 7).

Therefore, the conducted analysis demonstrates that "Korolivskyi" cheese, produced by the brand SierpC prevails over the similar product called "Staryi hollandets", produced by the brand "Komo", "Dobrodar" and the brand "Zveny Hora" first due to a lower price, but little concedes to the cheese "Nuar", produced by "Klub syru".

Table 7. Results of assessment of competitive capacity of cheese "Korolivskyi" of the brand SierpC

Indicators	"Staryi hollandets" of the brand "Komo", Ukraine	"Nuar" of the brand "Klub syru", Ukraine	"Dobrodar" of the brand "Zveny Hora", Ukraine
Consumer parameters index	0.959	0.898	0.969
Economic parameters index	0.869	0.980	0.882
Integral indicator of competitive capacity	1.104	0.916	1.097

Source: developed by the authors.

The work presents results of the performed sampling investigation, accompanied by sampling errors. Thus, the obtained results, due to available sampling and general aggregate, can be applied to all consumers of dairy products only with some assumptions. Besides, the article describes direction to improve competitive capacity of Ukrainian and Polish cheese at the market of Ukraine. However, it would be reasonable to study competitive capacity of Ukrainian commodities at the market of Poland.

CONCLUSIONS

The performed analysis of the market of dairy products in Ukraine confirms presence of negative tendencies at the market concerning decline in the production of most kinds of products. At the same time, one observes growth of the volume of import of dairy products of foreign producers in Ukraine.

Such situation requires analyzing of the competitive capacity of dairy products of foreign and Ukrainian producers at the market of Ukraine and determining of the directions of their increase.

The suggested hypothesis about the dependence of consumption of the dairy products of Ukrainian and Polish producers on the demographic and social-economic characteristics of consumers according to the results of the Pearson criterion (χ^2) is not confirmed. However, the hypothesis about the dependence between importance of the factors of dairy products purchase and choice of them by Polish or Ukrainian producers is confirmed only for fermented products.

Thus, choosing milk and cheese, consumers of the products of Ukrainian and Polish producers in Ukraine follow the same factors, and for the choice of fermented dairy products of Ukrainian producers, the most important factors include the price and fat content, and for consumers of the mentioned products of Polish producers, the factors include the price and content. The least important factors for consumers of fermented dairy products of Ukrainian products include design of packaging, and of Polish production – material of packaging.

The made calculations demonstrate that for strengthening of the competitive capacity of cheese of Polish producers it is first necessary to increase their products availability in retail trading and to improve consumers' awareness about those products. It can be achieved by activating of marketing policy of communications of the Polish producer at the market of Ukraine and by extending of his/her sale network using Internet technologies. Improvement of competitive capacity of cheese of Ukrainian producers should be focused on reduction of conserving agents use, transgenic modifiers, activation of the measures of sale stimulation and optimization of the price policy.

Considering great opportunities of dairy products export for Ukrainian producers at the world market, and increase of the global demand for dairy products, it is reasonable to continue the study of competitive capacity of the commodities of Ukrainian producers at the market of other countries and define directions for its improvement.

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FORECAST REGARDING THE EVOLUTION OF THE WINE VITICULTURE SECTOR FROM ROMANIA

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Abstract

Wine growing has always held a very important spot in agricultural economy both nationally and worldwide by being appreciated from many points of view such as: social (nutriment source: grapes, wine, traditional products that come from it) and economic (capitalizing viticulture products, home trade, international trade). This study analyzes the evolution of the viticulture sector and also Romania's spot among the large producers in the world. By analyzing the future perspectives of the viniculture sector on a national level we can note the fact that it has an ascending trend when it comes to surfaces and grape productions, the pedo-climatic conditions and the used technologies being of great importance. In order to develop this sector a series of financial aids and support measures have been provided so that the farmers can benefit.

Key words: *viticulture, production trends, evolution*

INTRODUCTION

Viticulture represents an agricultural activity that is usually more profitable on the surface than annual crops. The red and white grape varieties are cultivated for fresh consumption or for wine, juice and raisins production. The productiveness and quality of the grapes are determined by the fertility of the soil and the nutritional state of the plants. Grapes are placed among the main eaten fruits worldwide with a production of approximately 75 mil. tons every year, from which 50% are used to produce wine [4, 5, 6, 7].
Romania is placed among the main viniculture countries in the world. It ranks 11th worldwide and 5th in the EU when it comes to vineyards surface. In the Romanian agriculture the grapevine and wine sector represents an important share by contributing to the country's economy. The factors that contribute to the development of viticulture are the favorable conditions that the grapevine finds in the country's territory as well as the climate and soil [8, 2, 5].
Grapevine plantations are grouped territorially by viticulture regions, viticulture areas, viticulture centers, vineyards and viticulture lands according to The Vine and Wine Law no. 2004/2002.
Romania's viticulture regions are: Muntenia's Hills, Banat's Hills, Oltenia's Hills, Moldova's Hills, The Transylvanian Plateau, Crișana's and Maramureș's Hills, Dobrogea's Terraces [3, 10, 13].
By being a sector of interest, many studies have been made in this domain. The researchers and the breeders are motivated to reproduce new varieties that are used in viticulture so that they can stand the disasters that the viticulture is facing: epidemics, global warming but also the changes in consumer demands [10, 13].
Bărbulescu O. (2017), emphasized the fact that promoting the national viticulture sector on the foreign market it's essential to its development, especially by using autochthon grapevine varieties [1]. It can be taken advantage of this fact through the tourism potential of the specific areas, Romania having a series of viticulture wineries with diversified ranges of wine [11, 12]. The aim of the paper consists in a detailed analysis of the evolution of grape areas and productions

at national level but also an estimate of them until 2027, in order to more efficiently manage financial, material, human resources, etc. as well as the substantiation of the decisions at the level of the Ministry of Agriculture and Rural Development regarding the policy of supporting the products of national interest [9].

MATERIALS AND METHODS

The study followed the analysis of the evolution of the viticulture sector on both national and global level, highlighting the spot occupied by Romania within this sector.

The data used within the study that have been provided by National Institute of Statistics (NIS), International Organization of Vine and Wine (OIV) and information taken from professional documents and reports.

The statistic data in the study have been processed with the following statistical indicators: minimum, maximum, average, standard deviation, coefficient of variation and annual rate, for 2007-2019.

With the indicators help one can see the evolution in time of the grapevine sector, by analyzing surfaces, total and average production per hectare. For a future perspective of the viticulture sector on a national level the *Forecast* function has been used, so that we can estimate the value of surfaces and grape productions on an 8 years period, by observing the tendency of this sector.

RESULTS AND DISCUSSIONS

At global level

The viticultural surface at global and European level between 2014-2018, according to OIV data, the viticultural surface on a global level has decreased by 1.42% in 2018, compared to 2014 (7.56 mil ha). Regarding the viticulture surface at European level, it remained constant, varying around the average of 3.23 mil. ha.

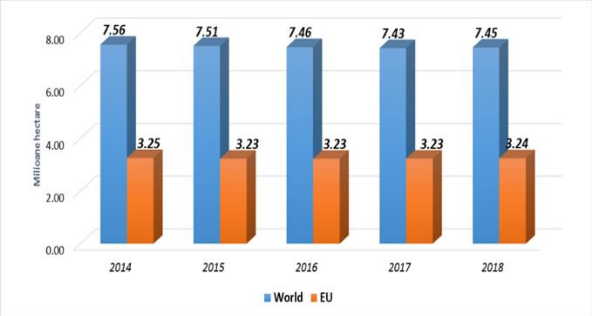

Fig. 1. Evolution of viticultural surface on EU and global level
Source: OIV processed information [12].

The global surface in 2018 for grapevine corresponding to total surface planted with grapevine, including the one that is not yet in production and for all purposes (wine, table and dried) has been of 7.4 million hectares.

Following the distribution of the viticulture surfaces worldwide (Fig. 2) one can see that Europe has approximately 43.5% (3.2 mil. ha) of total viticulture surface, being followed by the large producers such as China, Turkey, USA and Argentina with percentages of 11.75% (875 thousand ha), 6% (448 thousand ha), 5.9% (439 thousand ha) and respectively 2.93% (218 thousand ha).

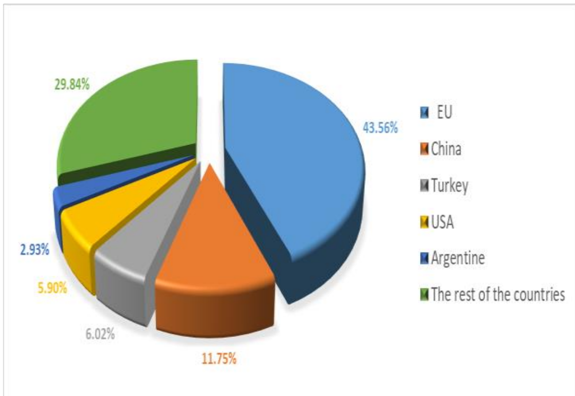

Fig. 2. Global distribution of viticulture surfaces, 2018
Source: OIV processed information [12].

In Europe the most recent available data shows a stabilization of the viticulture surfaces in Spain (969 thousand ha), France (789 thousand ha), Romania (191 thousand ha), Greece (106 thousand ha), Germany (103 thousand ha) and Switzerland (15 thousand ha). It’s estimated that the viticulture surface in Italy has grown with approximately 5 thousand ha between 2017 and 2018 in order to reach 705 thousand ha.

The global total grape production in 2018 has been of 77.8 mil. tons, with 4.7% more then 2014 (74.3 mil. tons). Following its distribution by ranges there have been registered percentages out of total of: 57% wine grape (44.34 mil. tons), 36% table grape (28 mil. tons) and dried grape 7% (5.44 mil. tons) (Fig. 3).

Table 1. Statistical indicators on the evolution of areas

	2007	2019	Min	Max	Average	St Dev	CV (%)	Annual Rate (%)
	Thousand Ha							
Bearing vines	187.6	178.23	176.62	187,629	179.43	3.53	1.97	-0,43
Table grape	11.20	6.28	6.284	11.20	8.13	1.56	19.16	-4,70
Wine grape	176.4	171.95	167.42	176,427	171.50	2.88	1.68	-0.21

Source: data processed from the NIS [9].

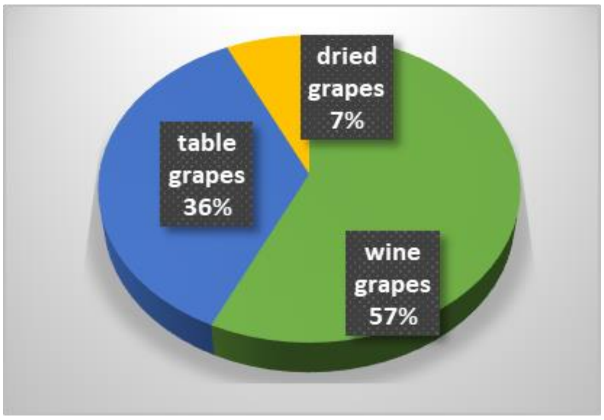

Fig. 3. Global distribution of grape production by ranges, 2018.
Source: Data processed from OIV [12].

Among the largest grape producers worldwide are China with 11.7 mil. tons, Italy with 8.6 mil. tons, USA with 6.9 mil. tons, Spain (6.9 mil. tons) and France with 6.2 mil. tons. Romania had in 2018 a grape production of 1.3 mil. tons, 1.67% of total global grape production.

Analyzing by grape varieties production one can note that:

-the highest percentages of wine grape have been registered in: France (99.6%), Germany (99.6%), Spain (96%) and Australia (90.9%), at the opposite being Egypt (0.50%), India (1.50%), Turkey (3.2%) and China 10.3%.

-main table grape producers: China (84.1%), Egypt (99.5%), India (92.6%), placing last are countries like France, Germany, Argentina and Spain.

-among the countries producing dried grape (grape raisings) can be found Turkey (40.7%), Iran (23.7%) and USA (18.1%).

At national level

The bearing vines surface at national level has been of 178.23 thousand hectares in 2019, being lower by 5% compared to 2007 (187.62 thousand hectares), throughout the whole period of study the bearing vines surface has registered a decreasing trend with a negative annual rate of 0.43% and a coefficient of variation of 1.97% for 2007-2019 span (Table 1).

Out of bearing vines surface total, table grape have 3.5% (6.28 thousand ha), while the rest of the percentage of 96.5% is held by wine grape, Romania being a country that produces wine of diverse variety acknowledged at an European level.

Analyzing the evolution of the grapevine surface cultivated for table grape on a national level between 2007-2019 it had followed a decreasing trend, decreasing from 11.2 thousand hectares in 2007 to almost a half until 2019, to 6.28 thousand hectares. The average annual rate registered in this period being a negative one of 4.7%, with a coefficient of variation of 19,16 %. The table grape surfaces followed the same trend, registering a decrease during the analyzed period, the average annual rate being negative, of 0.21%.

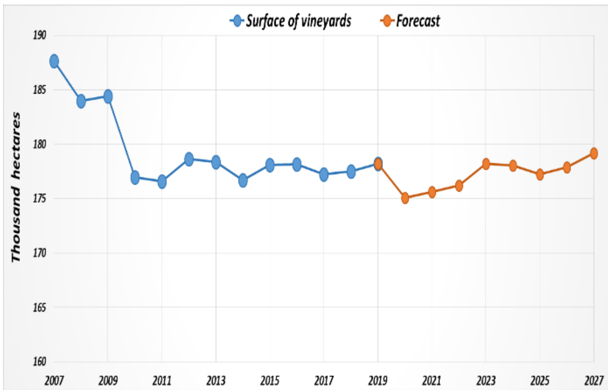

Fig. 4. Forecast of the surface of vineyards, Romania
Source: authors' calculations.

According to forecasts it's expected, up to year 2027, the bearing vines surface to surpass 177.8 thousand hectares, if this trend that had been analyzed between 2007-2019 remains the same (Fig. 4).

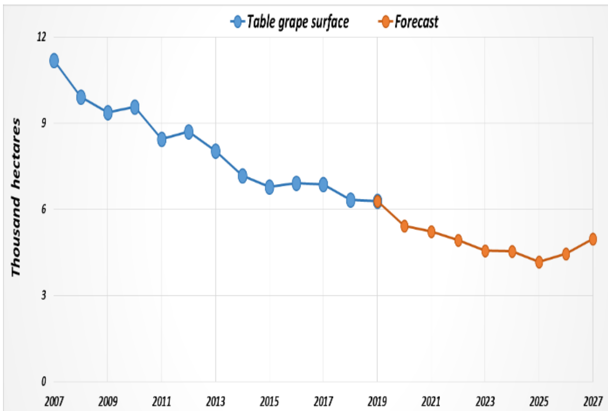

Fig. 5. Forecast of the table grape surface, Romania
Source: authors' calculations.

As for the table grape surfaces, as a result of the conducted forecasts, in the following period 2020-2027, they will decrease up to 4.49 thousand hectares (Fig. 5).

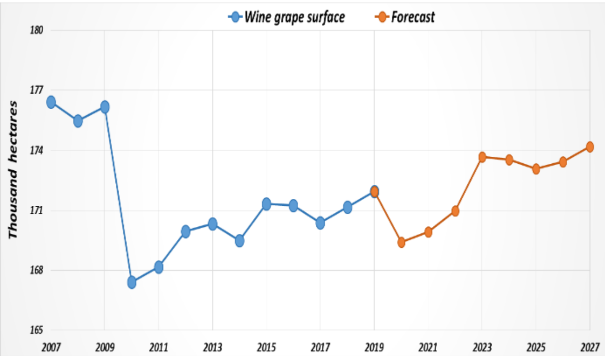

Fig. 6. Forecast of the wine grape surface, Romania
Source: authors' calculations.

According to forecasts the trend for the grapevine surfaces is an oscillating one, coming to 174.20 thousand hectares in 2027 (Fig. 6).

Regarding the total production of grape, it has varied between 873.22 thousand tons (in 2007) and 977.81 thousand tons. Analyzing the percentage of the grape types we can observe that during the analyzed period the largest percentage of production total was held by the wine grape, varying between 90.68% and 95.53%. The percentage of table grape production out of production total has varied between 4.59% and 9.32%.

Analyzing the bearing vines production between 2007-2019, it's noted that the country overall production registers an oscillating trend with a maximum in 2018 of 1,144.3 thousand tons.

The registered average annual rate has been positive, of 0.95%, with a coefficient of variation of 14.95% (Table 2).

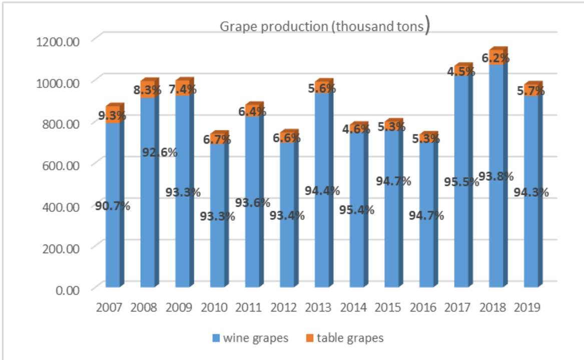

Fig. 7. The evolution of grape production, Romania
Source: NIS calculations [9].

Table 2. Statistical indicators on the evolution of production in Romania (thousand tons)

	2007	2019	Min	Max	Media	St Dev	CV (%)	Annual Rate (%)
	Thousand Tons							
Bearing vines	873.22	977.81	736.90	1,144.30	901.205	134.86	14.96	0.95
Wine grape	791.88	922.09	690.46	1,072.90	845.59	127.54	15.08	1.28
Table grape	81.35	55.72	35.96	81.79	56.80	15.52	27.33	-3.10

Source: authors' calculations.

The table grape production in 2019 has been lower by 31.87% than 2007 (81.34 thousand tons). The registered average annual rate is a negative one of 3.1%, with a coefficient of variation of 27.33% (Fig. 7).

At national level, the wine grape production has followed an ascending trend from 791.9 thousand tons in 2007, to 922.02 thousand tons in 2019.

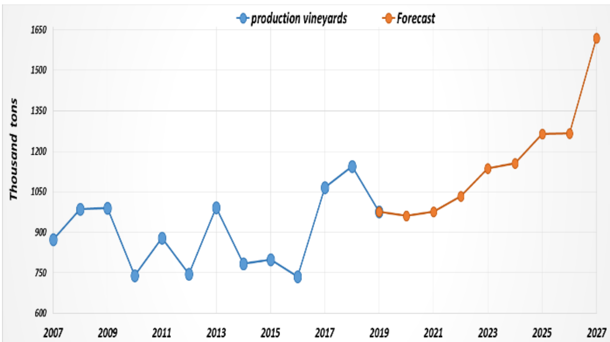

Fig. 8. Forecast of vineyards production, Romania
Source: authors calculations.

The average annual rate registered during the analyzed period has been of 1.28%, with a coefficient of variation of 15.08% compared to the period average of 845.6 thousand tons.
By forecasting the total grape production, we can observe in Fig. 8 the fact that it shows an ascending trend, also confirmed by the growth rate during 2007-2019, reaching a maximum value in 2027 of 1,620 thousand tons of grapes.

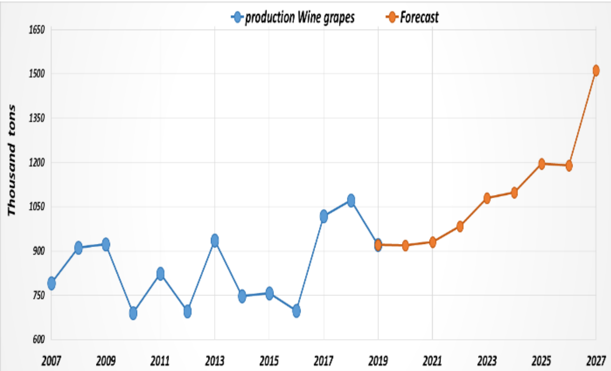

Fig. 9. Forecast of wine grape production, Romania
Source: authors' calculations.

According to forecasts (Fig. 9), the wine grape production shows an ascending trend between 2020-2027, reaching a maximum in the final year with 1,512 thousand tons, this being also due to the average annual rate registered in the period prior to the forecast.

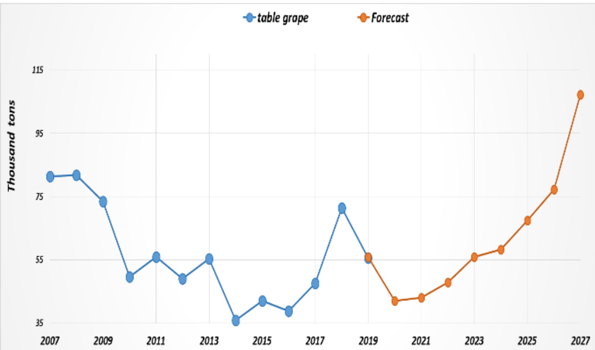

Fig. 10. Forecast of table grape production, Romania
Source: authors' calculations.

Regarding the table grape production, it is estimated to reach a value of 107,3 thousand tons in 2027, if the there is going to be an increase of the surfaces and the climate conditions will be favorable.
In Table 3 we can see the main statistical indicators calculated for average grape production at national level.

Table 3. Statistical indicators on the average production in Romania (tones/ha)

	2007	2019	Min	Max	Average	St dev	CV (%)	Annual Rate (%)
	Tons/ha							
Bearing Vines	4.7	5.5	4.14	6.45	5.02	0.75	14.92	1.38
Table grape	7.3	8.9	5.01	11.27	7.04	1.73	24.55	1.68
Wine grape	4.5	5.4	4.08	6.27	4.93	0.73	14.78	1.49

Source: authors' calculations.

The average grape production per hectare for bearing vines has registered values between 4.14 tons/ ha and 6.45 tons/ha, following an oscillating trend, the average annual rate being of 1.38% during 2007-2019.
Regarding the table grape, one can note they register the largest average production, of over 8.9 tons/ hectare compared to the average production of wine grape (5.4 tons/ha). They show positive average annual rates of 4.68%, respectively 1.49 %. Regarding the evolution in time the average grape production at national level regardless of range has shown fluctuations, these due to climate influence, to the used technology, but also to surface restructuring.

CONCLUSIONS

Grapevine cultivation enjoys a special attention in all the countries that show pedo-climatic conditions that correspond to the requirements of growing grapevine.
As a result of the conducted study it has been observed the fact that at global level the largest grapevine surfaces are owned by Spain, France, China and Turkey.
As for the grape producers, among the largest producers there are: China, Italy, USA, Spain and France. Although the grapevine surfaces are larger, in some countries the total production can vary due to the efficiency per hectare, due to the used variety and technology. Romania ranks 8th at worldwide level regarding grapevine surface and 6th regarding grape production at European level.
At national level we can notice a variation of grapevine surfaces and of grape productions, due to different factors. The forecasts made based on statistical data showed an increase trend on the long term of surfaces and productions so that we can say the fact that

the viticulture sector is one for the future. In order for Romania to keep its place among the large producers of grape/wines, consistent investments are necessary in the viticulture sector.

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ASSESSMENT OF POTATO GROWING POTENTIAL IN UKRAINE DUE TO ZONAL SPECIALIZATION AND RAW MATERIAL SOURCES

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Abstract

The paper studied the assessment of potato growing potential on organizational and economic bases in Ukraine. The materials presented according to specificity of production rates and conditions from 1940 to 2018. On the basis of the gross potato production indicator in Ukraine for 78 years (from 1940 till the current state), indicators and tendencies of potato growing development are determined. From the standpoint of potential vectors of zonal specialization (ZSP) and standardized raw materials sources (RMS) such realization was investigated. The survey has found, that the main principles of end-to-end coordination in potato growing industry of Ukraine depend on agricultural enterprises and farms input in the short and medium term and on households in the long term perspectives. The data showed that the technologies involved in potato growing still need systemic improvement and development towards convergent ones with the level of realization of the genetic potential of productivity for more than 70%.

Key words: *potato growing, production, productivity, assessment, sources.*

INTRODUCTION

Potato production and marketing in Ukraine are unique because, despite annual yields and consumption rates, the market prices of potatoes fluctuate significantly during the season and from year to year.
Cropping seasons and harvesting times may differ by several months between the south and north regions of Ukraine. Fresh table potatoes can easily outprice storage table potatoes as twice on the market. Such tendencies also exist in many European countries involved in the potato growing industry [11]. That is why the system of innovative transformations of the agro-industrial complex of Ukraine, as the potato growing industry is in need to be improved and highlighted with a perspective of further development. In current market conditions, the effective functioning of potato growing potential acts as a component of crop production and raw material basis for food, feed, and processing industries [4, 16]. Within the implementation framework of the innovative development model for the agricultural sector, the importance of the analytical, forecast, and logistic vectors is significantly increasing [17].
As of 2017, apart from Ukraine, only four countries produced more than 20 million tons of potatoes annually, namely Russia, America, China, and India. However, among the productive countries of this agricultural crop, only a few other countries are determined with exports of more than 1.5 million tons per year, such as France, Germany, and the Netherlands [9].
Among the main negative factors that hinder the development of the product market - small

volumes of production in private farms, diversity of varietal composition, and different quality indicators of products grown. Simultaneously, with the industry's technological backwardness and the lack of modern facilities for collecting, storage, transportation, and processing manufactured products.

On the other side, the positive dynamics are characterized by an increase in the area under organic potato production. Already in 2015, the area under organic production of this crop was 1,200 hectares, maintaining the trend of further growth. Thus, in terms of the number of areas under organic potato production, Ukraine is in the world's top ten countries.

Inspite, of need to develop environmentally sound fertilizer systems for crops, with a accent on the quality of products, environmental protection, with maximum use of natural factors. Integrated application of organic fertilizers (both traditional and manufactured) is also in process in such fertilizer systems of new technologies) and microbiological preparations [13].

Among the other positive signs of growth in the potato production market in Ukraine is the increase in the number of potato varieties from 37 to 150 (more than 4 times from 1991 to 2018), while the share of domestic varieties has increased from 22 to 72 [20].

Given the fact that potato is actively integrated into the system of nutrition, feed production, and processing, it becomes clear its potential compliance with the levels of development of raw material sources (RMS) [7].

At the same time, the presence of sufficiently formed potato growing zones and processing facilities is the basis for a dynamic growth of deep processing products. Also, retrospective monitoring and economic indicators of potato growing indicate the need for systematic work with zonal specialization, local technologies, and logistics system on the one hand and methodological and analytical support of the potato industry on the other [2].

Yet, there is a strong need for appropriate monitoring of the nature of such growing production and areas of use to justify and identify effective management decisions.

In the system of innovative development model for Ukrainian agribusiness, the dynamics of processes of transition from production at the expense of resource of sown areas and outdated technologies to zonal specialization and a role of crops as objects of transfer at the level of standardized raw materials noticeably increases in time [8].

The potato growing industry can reasonably be considered as a representative model object for the study of market transformations in crop production in Ukraine. It is the levels of diversification and integration that determine the need to assess potatoes as a standardized raw material resource (RMS) [15, 7].

Advanced science and high technology are an integral part of a competitive economy in modern conditions. The deformed structure of lands is characteristic of modern crop production in Ukraine [6].

The plowing rate of agricultural land is 0.778, and the use of arable land 0.852 [12]. During 2007-2016, there was an increase in the area of sunflower by 68.5% and a decrease in the area of potatoes by 9.7% (with an increase in production by 7%) [19].

Characteristic features of the development of domestic crop production are the use of high-cost energy-intensive technologies, technically and technologically obsolete equipment, inefficient forms of management [17, 18].

The development of the agricultural sector of the Ukrainian economy at a competitive level is possible only on the basis of an effective combination of all elements of innovation [3, 7, 14]. Legislatively, such relations are regulated by the Laws of Ukraine "On Innovation" and "On state regulation of activities in the field of technology transfer".

Potatoes as a raw material per unit area provide 1.5-2 times more carbohydrates than grains and are a crop that actively accumulates energy. In this regard, there is an insufficient in some aspects theoretical and practical justification of organizational and economical ways to increase the economic efficiency of potato production, taking into account the regional characteristics of the industry [21].

RESULTS AND DISCUSSIONS

Simultaneusly, if an increase in gross production characterized the 74-year period of 1945-1978 as a whole, the period of 1980-2011 was characterized by reduced production relative to the average long-term.

From 2012, gross potato production began to grow and show the dynamics typical of the period 1945-1978. This can be explained by different types of economies and positions of potatoes in the consumer and raw material segments before and after Ukraine gained independence in 1991.

Also, if in the first case, the factors of sown areas and state regulation mainly worked, in the second case, organizational, market, and technological factors began to intensify. And it is in the second option that the directions of diversification and in-depth processing of potatoes intensified, especially in the areas of obtaining native and modified starches and greater approximation of the quality of raw materials to the requirements of processing technologies.

In turn, the above is of practical importance for the optimization of logistics systems of zonal specialization by type of raw material processing zones on the one hand and the effective use of zonal agro-climatic conditions as specific factors in implementing a set of existing competitive advantages, on the other.

At the same time, from the standpoint of sustainable production, there is a systematic need for integrated technological solutions. Which, in turn, increases the relevance of methodological support of the transfer process. The significant changes that have taken place in the consumer sphere for potatoes, the destruction of economic ties, political processes, and global climate and political and economic transformations necessitate a systematic approach when considering potato culture as an object of transfer in barter tradings. Notably, as an onject of transfer in several positions at the USSR level, potatoes lose to cereals. Therefore, to ensure the functioning of potato growing at a practical level, the formation vectors of specialized agro-processing clusters and technologies on a modular basis may have increased relevance.

Examples include the "Comprehensive program of innovative development of the crop industry of Kharkiv region in the period up to 2025" and the formation of a system of agricultural holdings focused on foreign markets. All this should be taken into account and practically used to form and provide appropriate innovation-oriented educational and research programs.

Simultaneously, such an approach quite reasonably allows in the medium term to approach the transformation of higher education institutions (HEIs) into consulting and information-analytical centers for the transfer of integrated technological solutions close to convergent.

The distribution of years with gross potato production above and below the long-term average for 74 accounting years was 56.7: 43.3, or in the formalized model form 60:40 (3: 2). That is, there is reason to talk about the rather variable nature of agro-climatic conditions on the one hand and the insufficient level of zonal specialization and efficiency of the technologies involved on the other.

According to the average indicators of gross potato production for 74 accounting years (1940-2018), the deviations in the gradations of maximum (max) and minimum production to the average level were 16.2 and 21.0%, respectively, or in the formalized model form is close to 40: 60% (2: 3).

This can also be seen as a manifestation of the rather variable nature of agro-climatic conditions on the one hand and the insufficient level of zonal specialization and efficiency of the technologies involved on the other.

A more detailed block analysis of the nature of potato production for 74 years of monitoring (1945-2018) identifies 6 complete 10 annual blocks and 2 incomplete (5 annual - 1940-1949 and 9 annual - 2010-2018) (Table 1). (calculated on the basis of the State Statistics Committee of Ukraine [18])

Table 1. Potato production rates for 74 years of monitoring (1945-2018)

№	Periods	Number of years	Levels of gross production, mln.t						Number of years for the period with production	
			($\bar{x}$)		The scope of variability					
					max		min		above the average	below the average
			Average for group ($\bar{x}$ $\pm s_x$) mln.t	Variation coefficient ($V \pm s_v$) %	mln.t	+% to $\bar{x}$	mln.t	-% to $\bar{x}$		
1	1940-1949	5	18.80±1.66	19.73±6.48	22.26	18.40	13.77	26.80	3	2
2	1950-1959	10	18.67±0.98	16.57±3.81	23.13	23.90	14.68	21.40	4	6
3	1960-1969	10	19.35±0.62	10.09±2.28	22.49	16.20	16.45	15.00	5	5
4	1970-1979	10	21.44±0.78	11.43±2.59	23.92	11.60	16.47	23.20	6	4
5	1980-1989	10	18.63±0.92	15.59±3.57	21.41	14.90	13.13	29.60	8	2
6	1990-1999	10	16.66±0.82	15.58±3.57	21.01	26.10	12.72	23.70	5	5
7	2000-2009	10	19.03±0.39	6.49±1.46	20.76	9.10	16.62	12.70	7	3
8	2010-2018	9	22.16±0.55	7.46±1.77	24.25	9.43	18.71	15.60	6	3
	Total	74	-		-		-		44	30
	Average		19.34	-	22.40	16.20	15.32	21.00	59.46%	40.54%

Source: authors calculations.

Also, it should be noted that deviations from the average level of potato production were higher in the minimum output gradation (min - 21.0%) against the maximumoutput gradation.
(max -16.2%). What can be considered as increased actualization of the stable nature of potato production at a reasonable level due to both regulatory market and technological factors in optimal zones selection and the transition to the level of standardized raw materials (SSR).
It is significant that this approach coincides with the main directions of innovative transformations in the crop sector and highlights the increased role of end-to-end coordination.
A more detailed analysis showed that in general, the nature of the maximum (max) and minimum levels of gross potato production in Ukraine relative to the average during 74 years of monitoring was typical and reflected the trends inherent in the potato industry of Ukraine. Starting from the period 2000-2009, the average and maximum levels were closer than in other periods, which determines the relevance and strategic nature of the system analysis at the factor level (Fig. 1).

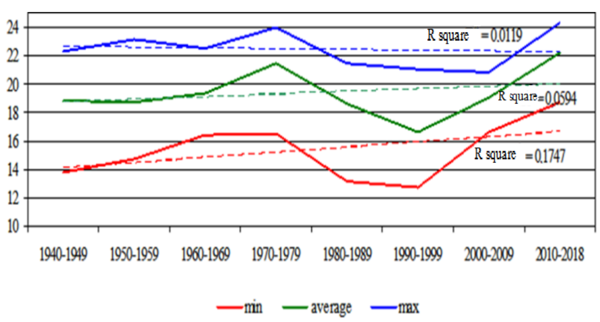

Fig. 1. Dynamics of gross potato production in Ukraine at the maximum (max), minimum (min) and average levels, 1945-2018, million tons (to Table 1).
Source: authors calculations.

During the monitoring period, the gross production of potatoes at the minimum and average levels showed an upward trend, and at the maximum (max) - a decrease, but the accuracy of the approximation (R square = 0.0119, 0.0594, 0.1747) on the short term was too low. On the one hand, the beginning of the launch of improving the efficiency of the technologies involved and spontaneous market-driven optimization of production areas and increasing the realization of genetic productivity potential (RGPP) in the medium term on the other.

The block analysis of the dynamics of gross potato production by the coefficient of variation

(V% - point method) for the monitoring period of 1940-2018 looks quite indicative in this respect (Fig. 2).

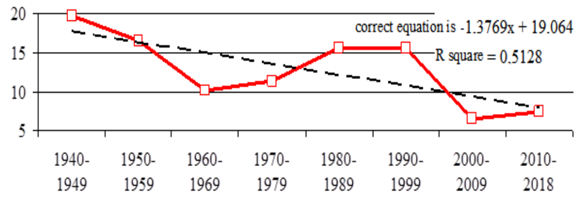

Fig. 2. Block analysis of the dynamics of gross potato production by the coefficient of variation (V%), 1940-2018 (to Table 1).
Source: authors calculations.

The coefficient of variation of the gross potato production in Ukraine during the monitoring period showed sufficient stability (variability V = 6.49-19.73%), which can be explained by the predominant localization of production in the household sector and rapid response to consumer demands. According to the trend of decreasing coefficient of variation of gross production (V%) and accuracy of approximation (R^2 = 0.5128) in the near future, the question of activation of vectors of zonal specialization, standardized raw materials, and integrated technological solutions can be considered justified. Simultaneously, the gross production of potatoes in the short term in the medium term should be progressively ensured by the yield factor.

Notably that in market conditions from the standpoint of processing problematic issues remain the optimal ratio between the table and technical (highly starchy > 19%) varieties on the one hand and quite problematic logistics of a reliable raw material base (SSR type) on the other. Significant prospects in this regard can be traced in the formation of specialized agro-processing clusters and land reform in the declared system of innovative development of the agricultural sector of Ukraine.

For a clearer understanding of the motivation at development trend of potato growing in Ukraine, an analysis of the main positions of the balance of potatoes for 2014-2018 was conducted (Table 2) State Statistics Committee of Ukraine [18]).

Table 2. Rates of the main positions of the balance of potatoes for 2014-2018

№	2014		2015		2016		2017		2018		Average	
	mln.t	%	mln.t	%	mln.t	%	mln.t	%	mln.t	%	mln.t	%
1	23.69	100	20.84	100	21.75	100	22.21	100	22.50	100	22.20	100
2	0.040	0.17	0.017	0.08	0.027	0.12	0.024	0.1	0.028	0.12	0.027	0.12
3	0.017	0.07	0.015	0.07	0.005	0.02	0.018	0.08	0.022	0.09	0.015	0.07
4	5.60	23.6	5.42	25.9	5.49	25.2	5.57	25.0	5.57	24.8	5.53	24.9
5	6.97	29.4	6.54	31.4	6.77	31.1	6.82	30.7	6.91	30.7	6.80	30.6
6	3.82	16.1	3. 80	18.2	3.17	14.6	3.36	15.1	3. 80	16.9	3.59	16.2

Source: State Statistics Committee of Ukraine and author's calculations.

From the standpoint of segmentation and to establish the dynamics and trends, the assessment was conducted in relative terms to the level of production (Fig. 3 and 4).

According to statistics, Ukraine has produced 523 kg of potatoes per capita in recent years, with an average consumption of 140.2 kg. That is, the share of consumption reaches 26.8%. On average, the leading segments in the balance of potatoes are: the use for feed purposes - 30.6% of the level of production; for planting - 24.9% and for processing - 16.2%.

It is also necessary to allocate a much larger share of imports (0.12%) compared to exports (0.07%), which indicates the increased relevance of selection and seed production patterns, young and exotic potatoes, and products of in-depth processing. Given the traditions and system of domestic consumption of potatoes in Ukraine and, in particular, the potential to enter foreign markets (system of external consumption), the domestic potato industry should quickly develop strategic areas of methodological support for innovative development; selection of genetic and technological directions based on end-to-end coordination, standardized raw material resources (SSR) and transfer of integrated technologies close to convergent ones. In the field of agricultural production, the priority is zonal specialization, state regulation, integration and diversification into other areas.

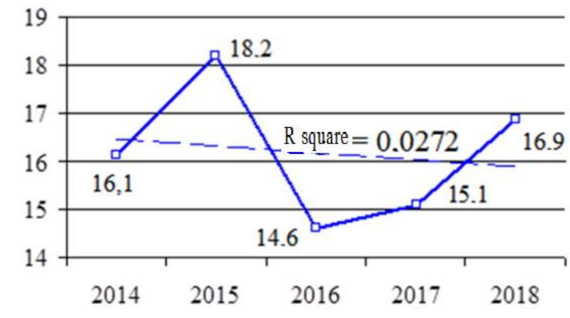

Fig. 3. The ratio between the share of potatoes for processing and production capacity, %
Source: authors calculations.

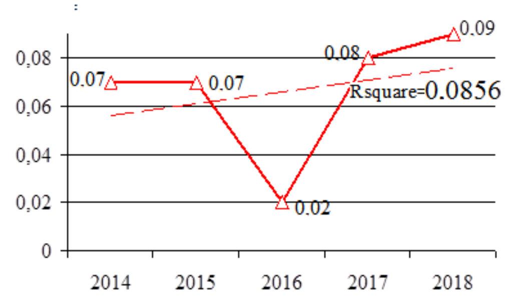

Fig. 4. The ratio between the share of potatoes for export and production capacity, %
Source: authors calculations.

Marker positions include: yield to the level of break-even potatoes (yield ≥3.0 t/ha); increasing the segment of in-depth processing; formation of specialized agro-processing clusters; formation of a system of analytical-forecasting and consulting centers of transfer.

At the same time, the prospects for concentrating efforts in the areas of increased economic efficiency and intellectualization also look quite expected. The analysis of economic indicators did not took into account the implementation on the level of some farms and agriculture enterprises technological features to combat erosion to increase the yields of vegetable or other crops [5]. These features may also include not only the selection of tillage, but also the integrated use of seeds, organic fertilizers and microbiological preparations in modern agricultural technologies [1, 10]. From this point of view, speaking of potato growing as an industry, all the main emphasis should be concentrated on the principles of end-to-end coordination due to zonal specialisation and available raw resources in regions. This in turn necessitates a change of point of view from ordinary local managerial agriculture administration to corresponding departments in government and state authorities.

CONCLUSIONS

At present, in the potato industry of Ukraine we can talk about the beginning of market-based zonal specialization, which only fragmentarily corresponds to the principles of end-to-end coordination. In the area of standardized raw material resources in the short and medium term, the focus on "agricultural enterprises" and "farms" is more effective, and in the long run on "households". In such conditions, on our opinion, potato production in the categories of "agricultural enterprises" and "farms" can be stabilized and increased only by the yield factors.

That fact systematically identifies state of things as the leading trends of the medium term development of holistic technological solutions. However, the technologies involved in potato growing still need systemic improvement and development towards convergent ones with the level of realization of the genetic potential of productivity ≥ 70%.

In the present situation, systemic development of potato growing as an industry very much in need of a methodological and analytical-forecast support in the system of end-to-end coordination between zonal production specialisation and available raw resources characterized by a limited number of producers types (farms, households, enterprizes) and their cooperation. For better development of potato growing in Ukraine, such situation needs to be corrected in nearest future.

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LIVESTOCK PRODUCTION CONTRIBUTIONS TO RURAL HOUSEHOLDS' LIVELIHOOD AND ITS CONSTRAINTS IN NIGER STATE, NIGERIA

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Abstract

The paper considered the livestock production contributions to rural households' livelihood and its constraints in Niger State, Nigeria. The data used were primary while the interview schedule was used to collect data from the 120 households. The paper engaged a quantifiable analysis using the descriptive and inferential statistics. The analysis revealed that households' socio-economic characteristics such as sex (χ^2 =9.362; $p<0.05$), marital status (χ^2=56.06; $p<0.05$), educational level (χ^2=18.367; $p<0.05$) and the constraints of livestock production (χ^2= 9.362; $p<0.05$) among the households are associated factors to the contributions of livestock production the households. These circumstances led to the age (r = 0.267; $p<0.05$), household size (r =-0.053; $p<0.05$), years of experience in livestock production (r = 0.204; $p<0.05$) and monthly income generated (r =0.080; $p<0.05$) having a significant relationship with the contributions of livestock production to the respondents' households. Based on the findings of this study, it was recommended that households should be encouraged in livestock production through provision of credit facilities, veterinary services and extension in order to contribute to the livelihoods of the households.

Key words: *livestock production, contributions, constraints, rural households' livelihood*

INTRODUCTION

Livestock production represents the only way by which the large parts of natural vegetation can be converted into economic products. Livestock products play an important role in export earnings. Livestock sector aids in supplementing smallholding household revenue, lessening down the protein breach, offering draught power, compost for crop farming and in getting overseas give-and-take. Animal husbandry mostly offers supplementary earnings of livelihood to the agrarians. Livestock rearing is a fundamental fragment of food production [17].

Livestock play important role in the economy of Nigeria and it is an important sub-sector of Nigerian Agriculture. Animals make an important contribution to livelihoods in small holder farming systems throughout the developing world. In these systems, there is often a dynamic interface flanked by livestock and crops [16]. These represents a number of other reimbursements to the agri-business households. Livestocks are major sources of investments and increase the values of a number of assets that could not otherwise be consumed by the agribusiness households. For example, the conversion of feed biomass such as the weeds, straw, cultivated forages, common grazing areas, surplus grains and converting it into valued foods like meat, milk and eggs for consumption and sales and /or the provision of services, for instance, the draught power pack. These enables members of the household to add value to their own labour o the farm [14].

Household livelihood on the other hand refers to the household's means of securing the basic necessities, food, water, shelter and clothing of life. Livelihood is a set of activities involving securing water, food, fodder, medicine, shelter, clothing and the capacity to acquire the above necessities working either individually or as a group by using endowments (both human and material) for meeting the requirements of the self and his/ her household on a sustainable basis with dignity [15].

Livestock are very important to man's welfare all over the world. The most important usage of livestock is to provide food and animal products which are used for food by the people in in many parts of the world. The animal products used as food for man are meat and milk which may also be included in feed of livestock [8]. Blood meal, and bone meal serves as sources of protein and minerals respectively. Livestock provides nutritive food to all categories of families both in rural and urban areas. Bullock power continues to be the main source of draught power for agricultural operations and transport of agricultural products to nearby markets and is likely to remain so for a long time to come [1].

Livelihood and production dilemma, malnutrition, high and worsening levels of poverty and stagnated or declining human development are some of the challenges and problems facing Africa [6] and [10]. Nonetheless, sub-Saharan Africa (SSA) countries are most awful affected in that way, parting these nation state as the poorest in the world. Undeniably of the thirty-one low human developed countries, twenty-eight were found in the sub-Saharan Africa [11]. Nigeria, for example is one of such countries characterized by high level of risk orchestrated by climatic change (for example frequent flood, drought, and cyclone), low resource endowment depicted by household operating near the margins of subsistence, and the civil war that ended just over a decade ago. All these compelled households to diversify their livelihood sources, as an attempt to overcome some of these challenges [5].

Some reasons offered for such diversification includes; Strong affinity of survival strategies particularly in drought prone areas, reduction of risk where climatic shocks are experienced, withdrawal from providing necessary infrastructure in support for agriculture by the states, diminishing returns on increasing investments in non-agricultural activities that most households are actively involved in synergies(economics of scope) among distinct activities and missing markets that compel self- provision of goods and/or services desired by the households for own consumption [12] and [5].

In Nigeria, diseases and pests are another constraints or problems facing livestock production. Examples are diarrhea, worm, coccidiosis diseases [2]. The existing diseases in livestock lead to animal death, thereby reducing productivity. It increases cost of production, thus reducing income of the farmer. The problem has implications for low productivity for the existing animal consumption [15]. This situation further widens the animal protein consumption gap. Sheep and goats provide about 20- 35% total protein intake, but still falls short of minimum animal protein requirement. [4] reported that the situation is probably due to ever increasing in population. Efforts being made to improve the level of livestock production have not yielded desired results.

Thus, in many Nigerian communities, chronic vulnerability and poverty are entrenched and exacerbated by the everpresent risk of extreme climatic (drought and floods), economic and policy shocks, food insecurity has been seeming primarily in terms of food crop disposal and ease of access [6] and [17]. The role of livestock, which touches upon the livelihoods of approximately 60 percent of the people in Nigeria, is not fully appreciated [18]. This desertion of the part livestock plays is somewhat due to deficiency of concrete empirical substantiation on the tangible offering livestock creates to livelihoods and the continued existence stratagems that are engaged during times of shocks [13].

In spite of the recognized usefulness of livestock, little attention has so far been paid to the contributions to livelihood of the country [7]. It is very important to obtain empirical data on the contributions of livestock to the livelihood of individuals. This knowledge will form useful information for the development of appropriate assistance by the government and policy makers to improve the level of livestock production and provide necessary facilities associated with the practice in the study area and other parts if the country.

This study was therefore conceived to assess the livestock production contributions to rural households' livelihood and its constraints in Niger State, Nigeria. The specific objectives are to describe the socio-economic characteristics of the respondents, examine the livestock inventory of the households, find out the specific contributions of livestock production to the households, and ascertain the constraints facing households in livestock farming.

MATERIALS AND METHODS

The study area was the Borgu Local Government Area of Niger State. The Local Government has an area of land of about 16,200 sq. km and also share boundaries with Benin Republic to the west, Agwara Local Government to the North- South and River Niger to the East. The study area lies between Latitude 9^o 53^l N and Latitude 4^o 32^l E. The area comprises of ten wards and twenty districts. The wards include Bussa Wawa, Rafi, Karabonde, Hsagunu, Pissa, Malale, Babanna, Dugga, and Konkoso Ward.

The population of the study comprised all households that rear livestock in Borgu Local Government Area of Niger State.

Simple random sampling was used in selecting a sample for the study. Out of the ten wards in the LGA, six wards were randomly selected for the study. Twenty households rearing livestock farmers were randomly selected from each of the six wards to give a total of 120 households as the sample size of the study.

Primary were used in the study. The data were collected from the households using the interview schedule. Other relevant information was obtained from journals, text books and the internet.

Data collected were analysed using descriptive statistics such as frequency and percentage while the hypotheses were tested using inferential statistics such as Chi-square and Pearson Product Moment Correlation (PPMC).

RESULTS AND DISCUSSIONS

Table 1 revealed that the majority of respondents (52.9%) are between the ages of 31 to 40 years. This inferred that most of the respondents were in their energetic time of life period. Hence, they were capable to endeavor into livestock production regardless of the extraordinary level of risks involved. This was consistent with the findings of [9].

Majority (67.3%) of the respondents were males while (32.7%) of the respondents were females. This is because females do not have time like the males due to their domestic activities and taking care of the young ones.

Majority (52.9%) of the respondents were married while those who were not married constituted a proportion of 47.1%. Those who were not married includes the spinsters, bachelors, widowed and the divorced respondents. This implied that the respondents who were married might be tasked with much family responsibilities thereby engaging in livestock production.

Majority (57.7%) of the respondents had post-secondary education while a few of the respondents had no formal education (5.8%). It implies that most of the respondents were relatively educated which could to a large extent positively influence the level of adoption of innovations in livestock production. Hence, education level is a key factor in shaping the perception of individual farmers, thereby more enlightened and educated people tends to be more dynamic to technological innovations and changes than their illiterate counterpart [3].

A larger proportion (44.2%) of the respondents were involved in livestock production which is also their major occupation. 18.3% of the respondents were crop farmers while 23.1% were traders and artisans. A proportion of 12.3% of the respondents were civil servants. This was an indication that majority of the respondents were involved in agricultural activities.

The average monthly income of the respondents was 69,355.80 Naira. By implication, this may be a major reason for the respondents to get involved in livestock production, hence, in other to make ends meet.

The mean household size was found to be 7 persons. This is an indication that the respondents have a relatively large family size although a majority (92.3%) of the respondents had family size of 10 persons and below.

Majority (82.7%) of the respondents over years had livestock production experience of 10 years and below. The mean years of experience in livestock production business of the respondents was found to be 7.3 years. The implication of this is that the respondents are experienced in the livestock production business.

Table 1. Socioeconomic Characteristics of households

Variables	%
Age (Years) ($\bar{x}$= 37.2)	
≤ 30	36.5
31-40	52.9
>50	10.6
Sex	
Male	67.3
Female	32.7
Marital status	
Not married	47.1
Married	52.9
Educational Qualification	
No formal Education.	5.8
Primary School.	11.5
Secondary School.	17.3
Post-Secondary	57.7
Adult Education	7.7
Major Occupation	
Livestock Farmer	44.2
Crop Farmer	18.3
Trader/Artisan	25
Civil Servant	12.5
Monthly Income (₦) ($\bar{x}$= 69355.8)	
≤ 45,000	36.6
>45,000	63.4
Family size (Persons) ($\bar{x}$= 7)	
≤10	92.3
>10	7.7
Experience (Years) ($\bar{x}$= 7.3)	
≤10	82.7
>10	17.3

Source: Own calculation.

Table 2 revealed the livestock inventory of the respondents. The table revealed that the most commonly reared livestock by the respondents (96.2%) were the goats. 94.2% of the respondents reared chicken, 87.5% of the respondents reared sheep while 80.8% of the respondents reared cattle. Furthermore, 77.9% of the respondents reared ducks while 76% of the respondents reared guinea fowl. The least reared livestock animal was the pig (62.5%) and this might be as a result of the religious beliefs of the dominant population in the study area.

Table 2. Livestock Inventory of the households

Livestock	Percentage
Goat	96.2
Chicken	94.2
Sheep	87.5
Cattle	80.8
Duck	77.9
Guinea	76.0
Fowl	74.0
Pig	62.5

Source: Own calculation.

Table 3 showed the contributions of livestock production to respondents' households. The most important contribution of livestock to the households include the increased cash income from sales of livestock and its products ($\bar{x}$ = 4.2). Other contributions are the fulfilment of socio-cultural needs ($\bar{x}$ = 3.7), job creation and improved households' nutrition ($\bar{x}$ = 3.6) and assets accrual ($\bar{x}$ = 3.3). The least ranked contribution was the having a better social status representation ($\bar{x}$ = 3.2).

Table 3. Contributions of livestock production to respondents' households

Contributions of livestock production	$\bar{x}$
Increased cash income from sales of livestock/livestock products	4.2
Fulfillment of socio-cultural needs	3.7
Improved households' nutrition	3.6
Job creation	3.6
Nutrients on the farm	3.5
Assets accrual	3.3
Better social status representation	3.2

Source: Own calculation.

Table 4 showed the constraints of livestock production among respondents' households. The most serious constraint of livestock production among respondents' households include diseases and high cost of feed ($\bar{x}$ = 2.5).

Other constraints identified were lack of market for livestock and theft ($\bar{x}$ = 2.3), while predators and inadequate space for livestock production ($\bar{x}$ = 2.2), the harsh weather conditions and inadequate veterinary assistance ($\bar{x}$ = 2.1), and the complaints from neighbors ($\bar{x}$ = 2.0) was ranked the least of the identified constraints of livestock production among respondents' households.

Table 4. Constraints of livestock production among respondents' households

Constraints	Mean
Diseases	2.5
High cost of feed	2.5
No market for livestock in my area	2.3
Theft	2.3
Predators	2.2
No enough space for livestock	2.2
Harsh Weather conditions	2.1
No veterinary assistance	2.1
Complaint from neighbors	2.0

Source: Own calculation.

Table 5 presented the Chi-square analysis which showed that the contributions of livestock production to households had a significant relationship with sex (χ^2 =9.362; p<0.05), marital status (χ^2=56.06; p<0.05) and educational level (χ^2=18.367; p<0.05). The result of the analysis suggested that the contributions of livestock production to the respondents' households really does differ by the sex, marital status and educational level of the respondents.

Table 5. Chi-square analysis of households' socio-economic characteristics and the contributions of livestock production to households

Variables	χ^2	p	Decision
Sex	9.362	0.009	Significant
Marital status	56.06	0.009	Significant
Educational level	18.367	0.049	Significant
Major occupation	7.435	0.491	Not significant

Source: Own calculation.

Table 6 presented the Person Product Moment Correlation analysis which showed that age (r = 0.267; p<0.05), household size (r =-0.053; p<0.05), years of experience in livestock production (r = 0.204; p<0.05) and monthly income (r =0.080; p<0.05) had a significant relationship with the contributions of livestock production to the respondents' households.

Table 6. PPMC analysis of households' socio-economic characteristics and the contributions of livestock production to households.

Variables	r-value	p	Decision
Age	0.267	0.006	Significant
Household size	-0.053	0.008	Significant
Years of experience	0.204	0.038	Significant
Monthly income	0.080	0.018	Significant

Source: Own calculation.

This implied that the age of the respondents, their household size, years of livestock production experience and monthly income are factors associated positively with the contributions of livestock production to the respondents' households.

Table 7 presented the significant relationship between the constraints of livestock production among households (χ^2= 9.362; p<0.05) and the contributions of livestock production to the respondents' households. The result of the analysis suggested that the contributions of livestock production to the respondents' households really does differ by the constraints of livestock production among households.

Table 7. Chi-square analysis of households' socio-economic characteristics and the contributions of livestock production to households

Variables	χ^2	p	Decision
Constraints to livestock production	9.362	0.009	Significant

Source: Own calculation.

CONCLUSIONS

Households' socio-economic characteristics and the constraints of livestock production among the households are associated factors to the contributions of livestock production the households. Based on the findings of this study, it was recommended that households should be encouraged in livestock production through provision of credit facilities, veterinary services and extension in order to contribute to the livelihoods of the households. Also, more educational programs should be organized to increase the knowledge and the importance of livestock to household's livelihood. Above all, there is a need for pricing policy review of livestock production inputs in order to bring down the prices of livestock and its products making it relatively affordable for the households.

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FARMERS' PREFERENCES, SEED SOURCE, PRODUCTION CONSTRAINTS AND IMPROVEMENT NEEDS ASSESSMENT OF BAMBARA GROUNDNUT (*VIGNA SUBTERRANEA* [L.] VERDC.) IN NORTHERN RURAL OF NAMIBIA

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Abstract

Bambara groundnut (Vigna subterranea [L.] Verdc.) is one of the neglected and underutilized legume crops grown by resource-poor smallholder farmers in sub-Saharan Africa (SSA). Its potential has been neglected for years by researchers and hence has remained an orphan crop. The objectives of this study were to assess preferences, seed availability, crop improvement needs and production challenges faced by Bambara groundnut farmers in Namibia. A cross-sectional survey comprising 100 randomly selected farmers was conducted in five of the eight northern regions of Namibia. Results showed that large seed size, cream seeds, early maturity, and drought-tolerant are the main farmer-preferred traits. Okaongoti was the most preferred (20%) variety. The primary seed sources are own saved seed (61%) and a combination of informal market and own saved seed (25%). The major production constraints of Bambara groundnut were insect pests, low yield and lack of improved varieties. Breeding of Bambara groundnut varieties with the farmer-preferred traits is vital to improving its yield level and overcome production challenges in the country

Key words: *farmer-preferred traits, Bambara groundnut, orphan crops, subsistence farming*

INTRODUCTION

Bambara groundnut (*Vigna subterranean* (L.) Verdc.) is an orphan, underutilized and less exploited legume crop in Africa and beyond. It is an edible grain legume crop indigenous to sub-Saharan Africa (SSA), playing vital socio-economic roles in the sub-continents semi-arid areas [16]. Bambara groundnut originates in West Africa, but the crop is currently grown in many African countries [11]. In Africa, it is ranked as the third most important legume after cowpea and groundnut [24].

Bambara groundnut is used as food and feed crop [22]. It is highly nutritious, containing 65% carbohydrate, 18% protein and 6.5% fat content [33]. The protein in Bambara groundnut might be a solution to malnutrition, making it a valuable food for poor people who cannot afford expensive animal protein in developing countries [32]. Bambara groundnut is of agronomic importance because of its ability to fix nitrogen in the soil, and therefore, suitable for low input production system [13]. Bambara groundnut being drought tolerant, can survive harsh environments and survive extreme heat. Different countries use Bambara groundnut in different ways; in Senegal, it is used for medicinal purposes in addition to food [29].

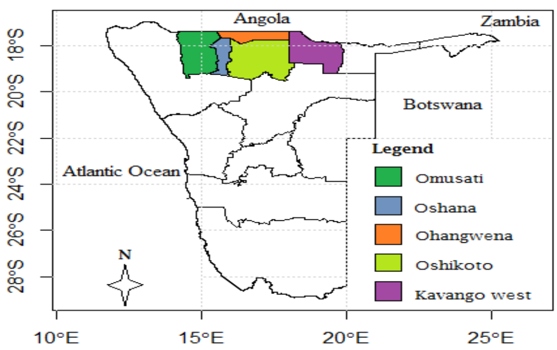
Despite its numerous benefits, Bambara groundnut has been ignored by research and conservation entities [14] and hence remains marginalised and underutilised. Currently, there are organisations such as Africa Center for Crop improvement, BamNetwork project, Crops For the Future, African Orphan Crops Consortium, and others are making an effort to research on the crop [10]. [19], reported that women in Mali sell Bambara groundnut to earn income. In Namibia, the crop is commonly used for human consumption, livestock feed and income generation [31].

In sub-Saharan Africa, agricultural production is limited by water scarcity, lack of improved crop varieties and loss of genetic diversity [17], increasing dependence on a few crops for food. In Namibia, the crop is mainly grown in northern areas of the country where it is ranked the second most important legume after cowpea [31, 8]. Through many years of successive cultivations, farmers have selected Bambara groundnut landraces with preferred traits, such as high yields, bunch type and other traits [1]. The seed production and marketing system of this crop is not formalised as farmers are still acquiring seeds informally by using their own seeds from the previous harvest [5]. Agricultural research on breeding of Bambara groundnut focused on selection between and within-population of landraces for yield performance, disease resistance and drought tolerance rather than other variables [9].

Bambara groundnut varieties exist as landraces, which are informally classified and named according to performance, colour and areas of production. As a result, a single accession may be produced under different names or vice versa [18]. Therefore, any breeding program should be farmer-preferences centred for easy adoption of released varieties. Undertaking a needs assessment study to find out what farmers have on their farm regarding Bambara groundnut preferences on the crop, production constraints and what they would rather have as an improvement is critical in guiding a successful breeding program. Therefore, the present study assessed farmers preferences, seed conservation and production constraints in Northern Namibia.

MATERIALS AND METHODS

Site description



Map 1. Map of Namibia showing the study area Northern Namibia
Source: Produced by author using ggplot package for R-statistics, Shapefiles obtained from GADM.

The needs assessment survey was conducted in five regions in northern Namibia, namely, Omusati, Oshana, Oshikoto, Ohangwena, and Kavango West (Map 1). Average annual rainfall in the study area ranges from 450–600 [3] and average minimum and maximum temperature is 23–39°C.

Questionnaire design and sampling

A cross-sectional survey was undertaken in July 2018. The questionnaire comprised both closed and open-ended questions. A total of 100 households (male and female-headed households) were involved in the survey. The sample was selected using a four-stage probability sampling methodology.

First stage involved a purposive selection of the regions. The regions also served as the primary domain of estimation.

Second stage was the selection of a single constituency from the regions using a simple random sampling technique.

Third stage involved the selection of villages within the constituencies using the simple random sampling technique.

Fourth and, the final stage was the selection of the households from the villages in stage three.

Table 1. Distribution of sampled household sizes by region and constituency

Region	Number of households*	Constituency	Households sampled
Omusati	54,383	Anamulenge	20
Oshana	44,544	Okatana	20
Ohangwena	49,470	Ondobe	20
Oshikoto	45,407	Omuntele	20
Kavango west	17,046	Kapako	20
Total	**210,850**		**100**

* Number of households are estimated as determined by the national demographic survey of 2016.
Source: Computed by author based on the summary data from the National demographic survey of 2016 by the Namibia Statistical Agency.

Table 1 above summarises the sample type per each of the 4-stage subset of the multistage probability sampling scheme.

A sample size of 100 was determined using the last column of Table 2 below and based on e total population of 210,850 households to attain a 10% error margin. Then 100 household sample size was then allocated using similar allocation scheme under stratification, with the region as the bases for stratification.

Table 2. Extract of sample sizes for selected error margins with 95% fiducial limits and p = 0.5 based on the formula of Yamane (1964).

Size of population	Sample size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

Source: Computed by the author using Yaro Yamane formula of 1964.

Validation of survey instrument

A total of 15 questionnaires were administered as a pilot to check the test items for consistency. No modification was done, and hence the pilot data was added to the overall sample

Data collection and analysis

Data on preferred traits, variety, seed color, seed source and constraints on Bambara groundnut production were recorded using a questionnaire. Descriptive statistics in the form of graphical presentation, cross-tabulation, and frequencies were used to address the objectives of the study. Non-parametric test of association/dependence was conducted using Pearson's Chi-squared test.

RESULTS AND DISCUSSIONS

Socio-demographic information of the farmers

The study focused on Bambara groundnut farmers' preferences of landraces used in the selected five northern Namibian regions. A cross-tabulation of regions by socio-demographics revealed a significant association between region and age (χ^2 = 23.628; P < 0.023). Thirty-one per cent (31%) of those interviewed are between the age of 46 and 60 years, 30% are above 60 years, 27% are between 31 and 45 years, while 12% aged between 15 and 30 years. The age category (46–60 years) of the respondents may have been attributed to the fact that most of the young people migrated to urban areas to search for jobs. In contrast, older people remained in rural areas carrying out farming activities. The chi-square test indicated a significant association between region and education (χ^2 = 42.935; P < 0.001). No association is detected amongst gender, marital status, household size, number of adults and owner of the house (Table 3).

Table 3. Socio-demographic of interviewed Bambara groundnut farmers

Variables		%	df	χ^2	*P*-value
Gender	Male	9	4	6.593	0.159
	Female	91			
Age	15-30	12	12	23.628	0.023
	31-45	27			
	46-60	31			
	≥61	30			
Marital Status	Single	41	8	8.018	
	Married	48			0.432
	Widowed	11			
Education level	None	15	12	35.798	0.000
	Primary	28			
	Secondary	56			
	Tertiary	1			
Household size (Number of children/family)	≤10	94	8	8.362	0.399
	11-20	5			
	≥21	1			
Household size (Number of adult/family)	≤10	90	8	9.528	0.300
	11-20	8			
	≥21	2			
Owner of the house	Man	59	8	6.051	0.641
	Woman	41			

Source: Author survey data (2019).

The demographic findings indicated that 91% of females and 9% of males are interviewed. Many farmers interviewed were females, possibly because Bambara groundnut is believed to be a women's crop. This finding was in agreement with those of [6, 12]. The study found that 56% of the farmers interviewed had attended secondary school hence literate. Primary school leavers were 28% as compared to 12% who had not attended school as a result, they knew the importance and benefits of using improved seeds according to their preferences. The total number of households in the five regions comprised 94% children, who could be fed with Bambara groundnut because it is rich in protein, carbohydrate, and fat. Hence it can be a substitute for meat [22] The marital status showed that 48% were married, 41% were single, while 11% were widows. Further, 59% of the respondents indicated that men headed households.

Bambara groundnut farmer-preferred traits

Farmers gave multiple responses about preferred traits. Farmers in the surveyed area preferred particular Bambara groundnut based on different traits such as seed size, seed coat colour, maturity, taste, and pods with two or more seeds. The preferred traits showed significant association (χ^2 = 58.852, $P <$ 0.066) between regions and traits. Seed size depicted the highest percentage (57%) of preferences as large-sized seeds were most preferred (Table 4). The same results obtained in Nigeria by [21]. The results can also be compared with some findings in Malawi, where farmers preferred small-seed Bambara groundnut for relish and big seeded Bambara groundnut for snacks [27]. However, in this study, the preference of seed size was not linked to any use except to high yield. High yield was the most preferred Bambara groundnut trait, and large-sized seeds could be one of the traits that correlate with high yield due to their mass. Hence, farmers need to have a high-yielding crop to produce a surplus for household consumption and income generation [15]. The combination of seed colour and seed size was preferred by 13% of the Bambara groundnut growers. Farmers also indicated drought tolerance as Bambara groundnut is regarded as a drought-tolerant crop compared to other legume crops and maturity as some of the preferences. Early maturity was favoured by 7% of the farmers. Maturity is essential in terms of not only giving an early harvest but also in escaping drought, which is a common phenomenon in arid and semi-arid regions such as Namibia [18] Other preferences ranged from 1–6%, indicating that the traits were less important to farmers (Table 4). Farmers expressed other preferences such as high yield, big leaves, thick pods, yellow pods, seed shape, bushy type, medium leaves, and nitrogen fixation. Farmers indicated that Bambara groundnut crops with big leaves is likely to give big pods and high yield. Also that bambara groundnut cultivars with big leaves because of their higher fodder yield for livestock [12, 30].

Table 4. Farmers' main preferred traits in five regions of northern Namibia

Traits	**Region**					**%**
	Omusati	Oshana	Oshikoto	Ohangwena	Kavango West	
Seed colour (SC)	1	1	2	2	0	6
Seed size (SS)	12	9	7	13	16	57
Maturity (M)	2	2	1	1	1	7
Pods with 2 or > seeds (P)	0	0	1	0	0	1
SS + M	0	0	3	0	0	3
SC + SS	4	5	2	0	2	13
SC + SS+ M	0	0	2	0	0	2
M + P	0	0	0	1	1	2
SC + SS + M + P	1	0	1	0	0	2
SC + taste	0	2	1	1	0	4
SC + SS + taste	0	1	0	0	0	1
SC + taste	0	0	0	2	0	2
Total number of farmers	20	20	20	20	20	100
χ^2						58.852
Df						44
P-value						0.066

Source: Author survey data (2019).

Farmer-preferred cultivars

Cultivar preferences appeared to be region-specific and are significantly different ($P <$ 0.000). Results showed that farmers had specific preferred cultivars which they cultivate and were named according to colours and performance. Significant association ($\chi^2 = 138.86$; P = 0.000) among different cultivar grown across the five regions are detected (Table 5). The cultivars which are grown in north-central regions (Omusati, Oshana, Oshikoto and Ohangwena) are given local names such as Engowa, Okambishi, Egogani, Okaongoti, Olunya, and Onkwaya [8]. In this regard, Okaongoti was 42% popular, followed by Olunya (25%) and Okambishi (23%). In one north-eastern region (Kavango West), cultivated seed types were described using colours. In this regard, 49% of the respondents showed that the cream seed is popular, followed by both black and red (21%). The farmers' response suggested that the most preferred are cream-seeded cultivars in the study regions Farmers preferred cultivars were named according to colours and performances [1]. Therefore, in the absence of a breeding program, farmers will continue with the traditional selection that may lead to loss of good cultivars. Since Bambara groundnut farmers had their preferred traits, and not all cultivars have high-quality traits that farmers need, crop improvement is required to fill this gap.

Table 5. Preferred cultivar in North-central and Kavango West of Namibia

	Region	Omusati		Oshana		Oshikoto		Ohangwena		Kavango West	
	Class	O	E	O	E	O	E	O	E	O	E
Cultivars	Olunya	0	2	8	2	4	2	0	2	0	2
	Engowa	0	0	2	0	0	0	0	0	0	0
	Egogani	0	0	2	0	0	0	0	0	0	0
	Okambishi	1	2	2	2	6	2	2	2	0	2
	Okaogonti	12	2	0	2	4	2	4	2	0	2
	Onkwaya	0	0	1	0	0	0	0	0	0	0
	Tan	0	0	0	0	0	0	0	0	2	0
	Red	1	2	1	2	3	2	0	2	5	2
	Maroon	0	0	0	0	0	0	0	0	2	0
	Black	0	2	1	2	2	2	4	2	3	2
	Cream	3	5	1	4	1	5	10	5	8	5
	No idea	3	3	2	3	0	3	0	3	0	3
	Total	20	20	20	20	20	20	20	20	20	20
	df									44	
	χ^2									138.9	
	P-value									0.000	

Source: Author survey data (2019), O is the observed frequency and E is the expected frequency computed as the row total by column total divided by the grand total.

Bambara groundnut seed source and selection

Seed source is not significant ($P < 0.204$) to farmers in all regions studied. Results showed that many farmers (61%) obtained their seeds from the previous harvest. Twenty-five per cent (25%) of farmers acquired seeds both from the open market and from the previous harvest (Table 6). Farmers in the study area are using unimproved cultivars sourced from informal market, neighbour and relatives. The informal acquiring of seeds, it might be due to the informal nature of seed exchange among farmers coupled with the recycling of the seeds by the farmers, which might lead to a slight genetic erosion since the crop is self-pollinated. This result is in line with the results presented by [12, 23]. However, [25] reported that farmers from Burkina Faso also obtain seeds from the previous harvest. They further stated that seeds sown were mixed and environmental conditions of each year could favour one or some accessions to the detriment of others, hence only adapted accessions will produce more progenies. So, the composition of seed will change from year to year according to previous environmental conditions. [2] results also showed that farmers' selected seed for the following season based on seed and cultivar traits such as seed colour, seed size, taste, early maturity and, to some extent, based on pods with two or more seeds, among others. Chi-square test indicated that there was a highly significant association ($\chi^2 = 57.271$; $P \leq 0.000$) in seed selection criteria among the regions. Seed size was considered to be the most important criterion, followed by seed colour and size; seed colour, taste, seed size and then by other axillary criteria such as maturity and yield (Figure 1).

Table 6. Bambara groundnut seed source in five northern regions of Namibia

Seed Source	Region					%
	Omusati	Oshana	Oshikoto	Ohangwena	Kavango West	
Own seed (OS)	13	16	5	10	12	61
Open market (OM)	0	1	0	3	1	5
Neigh bour (N)	0	1	3	1	0	5
OS + OM	6	1	5	6	7	25
OM + N	1	0	1	0	0	2
OS + N	0	1	0	0	0	1
OS + OM + N	0	0	1	0	0	1
Df						24
χ^2						29.433
P-value						0.204

Source: Author survey data (2019).

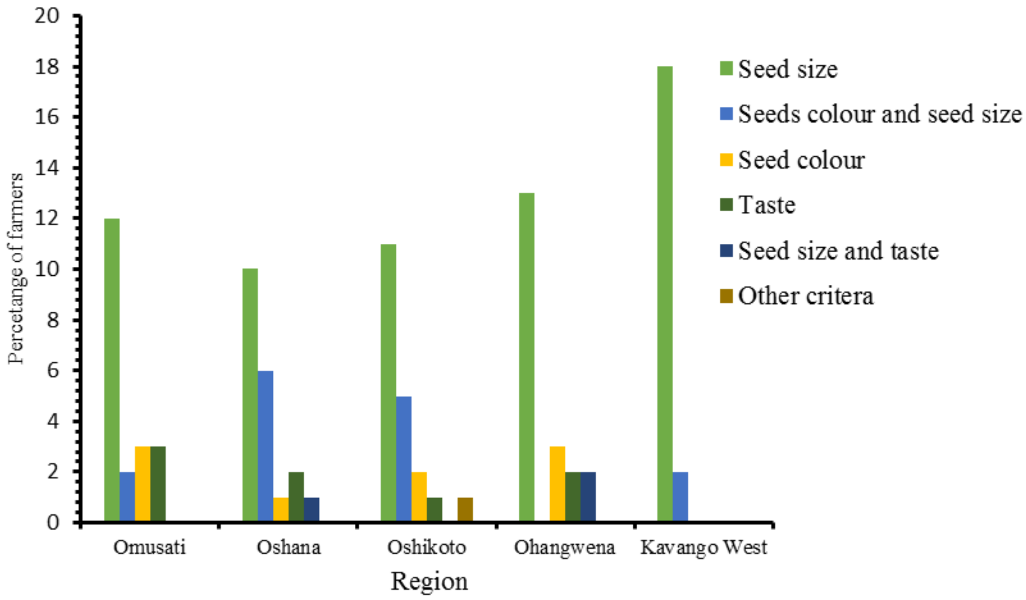


Fig. 1. Farmers seed selection by traits in the five regions in northern Namibia
Source: Author survey data (2019).

Seed coat colour preference

Seed colour is another attribute that farmers considered in all the regions one of the important bases used to select seeds for planting. Forty-five (45%) of the respondents chose seed colour trait as one of their selection criteria for planting seeds, where cream colour was the most selected colour (36%), followed by tan colour (33%) (Figure 2). The least selected colour was purple, liked by one farmer representing 2%. There was a significant association among the regions for seed colours, with the preferred colours being cream, tan, black, red and purple; these findings are similar to that of [21, 23]. Farmers indicated that the cream Bambara groundnut was most preferred, because of its sweet taste, less cooking time, marketability, preference for home consumption, uniform seed size. These results are in agreement with that obtained by [1]. The black colour was preferred by 18% of the farmers, who said that black/dark -seeded cultivar is drought tolerant [24, 29]. The red colour was selected by 11% of farmers. The order for preference is cream, red and black, and this finding is similar to that reported by [4].

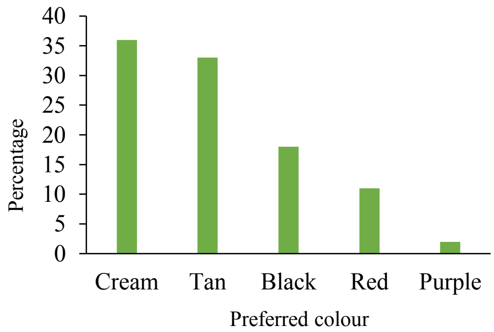


Fig. 2. Farmer-preferred seed colour in the study area
Source: Author survey data (2019).

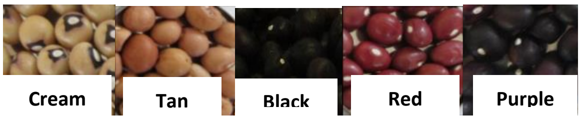


Photo 1. Preferred seeds coat colour of Bambara groundnuts in study area
Source: Author survey data (2019).

Improvement needs on preferred traits

Crop improvement of Bambara groundnut is one of the main objectives in the breeding of this crop.

The chi-square test detected a significant association (χ^2 = 34.783; $P \leq 0.000$) among farmers' responses towards the adoption of improved varieties. Ninety-two per cent (92%) of the Bambara groundnut farmers in the study area admitted that improved cultivars are needed. In exception of farmers (8%) from Kavango west who did not agree on cultivar improvement for the reason that Bambara groundnut is not their major crop. less than 55 kg/ha.

The chi-square test for trait showed that there was a highly significant association (χ^2 =79.334; $P \leq 0.000$) between regions and trait need improvements. (Table 7).

Forty-two per cent (42%) of the farmers indicated the need for Bambara groundnut yield improvement.

Every farmer needs to have high yielding varieties for every crop that is why yield scored the highest percentage that improvement is required. However, many farmers in the study area indicated that Bambara groundnut is low yielding.

Furthermore yield is a polygenic trait and can be influenced by environmental factors [26], including climate change [7] that may contribute to poor yield. A combination of yield, seed size, and insect tolerance was, to some degree, recommended by 16% of the farmers.

Table 7. Farmer-preferred traits to be improved in five northern regions of Namibia

Traits	Omusati	Oshana	Oshikoto	Ohangwena	Kavango West	Percentage
Yield (Y)	14	12	5	9	2	42
Seed size (SS)	2	1	2	2	1	8
Insect resistance (IR)	0	0	1	1	0	2
Drought tolerant (DT)	0	1	0	0	3	4
Y+ SS+Others	1	0	0	0	0	1
Y + SS	2	4	5	2	0	13
Y+ SS + IR	1	1	6	6	1	15
Yield + Others	0	1	0	0	1	2
IR + Others	0	0	0	0	4	4
Y+ IR+Others	0	0	0	0	1	1
SS +IR	0	0	1	0	0	1
Total	20	20	20	20	13	93
χ^2						79.334[a]
df						40
P-value						0.00

Source: Author survey data (2019).

Production constraints

The Bambara groundnut farmers' production constraints varied significantly across the regions studied. Production constraints were ranked according to the farmers' responses. Farmers constraints on Bambara groundnut production varied significantly ($\chi^2 = 142.616$; $P < 0.036$) across the regions. Results indicated that the main challenges were insects (26%), especially aphids and termites, low yield, use of unimproved varieties and other constraints including flooded field, squirrels, and rodents (Figure 3).

The low yield caused by insect pests usually destroyed pods and leaves, Similar results were reported by Ibrahim et al. (2018) in Western Niger [12].

Other causes of low yield reported by farmers included floods, squirrel and rodents, and these findings were in agreement with those of [20].

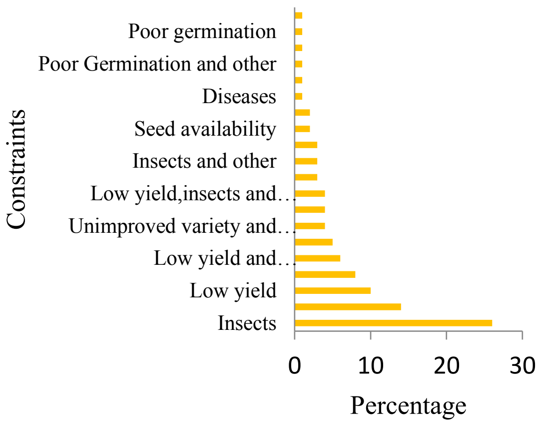


Fig. 3. Constraints faced by farmers in the production of Bambara groundnut in study area
Source: Author survey data (2019).

CONCLUSIONS

In five regions of northern Namibia, more women than men were involved in Bambara groundnut farming. The farmers' most preferred traits were seed size, seed coat colour, early maturity, high yield and drought tolerance. Farmers preferred cultivars included Olunya, Okaongoti, Engowa, Okambishi, and Egogani, whose names may have been derived from their seed colours and production levels. Most farmers sourced Bambara groundnut seeds from the previous harvest or informal markets. The formal seed production and marketing of Bambara groundnut need to be created and improved. The organisations that are researching on underutilised crops need to do more research on improvement to incorporate preferred traits of farmers and consumers and commercialise the crop.

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A HYPOTHETICAL FUNCTIONAL MODEL OF SOCIO-DEMOGRAPHIC DEVELOPMENT BASED ON THE RELATIONSHIP BETWEEN THE INCOME HETEROGENEITY OF THE RURAL POPULATION AS A FACTOR OF SOCIAL DYNAMICS

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Abstract

In modern Russia, the main features of the current demographic situation are: significant scale of population decline, low birth rate, continuing population aging. Currently, the Russian Federation is experiencing high mortality and low fertility. Using the tool of the space of value orientations, based on the methodology proposed by Urnov M.Yu., Kasamara V.A., the initial indicators were changed to economic ones and their influence on the socio-demographic development of rural areas was determined. The hypothetical substantiation of the dependence of economic indicators of value heterogeneity in terms of economic indicators of society and social dynamics was tested on the basis of a hypothetical model based on matrix algorithms. A model of socio-demographic development has been developed based on the relationship between the value heterogeneity of the rural population as a factor of social dynamics, uniting a system of economic and social indicators on the basis of a functional approach, stratification indicators of the value orientation of rural areas have been determined depending on the level of income of the population, which will determine the growth of job creation. places and size of wages. The verification of the economic indicators of a hypothetical model of the dependence of the socio-demographic development of rural areas in the region on the level of value heterogeneity of society in terms of wages, as a factor of social dynamics, has been carried out. The calculations showed that in agricultural enterprises of the Russian Federation, in the period f1 in relation to the period f0, the increase in income was: in the first group of districts 114,761.9 thousand rubles. or 75.07%, in the fourth group 1,043,889 thousand rubles (58.53%) due to a significant increase in capital productivity for the intensive type of development, and identified additional investments in the acquisition of fixed assets in the amount of 143,928.24 and 1,253,302.33 thousand roubles. Profit from intensive use of agricultural land is determined in 1-4 groups of districts in the amount of 73.26; 77.15; 70.16; 59.22%, respectively, of the total profit of enterprises in order to maintain the achieved level of profit, it is necessary to increase the area of agricultural land by 20% on average for groups.

Key words: *model, demography, income level, return on assets, profitability, production*

INTRODUCTION

A necessary condition for the existence and development of society is the process of human reproduction, which directly depends on the course of demographic processes. The processes of migration, mortality, fertility have a direct impact on the quantitative and qualitative composition of labor resources and its potential, which is reflected in the effectiveness of economic and social policy, both in the country as a whole and in its individual subjects [11]. The decline in the rural population is one of the pressing problems of Russian demography. The key factors in the development of the village are underdeveloped infrastructure, lack of a sufficient number of jobs, low wages, a low level of the cultural and leisure complex, a decrease in the birth rate with a simultaneous increase in mortality, and an outflow of the population.

The study was based on the latest work of world and Russian scientists in the field of mathematical modeling and sociological analysis.

In his works, Ao, Zou (2015) established the influence of the vector model in establishing errors in the impact of social expectations on the macroeconomic problems of Shanghai, which will allow, by assessing the situation, to determine the total volume of retail sales of consumer goods and the total volume of investment in fixed assets, and social expectations are indicated by the leading index in the system of indices of the economic climate [1].

Research by Sanchez-Fernandez, Raquel, Jimenez-Castillo, David, Iniesta-Bonillo, Angeles (2017) has identified a perceived model of sources of economic value that can improve satisfaction, organizational image and target audience identification using partial least squares (PLS) and, possibly It should be noted that the results obtained provide useful theoretical and practical conclusions and emphasize the importance of identifying the heterogeneity of structural models [5].

Mark Fossett (2006), in its research emphasized the importance of developing Schelling-style agent-based preference influence models when he described models that show decision-making about the location of individuals based on preferences determined on the basis of surveys, which can lead to integration or support it [4].

MATERIALS AND METHODS

Research results from Li, W., Li, J., Cui, J. (2020) showed that rural emigration has increased significantly in the Hubei province of Central China as a result of the aging of the rural population and the deterioration of educational levels. For the development of rural areas, the authors put forward well-calibrated and differentiated development strategies in eight categories, areas [6].

The study of the tasks in the field of the proposed topics was carried out based on the representative methodology of analysis in the study of the population proposed by Urnov M.Yu., Kasamara V.A., the main idea of which is to verify a hypothetical model of the dependence of social changes on the level of value heterogeneity of society as a factor of social dynamics [9] on the choice and justification of hypothetical models.

The study of the impact of the current economic situation in certain groups of districts will allow determining the intensive path of development of economic entities and finding out its impact on socio-demographic processes: fertility, mortality, migration processes [7]. To timely take into account the impact of the economic development of the region on demography, the average annual wage was selected as a criterion for the economic heterogeneity of the population and the grouping was carried out using the method of Herbert Sterzhes [2, 8].

RESULTS AND DISCUSSIONS

The functional model of the intensity of socio-demographic changes, depending on the level of social heterogeneity of society, has the form:

$VHS_{S1}^{t0}>VHS_{S2}^{t0}$, then $SD_{S1}^{t1\text{-}t0}> SD_{S2}^{t1\text{-}t0}$ or
$VHS_{S1}^{t0} <VHS_{S2}^{t0}$, then $SD_{S1}^{t1\text{-}t0} <SD_{S2}^{t1\text{-}t0}$

where:

VHS - economic indicators for a certain period of time;

SD - social indicators for the same period of time.

The calculations and comparison of inequality indicators $VHS_{S1}^{t0}>VHS_{S2}^{t0}$, then $SD_{S1}^{t1\text{-}t0}> SD_{S2}^{t1\text{-}t0}$ or $VHS_{S1}^{t0} <VHS_{S2}^{t0}$, then $SD_{S1}^{t1\text{-}t0} <SD_{S2}^{t1\text{-}t0}$ allow us to assess whether the hypothesis is true. Rather «yes» than «no». The relative indicators of capital productivity, profitability of agricultural land, output per worker were selected as economic indicators for verification, and the general coefficient of demographic growth was selected as an indicator of socio-demographic development. [12, 10] To test the hypothesis put forward, we took the above-mentioned economic indicators for six groups of regions: S1, S2, S3, S4, S5, S6 in comparison S1-S2; S2-S3; S3-S4; S4-S5; S5-S6 for the period under review f0. As a socio-demographic indicator, the general coefficient of demographic growth (the deviation of its value for the periods f1 and f0 under consideration) was taken (Table 1).

The relationship of value heterogeneity is partially positive. This gives the basis for building a functional model for a separate group of indicators based on the IDEF0 (Integrated Definition Function Modeling) methodology (integrated modeling of definition functions). It is based on the idea of an indivisible particle - a block. Our hypothetical model consists of: on the left is an entry block, on the right is an exit, on the top is control, on the bottom is the result. Calculations were made using the method of two-row matrices

Table 1. Empirical testing of hypothetical model results

VHS		SD Total demographic growth rate
Return on assets, RUB/RUB		
S1-S2	1.147> 0.77	-10.34 < -9.93
S2-S3	0.77 < 1.05	-9.93> - 12.06
S3-S4	1.05< 1.09	-12.06 < -11.23
S4-S5	1.09> 0.97	-11.23 < -9.68
S5-S6	0.97< 1.28	-9.68 > -11.25
Efficiency of using agricultural land		
S1-S2	2.782 <3.34	-10.34 > -9.93
S2-S3	3.34<6.55	-9.93 <- 12.06
S3-S4	6.55<6.62	12.06 > -11.23
S4-S5	6.22 <9.08	-11.23 < -9.68
S5-S6	9.08 <12.31	-9.68 > -11.25
Generation, RUB/person		
S1-S2	2,178.79 < 2,736.93	-10.34 > -9.93
S2-S3	2,736.93 < 4,122.25	-9.93 <- 12.06
S3-S4	4,122.25 > 3,888.17	12.06 > -11.23
S4-S5	3,888.17 > 3,270.67	-11.23 < -9.68
S5-S6	3,270.67< 4,494.65	-9.68 > -11.25

Source: Calculated by the authors.

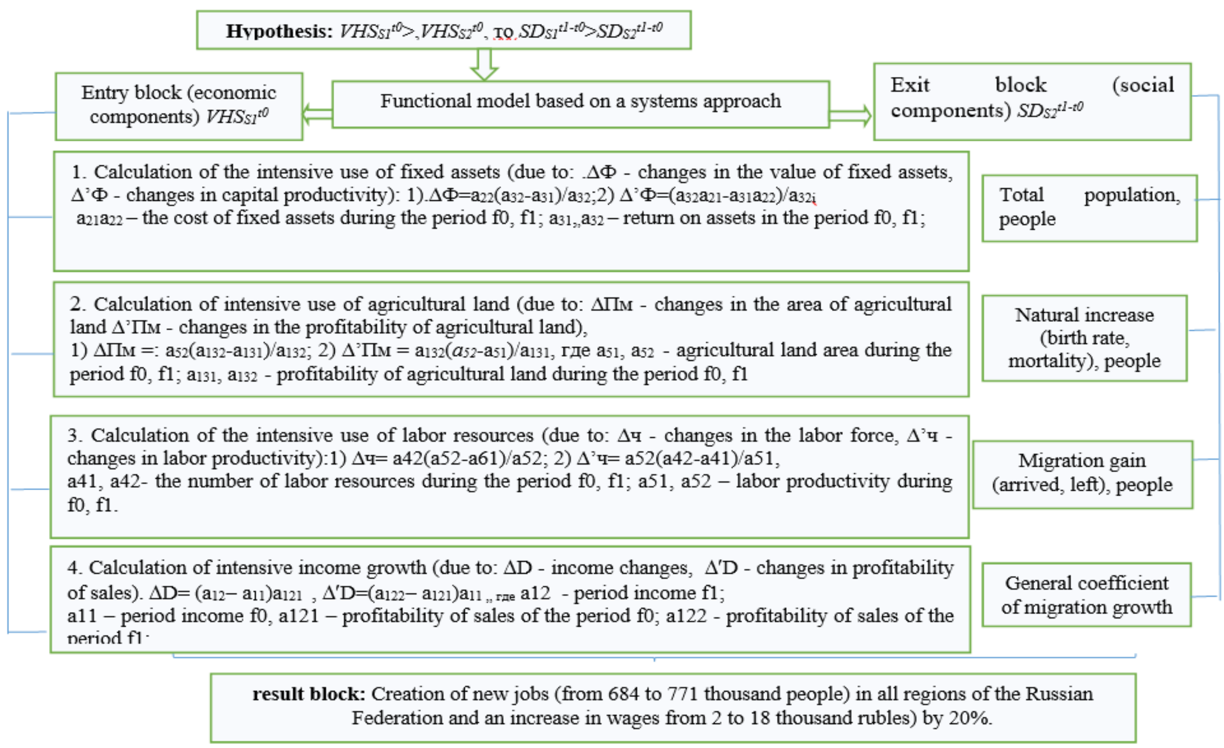

Fig. 1. A hypothetical model of socio-demographic development based on the relationship of social heterogeneity in terms of income of the rural population, as a factor of social dynamics
Source: Developed by the authors.

Verification of economic indicators by regions established an increase in revenue from groups 1 to 4 according to the intensive type of development and amounted to 457,041.83, 29,460.7, 95,407.46, 161,502.18 thousand rubles, respectively.

The studies found that agricultural producers of the Russian Federation during the f1 period compared to the f0 period increased labor productivity by 60.47% on average from groups 1 to 4 and only 0.3% increased the number of employees, which resulted in an increase in income by 2,074,745.84 thousand rubles. in total due to the use of intensive factors of production (fixed assets, agricultural areas), which account for 42.19% of the total. These indicators testify to the optimization of the number of employees according to the intensive type of development and the possibility of providing 596 (49 + 135 + 133 + 279) thousand people with new jobs. An increase in employment of the country population by 615 thousand people (43 + 153 + 122 + 297) contributed to an increase in output by 4,832.009 (868.759 +1,006.100 +1,468.884+ 1,494.266) thousand rubles/person. In the 5-6 group of agricultural enterprises of the Russian Federation in the period f1, in order to maintain the achieved income from the sale of products due to intensive factors, there is a reserve of workers for 586 thousand people (Table 2).

Table 2. Results of determining the number of creation of additional jobs

Estimated indicators	The values
1st group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	48.98
Increase in income, thousand rubles	106,718.31
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	42.84
Increase in income, thousand rubles	-13,377.77
2nd group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	134.55
Increase in income, thousand rubles	368,261.39
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	153.04
Increase in income, thousand rubles	50,594.16
3rd group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	133.28
Increase in income, thousand rubles	549,394.27
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	121.83
Increase in income, thousand rubles	-47,176.84
4th group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	279.46
Increase in income, thousand rubles	1,086,580.34
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	297.29
Increase in income, thousand rubles	69,339.09
5th group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	147.91
Increase in income, thousand rubles	483,756.81
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	145.91
Increase in income, thousand rubles	-6,541.34
6th group	
ΔΦ Efficiency of use of labor resources (due to changes in the number)	441.69
Increase in income, thousand rubles	1,985,244.13
ΔΦ Efficiency of use of labor resources (due to changes in labor productivity)	453.57
Increase in income, thousand rubles	53,373.97

Source: Calculated by the authors.

The study of the empirical-factual base of the main economic indicators of rural regions of the Russian Federation showed the presence of favorable conditions for an intensive increase in the production of raw materials and the development of human potential. At agricultural enterprises, the volume of production in the period f1 (2020) compared to the period f0 (2019) increased by 20,762,313.50 thousand rubles. and amounted to 64,944,892.00 thousand rubles. In general, in the country, the increase in production was 46.99%. The source of natural increase (decrease) of the population is migration flows, mortality and fertility rates (Table 3).

Table 3. Natural increase (decrease), thousand people

Region groups	2019	2020	+,- 2020/2019	% 2020/2019
1	-100.20	-162.00	-61.80	280.91
2	-153.71	-217.00	-63.29	55.16
3	-292.22	-395.44	-103.22	54.01
4	-514.00	-872.83	-358.83	47.24
5	-240.89	-363.33	-122.44	205.53
6	-132.00	-258.50	-126.50	98.53

Source: Federal statistic service [3].

For all groups of regions, the population is declining to a large extent due to an increase in the outflow of its rural part in 2020. C1 for 6 groups, respectively, -2.07; -1.65; -2.43; -2.32; -1.43; -2.04% compared to 2019 in the intensively-oriented group of districts (1-4), due to an increase in natural decline (increase in mortality over births) from 47.24 to 280.91% and migration gain (decline) from -49.24 to 83.52%. And in 5-6 groups of districts, the same indicators were -33.57 and + 21.97% due to the influx of labor into the suburbs of urbanized regional centers, respectively, for the analyzed period. A stable negative overall coefficient of natural increase (decline) of the rural population will not allow at least partially to compensate for the natural decline.

CONCLUSIONS

A functional hypothetical model of the socio-demographic development of rural areas on the example of regions of the Russian Federation is proposed. A grouping by wages was carried out, as a criterion of economic heterogeneity, in a breakdown of 6 groups by the Sterzhes method. An increase in income due to an increase in the scale of production or profitability of sales, and the verification of the calculation results was carried out. A functional model was built according to the IDEF0 (Integrated Definition Function Modeling) method, which includes 4 blocks (input, output, management decisions, result), combining economic and social indicators. allowing to determine the possibility of creating new jobs from 43 to 453 thousand people and an increase in wages from 14 to 49 thousand rubles.

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FACTORS AFFECTING FARMERS' DESIRE TO CHANGE THE CULTIVATION PATTERN (MEDICINAL PLANTS CULTIVATION)

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Abstract

Achieving sustainable development is one of the most important agricultural resources. Therefore, the overall purpose of this study is to investigate the factors affecting farmers' desire to change the cultivation pattern to cultivation of medicinal plants. The research method is allowed as a field-library. After determining the variables through questionnaires and software SPSS. The statistical population of this study is rural producers in Targabah district in Khorasan Razavi Province in Iran. The statistical sample for this study was 204 rural households. The sample was calculated using random sampling based on Cochran formula. The results show that the farmers' desire to change the cultivation pattern to cultivation of medicinal plants has a significant positive correlation with its level of economic, social, technical and environmental awareness. Also, it has a significant and positive relationship with his understanding of the production of medicinal plants which can enhance the protection of the environment. The results of the diagnostic analysis showed that the level of economic awareness and awareness of processing plants and product packaging can affect the farmers' desire to change the cultivation pattern to cultivation of medicinal plants.

Key words: *medicinal plants, change the cultivation pattern, farmers' desire*

INTRODUCTION

Today, the cultivation and use of medicinal and aromatic plants due to human re-orientation to nature and natural products, side effects of synthetic materials and the discovery of new drugs from natural compounds that have complex chemical structures and cannot be synthesized, has grown greatly. Attention to natural products has led to the development of the use of various medicinal and aromatic plants and other natural compounds in their products in various food, pharmaceutical and cosmetic industries, which has ultimately led to the creation of a large market for these plants [37].

The increasing trend of increasing the consumption of medicinal plants without the development of proper methods of cultivation and proper management and planning, will have a worrying consequence, ie the destruction of nature. In this regard, the study of agricultural operations such as the time and manner of sowing, the method of propagation, the method of harvesting, feeding and managing it will t will play an important role in increasing the product and its quality [10].

Existence of 11 climates from 13 known climates of the world, having 300 sunny days a year and temperature difference between 40 to 50°C between the coldest and warmest zone in Iran has provided favorable conditions for the country in terms of having an exclusive ecology. These conditions predispose the growth and development of wild and medicinal plants [1,7]. The flora of Iran contains more than 8,000 species, of which 1,100 are used in traditional Iranian medicine [19, 25].

WTO reports from 2004 to 2013 show that China is the world's largest exporter and the United States the largest importer of medicinal plants. In general, the United States, Germany, China (Hong Kong) and India are the main centers of trade in medicinal plants in the world. China, the world's largest supplier and exporter of medicinal plants, exports its products to 103 countries, and China's exports have grown by 15% over this ten-year period [18].

The development of exploitation and production of medicinal plants and the creation of employment in this field is effective in order to diversify the strategic rural economy. The more diverse the rural economy is, the more opportunities and opportunities will be provided for the rural poor to have access to living standards. In the approach of sustainable livelihood, in order to solve the problem of poverty and increase the wealth of local people, much emphasis is placed on diversifying the economic activities of the villages. So that a more diverse rural economy leads to increased access and strengthening of rural capital as a result of their empowerment [12, 20].

Every strategy must have a long-term perspective. In many countries, medicinal plants seem to be a bridge between sustainable economic development, cost-effective health care and the preservation of vital biodiversity [33].

The definition of a medicinal plant is: Plants and plant raw materials include leaves, flowers, fruits, stems, bark, wood, roots, rhizomes, and other parts of plants that may be whole, powdered, or partial. Consume the component [2].

Protection of traditional knowledge based on medicinal plants, which is supposedly disappearing fast, is another major conservation issue. Traditional and indigenous knowledge and practices about the medicinal plants are weakening and, in many cases, vanishing altogether. [8, 9] noted that every year, the sum total of human knowledge about the types, distribution, ecology, methods of management and methods of extracting the useful properties of medicinal plants is declining rapidly. It is a continuation of a process of loss of local cultural diversity that has been underway for hundreds of years. Thus the conversion of socio-cultural traditions and indigenous knowledge into livelihood means and economic opportunities also has the advantage of preserving the rapidly eroding cultural knowledge and practices which are increasingly threatened due to globalization and the homogenization of people and communities [13, 14, 15].

Plants that have medicinal properties with an optimum active ingredient in some form or another are regarded as medicinal plants. These are invaluable natural resources; they are exhaustible if overused and sustainable if the juxtaposition of present and future needs takes place within the behavioral pattern of various kinds of users. Sustained and coordinated efforts are needed to transform unsustainable practices of medicinal plant collection from wild sources to more ecologically sustainable, socially acceptable and economically equitable production and utilization systems [23, 24, 26].

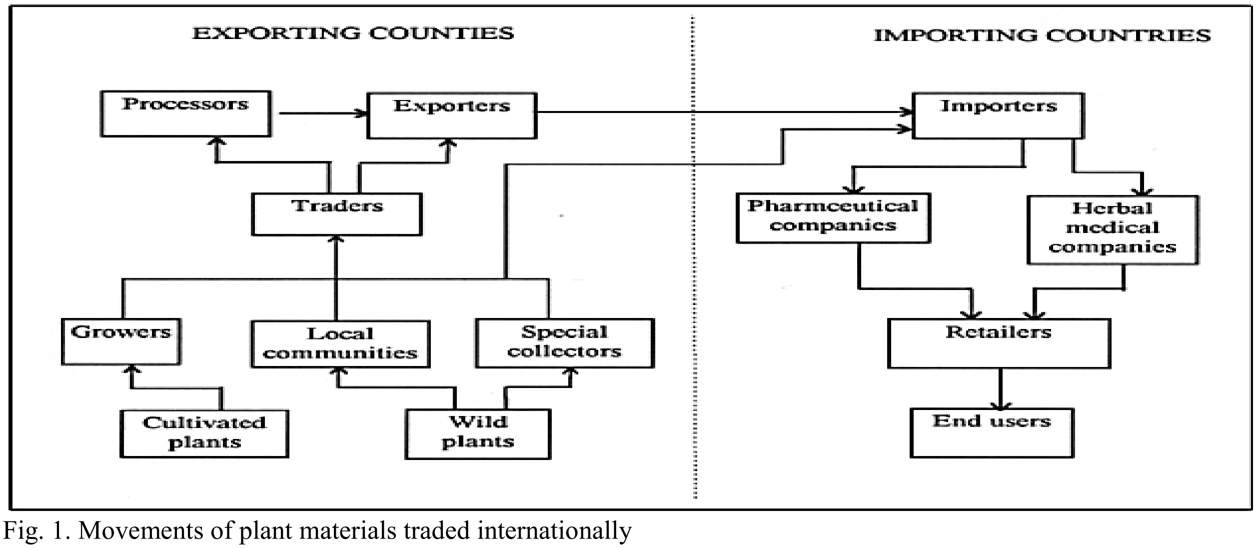

Fig. 1. Movements of plant materials traded internationally
Source: WWF, 2000 [36].

In the face of threats caused by both anthropogenic and natural reasons, the question of the production and sustainability of medicinal plants has emerged very strongly in recent times. These plant resources, therefore, have become important domains of intervention and are increasingly attracting the attentions of public and private sector policy researchers, policy makers and development program implementer. In recognition of such importance this research is undertaken to specifically focus on two key aspects of medicinal plants in Bangladesh: i) their local status and ii) the market scenario. First, the focus was on their status; the causes of threats were examined and conversely the measures and initiatives to conserve these medicinal plants and the associated livelihood and economic implications of such initiatives were evaluated. Second, the research critically examined the medicinal plant-based herbal market system, especially to map the industry value chain in function or place.

The studies on the topic offered by the literature in the field are summarized and presented in Table 1.

Table 1. Summarize the literature review

Researcher	Year	Summary of results
Silori and Badola [32]	2000	Economic and social knowledge of medicinal plant cultivation and evaluation of the future perspective of action for sustainable development among the local community and encouraging and promoting medicinal plant cultivation to improve the standard of living of poor communities as well as preserving these plants in nature and preserving indigenous and cultural knowledge in Help among the locals.
Saddiqui et al [28]	2004	The present century can be described as the century of return to medicinal plants.
Canter et al [5]	2005	Traditional and unreasonable harvesting of medicinal plants from nature, as well as misidentification by non-specialists who traditionally collect medicinal plants from the natural environment, causes environmental degradation, causes the loss of genetic diversity, so the production of medicinal plants It is a good alternative and an opportunity to overcome these problems.
Kala et al [11]	2006	Proper performance of medicinal plants can be very effective for sustainable development and improving the living standards of poor communities.
Schippmann et al [30]	2006	Many species of medicinal plants are traditionally collected and cultivated, which is why a number of organizations recommend that medicinal plants be cultivated sustainably, as sustainable cultivation is one of the most important Conservation strategies for most species of medicinal plants are due to their contribution to the local economy and more added value to the crop in the long run.
Kazemi et al [17]	2007	Before recommending to change the cultivation pattern, the agronomic conditions of the plant must first be adapted to the climatic conditions of the region.
Moradi et al [22]	2008	Work experience, level of education and participation in training courses are related to the level of knowledge of people about medicinal plants.
Doherty [6]	2009	In order to export more and more medicinal plants and improve the position of this product in the world, the selection of potential foreign markets is very important.
Kashfi [16]	2010	The emphasis of the World Health Organization on the gradual replacement of natural materials instead of chemicals has led various countries around the world to invest, plan cultivation and mass production of medicinal plants at the industrial level and use it in the pharmaceutical, health and food industries.
Sher et al [31]	2010	Lack of awareness of local people about the economic importance of medicinal plants has caused damage to vegetation and improper production of herbal medicines, as well as insufficient knowledge of the market and lack of government support for this industry has caused great damage to the trade of these plants. It has reduced the harvest and production of these plants.
Tatian et al [34]	2014	the farmers don’t tend to the medicinal plants cultivation because of unfamiliarity of medicinal plants kinds for cultivate and production, lack of confidence and satisfaction of good income from production and sale of these plants.
Mojaverian et al [21]	2015	Iran has an advantage in the production and development of medicinal plants.
Sadatpour [27]	2017	Due to the limitation of internal resources, the development of employment projects based on the cultivation and development of medicinal plants compatible with the ecological conditions of the region, can be a good way to conserve existing resources
Khodaverdizadeh and Mohammadi [18]	2017	Iran can improve its comparative advantage and export price of medicinal plants by connecting with new markets, accessing reliable foreign markets, and pursuing a policy of diversifying its target export markets and reducing its focus on a limited number of markets.
Noorhosseini et al [25]	2017	Factor analysis revealed that the main deterrents could be grouped into four factors related to i) limited support of MDPs, ii) poor access to processed MDPs, iii) lack of alternatives and spatial limitations, and iv) uncertainty and lack of confidence.
Bahl et al [4]	2018	Medicinal plants are now considered as important commercial items for the sustainable economic development of countries.
Astutik et al [3]	2019	we advance the need for empirical investigations on the performance of medicinal plants production systems and their contribution to livelihoods in diverse institutional contexts.
Trisilawati et al [35]	2020	Along with the increase in public awareness and the global demand of efficacious but safe herbal products, the organic cultivation of medicinal plants is a necessity. In organic farming, crop cultivation relies on the use of organic (natural) ingredients and avoids the use of synthetic chemical inputs (pesticides, herbicides, fertilizers), and genetically modified organism seeds.

Source: Authors' synthesis.

MATERIALS AND METHODS

The present study is an applied research in terms of purpose and descriptive-survey research in terms of data collection [29]. This research is also a type of field research in which the researcher is present to collect data in the desired areas. Part of this research has also examined related articles and books, which can be called non-field studies or library studies.

Photo 1. Pastures with medicinal plants
Source: Survey data.

Photo 2. Medicinal plants in the research area
Source: Survey data.

In this study, multi-stage sampling with proportional assignment was used. Cochran's formula was also used to determine the sample size (Equation 1). The statistical population of the study was the producers of medicinal plants in Torqabeh village located in Binalod Towenship in Iran. Due to its favorable climate, this area is a great advantage for the growth and cultivation of various species of medicinal plants. According to the census, there were 1,900 rural households living in the area, with more than 50% of the Panans engaged in the cultivation and harvesting of medicinal plants from the rangelands.

Equation 1: $n = \frac{\frac{z^2pq}{d^2}}{1+\frac{1}{N}\left(\frac{z^2pq}{d^2}-1\right)}$

where:
n = Number of research samples (204)
z^2 = 1.96
p = 0.5
q = 0.5
d^2 = Sampling accuracy (0.05 to 0.1) (0.06)
N = Number of research statistical population (1,900)

The data gathering tool in this research is a structured questionnaire that was prepared according to the goals and hypotheses of the research and according to the indicators and was conducted through an interview.
The 5-point Likert scale (1. Strongly Disagree, 2. Disagree, 3. Undecided, 4. Agree, 5. Strongly Agree) was used in structured questionnaire.
The Cronbach's alpha for the whole questionnaire was 0.80 (Equation 1 was used to calculate Cronbach's alpha).

Equation 2: $a = \frac{k}{k-1}\left[1 - \frac{\sum_{i=1}^{k} s_{i}2}{\sigma^2}\right]$

where:
a = Cronbach's alpha coefficient
k = Number of questions per component
s^i = The variance of each component
δ^2 = The total variance of the test

Table 1. Cronbach's alpha coefficient for questionnaire elements

Component	Number of variables	Cronbach's alpha coefficient
Awareness	10	0.805
Attitude	12	0.745
Economical factor	9	0.710
Social factor	7	0.817

Source: Survey data.

According to the results of previous researches, Asteraceae family with 2 species, Lamiaceae without 3 species, Euphorbiaceae, Malvaceae and Rosaceae each with 2 species are the most abundant species in the region (Table 2).

Table 2. The most abundant species in the research region

Family	Species
Apiaceae	Bunium persicum (Boiss.) B. fedtsch.
Asteraceae	Achillea arabica Kotschy.
Asteraceae	Sonchus oleraceus L.
Asteraceae	Tanacetum parthenium Sch.Bip.
Asteraceae	Tripleurospermum disciforme (C.A.Mey.) Sch.Bip.
Brassicaceae	Alyssum szovitsianum Fisch. & C.A.Mey
Brassicaceae	Descurainia sophia (L.) Webb & Berth
Euphorbiaceae	Euphorbia microsciadia Boiss.
Euphorbiaceae	Euphorbia spinidens Prokh.
Fabaceae	Astragalus sieversianus Pall.
Fumariaceae	Fumaria vaillantii Loisel.
Hypericaceae	Hypericum perforatum L
Lamiaceae (Labiatae)	Clinopodium graveolens Kuntze (Syn.: Acinos graveolens)
Lamiaceae (Labiatae)	Hymenocrater calycinus Benth.
Lamiaceae (Labiatae)	Mentha longifolia (L.) Hudson.
Malvaceae	Alcea angulata Freyn & Sint
Malvaceae	Malva sylvestris L.
Plantaginaceae	Plantago major L
Rosaceae	Crataegus turkestanica Pojark.
Rosaceae	Sanguisorba minor Scop.
Scrophulariaceae	Scrophularia variegata M.Bieb
Solanaceae	Solanum nigrum L.
Urticaceae	Urtica dioica L. subsp. Dioica.

Source: Research data.

RESULTS AND DISCUSSIONS

The result of research showed that the average age of respondents was 52 years and 87% of respondents were male. Also, about 78% of the respondents have illiterate or primary education and only 1% have university education.

Table 3. Description of the characteristics of farmers growing medicinal plants

Variables	Frequency	Percent	Cumulative percent
Gender			
Man	177	86.8	86.8
Female	27	13.2	100
Plural	204	100	
Age (years)			
<40	54	26.5	26.5
40-55	66	32.4	58.8
55-70	58	28.4	87.3
<70	26	12.7	100
Plural	204	100	-
Educational level			
Illiterate	40	19.6	19.6
Primary school	120	58.8	78.4
Secondary school	27	13.2	91.7
High school	15	7.4	99
Post high school	2	1	100
Plural	204	100	-
Main job			
Employee	3	1.5	1.5
Manual worker	3	1.5	3
Farmer	185	85.7	88.7
Other	13	11.3	100
Plural	204	100	-

Source: Survey data.

One of the things that helps to develop the cultivation of medicinal plants is the way the product is sold. Based on the research results (Table 4), it can be said that the main method of selling the product of medicinal plants produced by the farmer is selling to intermediaries (brokers).

Table 4. Type of sale of medicinal plants by Farmers

Type of sale	Frequency	Percent	Cumulative percent
Direct supply to the consumer	46	22.5	22.5
Direct supply to local distributor (Attari)	50	24.6	47.1
Sales through intermediaries(brokers)	80	39.2	86.3
sell of product to factories	28	13.7	100
Plural	204	100	-

Source: Survey data.

The level of farmers awareness about the production of medicinal plants was also evaluated by 5- Likert scale (VL=very low, L=low, M=medium H=high and VH=very high). The results showed that the highest level of farmer awareness is related to technical-production awareness in cultivation and harvesting of medicinal plants. Also, the lowest level of farmer awareness is related to social awareness in the cultivation and harvesting of medicinal plants (Table 5).

Table 5. The level of farmers awareness

Rank	Item	5-point Likert scale				
		VL%	L%	M%	H%	VH%
4	Social awareness	0.0	12.7	38.2	41.3	7.8
3	Economic awareness	0.0	17.6	36.3	34.3	11.8
1	Technical-production awareness	0.0	1.5	7.4	42.1	49.0
2	Environmental awareness	0.0	1.0	45.6	52.0	1.4

Source: Research data.

The relationship between individual characteristics and the farmer's awareness about the production and harvest of medicinal plants was also examined. the results showed that Variables such as income level, use of social networks, work experience and indigenous knowledge are related to the farmer's awareness (Table 6).

Table 6. Correlation test to investigate the relationships between variables

Dependent variable	Independent Variables	r	sig
The level of farmers awareness	Income frome sale of medicinal plants	0.360**	0.000
	Age (years)	0.019	0.785
	Educational level	0.066	0.351
	Use of social networks	0.357**	0.000
	Work experience in the production and harvesting of medicinal plants	0.408**	0.000
	Farmer indigenous knowledge	0.215**	0.002
	Belief in environmental protection	0.142*	0.043

Source: Research data.

The results showed that the type of sale of the farmer also affects his level of awareness. To test this hypothesis, Kruskal-Wallis test was used and the results showed that if a producer of medicinal plants sells his product to factories, it will have a positive effect on his level of awareness (Table 7).

Table 7. The Kruskal Wallis test of the average farmers awareness

The farmers awareness	**Ranking Mean**	df	Kruskal Wallis	sig
		3	71.062	0.000
Direct supply to the consumer	59.21			
Direct supply to local distributor (Attari)	57.36			
Sales through intermediaries(brokers)	123.03			
Sell of product to factories	129.59			

Source: Research data.

Also, the result of cluster analysis in farmers awareness showed that the variables such as: selling type and economic awareness in separating into two strong and weak the farmers awareness (Table 8).

Table 8. Analytical diagnostic function in the distinguishing variables of classes of farmers awareness groups (Enter)

Variables	Wilk's Lambda	F	df1	df2	sig
Selling Type	0.759	63.889	1	201	0.000
Economic awareness	0.688	45.417	1	200	0.000

Source: Research data.

In the general model, the focal correlation coefficient is equal to 0.559. Therefore, it can be said that 56% of the changes in the farmers awareness variable of the individuals under study are explained by these variables (Table 9).

Table 9. Canonical correlation and Wilkes lambda for the model

Eigenvalue	**0.454**
Percentage of variance	100
Cumulative percentage	100
Canonical correlation	0.559
Wilks' Lambda	0.688
Chi-square	74.888
Df	2
P-value	0.000

Source: Research data.

The variables of selling type and economic awareness had the highest standard coefficient and this shows the importance of these variables in predicting the farmers awareness (Table 10).

Table 10. Standard and non-standard coefficients of Canonical detection function

Variables	**Standard coefficients**	**Non-standard coefficients**
Constant	-	- 3.644
Selling Type	0.671	0.653
Economic awareness	0.572	0.036

Source: Research data.

$$Z = \text{Constant} + W_1X_1 + W_2X_2 + W_3X_3 + \ldots + W_nX_n$$

$$Z = -3.644 + 0.116533\ (\text{Selling Type}) + 0.036\ (\text{Economic awareness})$$

Also, the research findings show that this model correctly classifies 94.10 % of farmers with high awareness and 75.70% of farmers with low awareness (Table 11).

Table 11. Classification results to determine the accuracy of segregation

Classification	**G_1**	**G_2**	**Total**	**Accuracy of segregation**
	Frequency			
high awareness	6	99	105	
low awareness	78	24	99	
	Percent			
high awareness	5.90	94.10		
low awareness	75.70	24.30		80.30

Source: Research data.

The results showed that the average age of the respondents was 52 years and this indicates the high age of the farmers. The results showed that the lack of awareness of local people about the economic importance and insufficient knowledge of the product market has created many problems for the production and trade of medicinal plants. Based on the type of product sales, the highest frequency from the respondents' point of view is related to the option of selling to intermediaries. Factory sales are reported at only about 13 percent. This reported rate is not due to the reluctance of people to sell their products to factories, but because of the lack of factories.
Findings show that based on the level of technical-productive awareness of farmers, 81% is in good condition. Also, based on the level of social awareness of medicinal plant producers, it is 59% and weak.

CONCLUSIONS

According to the results obtained in the research area, the number of women producing medicinal plants is more than men, but their production is lower. This is rooted in traditional rural culture, where women are less involved in the economic sphere than men. Women own less land than men.
According to the results, the higher the level of economic awareness, the greater the general awareness of farmers producing medicinal plants. In the study area, farmers

have a moderate level of economic awareness. In addition, most of the population of these villages are elementary literate and have not received specialized training in the field of rural development and rural capacity.

The results showed that the level of awareness of medicinal plant producers in the community of producers who sell their products in different ways is different, the level of awareness in the three communities of supply to consumers and perfumers and intermediaries with the fourth community, ie supply The processing plant has created a very significant difference in the level of awareness of manufacturers.

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EFFECTIVENESS OF DRIP IRRIGATION TECHNIQUES ON THE GROWTH AND PRODUCTION OF PAK CHOY (*Brassica rapa usubsp. Chinensis*) IN GUNUNGSITOLI, INDONESIA

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Abstract

Proper drip irrigation techniques can optimize the use of water in crop cultivation. Pak Choy (Brassica rapa subsp. chinensis) is one of the commodities that can grow and produce more effectively using drip irrigation techniques. This study aims to look at the growth response and production of Pak Choy plants using drip irrigation system techniques. This research was conducted in Gunungsitoli, North Sumatra. The method used is a randomized design of groups (RAK) with 2 treatment factors, namely liquid organic fertilizer with drip irrigation system. The factor of liquid organic fertilizer (P) consists of 3 levels, namely P0 = Control; P1 = 2 ml/l; P2 = 4 ml/l. Drip irrigation factor (I) consists of 3 levels, namely: K0 = Control; I1 = 35 drops/minute; I2 = 45 drops/minute. The results showed drip irrigation techniques had a significant effect on the number of leaves (strands) 25 days after planting and 30 days after planting, and had no significant effect on the height of plants and the wet weight of Pak Choy plants

Key words: *effectively, drip irrigation techniques and pak choy plants*

INTRODUCTION

Plant cultivation techniques using drip irrigation are a solution to be able to optimize the use of water, especially in areas that are difficult to get access to water and during the dry season. Global climate change is also affecting the agricultural sector. In Indonesia, the area of agricultural land reaches 76 million hectares and more than 89 percent is dry land. To find out the condition of the soil that has water stress one of the indicators is to look at the number of dry days during the growing season. According to Agus et al. (2005) plant conditions for seven days or more without obtaining a water supply sourced from the rain so can result in inhibiting the growth process of plants while the roots of plants are still limited to several centimeters on the surface layer [2].

Plants can receive water through water from the ground and subsurface which can be done by soaking water into the soil under the rooting zone either through an open system or using porous pipelines. Water supply with a watering can be done by sprinkler irrigation or drip irrigation. Arsyad (2010), suggested that the use of water on the land can be more efficient by comparing the amount of crop production per unit used during one growing season. This can be done using drip irrigation techniques effectively [3].

This study will look at the effectiveness of the use of drip irrigation on the cultivation of Pak Choy plants both their growth and production. Pak Choy with the name "sawi sendok" (*Brassica rapa subsp. chinensis*) is one of the vegetable plants that are now widely cultivated organically in Indonesia (Perwitasari, 2012 and Fatma, 2009) [4, 14].

Effectiveness of Drip Irrigation Techniques to Pak Choy Growth and Production

Pakcoy vegetable production can be increased by making various efforts such as in the use of proper irrigation systems and good crop growing media. A proper drip irrigation system will give good results to the growth and production of Pak Choy crops on agricultural land. Advantages in the use of drip irrigation that can save water, energy, management costs, the use of appropriate fertilizers, energy and can also control diseases that exist in plants and can also be used for uneven land and narrow land (Susila and Poerwanto, 2013) [27].

The drip irrigation system is the most efficient irrigation system for crop growth in agricultural land. The efficiency of water use of drip irrigation systems can reach 80% to 90% due to the direct feeding of water to rooting areas regularly and slowly (Simonne et al., 2010) [21] and has an efficiency value of 80-95 percent compared to sprinkler irrigation and surface irrigation (Valenzuela, 1997; Shock, 2003; Mechram, 2008) [12, 22, 28]. The efficiency of water use in agricultural land can be optimized through the use of appropriate irrigation techniques (Haryati et al. 2011) [9].

Irrigation aims to meet the needs of plant roots to grow and develop, especially in dry conditions in a dry land. Irrigation is defined as a process of tapping or extracting water from the source for agricultural purposes to meet the needs of crop water (PP Irrigation No. 20, 2006) [13]. The supply of water in small volumes and sustainable through drip irrigation aims to maintain soil moisture to avoid losing such as percolation and runoff so that the availability of water for plants is fulfilled. Drip irrigation is a method of providing water with low discharge and high frequency continuously in plants either through the ground level or directly to the root zone using an emitter either single or in the form of a drip line (perforated hose) (Hanafiah, 2005) [6]. The flow of water in drip irrigation utilizes capillary forces and gravity that move vertically and horizontally in the soil profile (Hansen et al. 1992) [6].

Morphology of Pak Choy

Pak Choy plant has a taproot system with long round root branches that spread all directions at a depth between 30-50 cm (Setyaningrum and Saparinto, 2011) [20].

This plant has a very short stem and segments, so it is almost invisible. This stem serves as a shaper and leaf support. Pak Choy has smooth leaves, hairless, and does not form a crop formation. The stem of the leave is wide and sturdy, the bones of the leaves and leaves are similar to green Pak Choy, but the leaves are thicker than the green Pak Choy (Haryanto et al., 2007) [7].

The flower structure of Pak Choy plants is arranged in long, multi-branched flower stalks. Each flower bud consists of four petals, four crown leaves, four stamens, and one hollow two pistils. Pollination of the flowers of this plant can take place with the help of insects as well as by humans. Mustard fruit plants include a type of pod-shaped elongated and hollow with small round seeds blackish brown (Sunarjono, 2013) [26].

Terms of Growing Pak Choy Plants

Pak Choy is a seasonal plant that can only be harvested once. Pak Choy can be harvested at the age of 40-60 days (planted from seeds) or 25-30 days (planted from seedlings) after planting (Prastio, 2015) [16]. Pak Choy plants can grow on lowland to highlands with an altitude of 5-1,200 m above sea level. But Pak Choy plants will be better if planted on high ground with cool air (Haryanto et al., 2007) [7].

A good climate for Pak Choy growth is an area that has a temperature of 15-30oc, has rainfall of more than 200 mm/month, as well as solar illumination between 10-13 hours (Rukmana, 1994) [18].

The humidity suitable for Pak Choy growth is between 80-90%. Soil suitable for the growth of Pak Choy plants in loose soil that contains a lot of humus, fertile, with a pH between 6-7, as well as good drainage because Pak Choy plants do not like puddles.

MATERIALS AND METHODS

The research was conducted in Gawu-gawu Bousu Village, North Gunungsitoli District, Gunungsitoli City, altitude level is ±40 meters above sea level. The materials used in this study included several parts, namely Pak Choy plant seeds, liquid organic fertilizer, water. The tools used in this study included several parts, namely hand sprayer, aqua bottle size 1.5 l, infusion rope (diameter: 1 Ø 3.0 mm, 0 Ø 4.1 mm), scales, and other tools that support the implementation of research. The research method was a Randomized Design group (RAK) with two treatment factors, namely: Factor 1: The provision of liquid organic fertilizer (P) consisted of 3 levels of treatment, namely, P0 = 0 ml/liter;

P1 = 2 ml/liter; P2 = 4 ml/liter. Factor II: Administration of drip irrigation (I)/minute consisted of 3 levels of treatment, namely: I0 = 0tetes/minute; I1 = 35 drops/minute; I2 = 45 drops/minute. The implementation of the research was soil processing by making a plot with a size of 1 m x 1 m 27 plots with a height of 30 cm and a distance between the replay of 50 cm and the distance between the plot 30 cm which served as a drainage channel. Soil processing to 2 at once by inserting liquid organic fertilizer (POC) into the aqua that has been given 1 liter of water. Observations were made on the height of the plant (centimeters), the number of leaves (strands), wet weight per sample (grams), and wet weight per plot (grams).

RESULTS AND DISCUSSIONS

Drip irrigation system analysis had no significant effect on plant height 30 days after planting.

Table 1. Single effect of the drip irrigation system on plant height (cm) at the age of 30 days after planting

Treatment - Drip irrigation (ml/l)	Plant Height (cm)
I0	18.68^{tn}
I1	16.49^{tn}
I2	15.77^{tn}

Source: Own Calculated (2021).

Table 1 shows that the single effect of the highest drip irrigation application was on the I0 treatment of 18.68 cm and the lowest score was in the I2 treatment of 15.77 cm.

According to Hendriyani and Setiari (2009), the application of water with different volumes will not have a real effect on the growth of plant height (cm), because the difference in plant height depending on the type of planted plant [10].

But according to Sugito (2012), the amount of water that was less can also inhibit the high growth of plants because water that served as mineral solvents and nutrients in the soil was not enough to dissolve so that plants lack nutrients [23]. According to Rahmat, (2009) land with high permeability will be able to increase the rate of infiltration that occurred to lower the rate of running water [17].

Permeability is the ability of the soil to be able to hold water, if the ability of the soil in holding water is weak it will be able to affect the water in the irrigation channel, then the soil in the irrigation channel that has a weak permeability will be able to cause water loss in the soil (Sunardi, 2006) [25].

According to Isdarmanto (2009), with increased metabolic productivity, plants will need more nutrients and increase water absorption, this was related to the need for plants in the period of growth and development. Analysis of drip irrigation system has a significant effect on the number of leaves (strands) at the height of plants aged 25 days after planting [11].

Table 2. Effect of single drip irrigation system application on the number of leaves (strands) at age 25 days after planting

Treatment - Drip irrigation (ml/l)	Plant Height (cm)
I0	4.51b
I1	3.88ab
I2	3.74a

Source: Own Calculated (2021).

Table 2 showed that the single effect of the highest drip irrigation application was on the I0 treatment of 4.51 strands and the lowest score was in the I2 treatment of 3.74 strands. I0 treatment was no different from I1 treatment but different from I2 treatment. I1 treatment was no different from I0 treatment but different from I2 treatment. The I2 treatment was significantly different from the I0 and I1 treatments.

This was due to the age of 25 days after planting plants in the vegetative period where the roots have been numerous and the number of leaves has increased. In this vegetative period, Pak Choy plants can absorb nutrients through roots and leaves. Elements C and O are taken from the air in the form of CO_2 through leaf stomata in the process of photosynthesis. Water was also absorbed by plants through the leaves but in small amounts. Increasing the number of leaves will increase the rate of photosynthesis and produce carbohydrates in large quantities. Carbohydrate compounds were the basic ingredients for the synthesis of proteins and other compounds used to compose plant organs as well as plant life activities thus on the synthesis of more leaves (Hamim 2004). states more and more leaves allow more photosynthesis to occur. Increased photosynthesis will result in more and more photosynthesis so that the dry weight of the top of the plant will increase photosynthesis and the resulting energy was used to form and maintain the quality of the leaves [8].

This was following the opinion of Sarido and Junita (2017) [19]. Analysis of drip irrigation systems had no significant effect on wet weight per sample (gram) age of 30 days after planting.

Table 3. Effect of single drip irrigation system application on wet weight per sample (gram) at age 30 days after planting

Treatment - Drip irrigation (ml/l)	Wet weight per sample (gram)
I0	9.44tn
I1	8.42tn
I2	7.59tn

Source: Own Calculated (2021).

Table 3 showed that the single effect of the highest drip irrigation application was found in the I0 treatment of 9.44 grams and the lowest score was in the I2 treatment of 7.59 grams. Analysis of drip irrigation system has no significant effect on wet weight per plot (gram) age of 30 days after planting.

Table 4. Single effect of liquid organic fertilizer (POC) application with drip irrigation system on wet weight per plot (gram) at age 30 days after planting

Treatment - Drip irrigation (ml/l)	Wet weight per sample (gram)
I0	18.52tn
I1	25.37tn
I2	15.18tn

Source: Own Calculated (2021).

Table 4 reflected that the single effect of the drip irrigation system was found in treatment I1 of 25.37 grams and the lowest score was in the treatment of I2 of 15.18 grams.

According to Suhartono (2008) that water is a major component in plant life, about 70% to 90% of the fresh weight of plants containing water [24].

Water can enter the plant through the so-called diffusion process. The diffusion process is influenced by differences in water concentration and environmental factors that also play a role in the process of water balance in the soil, plants, and air. The results of the analysis in this study were different from the opinion of Poli (2009) in his research which suggested that the increasing number of plant leaves will automatically increase the fresh weight of the plant because the leaves were the sink for plants [15]. Also, the leaves on vegetable crops were organs that contain a lot of water, so with the number of leaves that were getting more and more, the water content of plants will be high and cause the fresh weight of plants to be higher as well. This showed that the research conducted has not met the water needs of Pak Choy plants because environmental factors such as high intensity of solar illumination will cause plant growth to be hampered by short stems and small leaves that cause low yields but high nutrient content in crops (Sugito, 2012) [23].

The response of plants to temperatures varied depending on the type of plant and the stage of growth. Pak Choy plant was a cold area plant so it was less suitable in hot areas such as Gunungsitoli. According to Adhiguna (2018) [1] drip irrigation technology can manage the provision of water in crop rooting zones in a sustainable manner to increase land productivity and cultivation activities can take place at all times. But this application should also pay attention to the optimal water needs of plant types.

It was very important to calculate the number of drops of water per minute to get optimal water needs to support the growth and production of Pak Choy plants because this plant was strongly influenced by climate conditions or environmental weather.

The application of a drip irrigation system based on the automatic controlling system can increase the efficiency of water use in plants because it was able to work based on the actual condition of agricultural land through the soil moisture level.

The effectiveness of cultivation using drip irrigation techniques can be achieved if paying attention to environmental factors that support the growth and production of Pak Choy plants.

CONCLUSIONS

Based on the results of research on the effectiveness of drip irrigation techniques to the growth and production of Pak Choy plants can be achieved if paying attention to environmental supporting factors such as season, the intensity of sunlight, temperature, and so forth. Researchers should also adjust the number of drops of water per minute sufficient for the growth and production of Pak Choy plants

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