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THE ROLE OF INFORMATION TECHNOLOGIES FOR THE DEVELOPMENT OF SMEs IN THE AGRI-FOOD SECTOR OF THE REPUBLIC OF MOLDOVA

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Abstract

The economic efficiency, the yield of the agricultural activities of the enterprise were the basis of some in-depth studies and researches, constituting the preoccupation of several scientists and specialists in the field. Currently, there are a multitude of scientific works on agricultural management, but there is very little research on the management of agricultural activities in terms of computerization, given that the process is relatively new, is being implemented and has not yet been completed, accumulated enough data to conduct scientific research. Despite the lack of data in agriculture, the computerization process has proven its importance in industry, services, etc. In this regard, it becomes useful to study the aspects of agricultural management in the context of economic computerization. The main purpose of this research is to identify opportunities for sustainable development of the agricultural enterprise by managing agricultural activities through the implementation of information technologies on the farm, taking into account the fact that many routine processes can be easily automated. General scientific research methods were used within the framework of comparative statistical analysis, as well as an analysis of the structure and dynamics, graphical interpretation of data on the informatization of agricultural enterprises at the international and national levels. In this research is noted the value of open, cooperative, publicly funded and locally funded data systems and technologies as first steps in supporting solutions that contribute to data justice for farmers. Greater economic barriers in agriculture certainly limit the extent to which digitalization can support the interests of marginalized farmers and food producers. Then is needed to work much more learned and pragmatically if we are to better understand what data justice means to the agri-food community and how it can be done sooner.

Key words**:** *agricultural development, information technologies, economic computerization, management*

INTRODUCTION

Currently, we are witnessing the introduction of information technology in most areas of life. The availability of these technologies is enhanced and accelerated by the spread of the Internet. This tool is the result of a communication revolution both in the internal and external environment of companies, government agencies, and in the personal, social life of every person anywhere in the world.

Based on the statement of one of the latest DEX 2016 publications, informatization technology is the use of computer science in the process of solving many problems. And, accordingly, computer science is explained as a science that studies aspects of automatic processing and analysis of information. All this leads to the fact that economic computerization is considered in two directions: automatic data processing and calculation of economic indicators [4].

Informatization is an absolute need that we cannot get rid of, it has a very big role in most aspects of our lives, it answers most of humanity's problems. Technologies have evolved over the centuries. Their importance lies in the comfort of use in any form always aimed at making life easier.

Gradually, information technology seeped from everyday life into such important economic sectors as agriculture. This inspired scientists to intensify the use of these technologies in agricultural activities, which entails the facilitation and simplification of numerous field and production processes.

Computerization can help not only with the present, but also with the approximation of the future. Can calculate potential profits and losses. And based on that, we can create plans and a list of precautionary steps for the future of our descendants [12].

According to the United States National Food and Agriculture Institute, farmers no longer have to apply water, fertilizers and plant protection products evenly throughout the fields [14].

Instead, they can use the minimum amounts needed and target very specific areas or even treat different plants differently.

Analyzing the global demand and consumption of agricultural crops for food, feed and fuel, a significant increase has been observed recently. This demand for plant materials has been expanding for many years.

However, recent increases in meat consumption in emerging economies, together with the accelerated use of cereals for biofuel production in developed countries, have put new pressure on global grain supply.

Today, given the intensity of growth in global demand for crops, two main approaches to solving emerging problems are widely used: increasing the area under these crops and increasing productivity on existing agricultural land. At the same time, it is worth considering the fact that these approaches are increasingly used as complementary to each other. For example, both of them will be included in the additional production of more than 200 million tons per year of the necessary: corn (*Zea mays*) and wheat (*Triticum aestivum*), which are fundamental crops in most countries of the world [5].

Both options will change the ecological footprint of agriculture. Increasing productivity on existing agricultural land is preferable for these two options, as it avoids greenhouse gas emissions and large-scale disruption of existing ecosystems associated with bringing new land into production.

At the same time, the economic aspect of increasing crop productivity allows farmers to continue working, investing in processes of efficiency and computerization of agricultural activities.

In addition, robotic technologies allow for more reliable monitoring and management of natural resources, such as air and water quality. It also gives producers more control over cost planning, procurement of materials, such as seeds, plant protection products, fuel and lubricants, etc.

Sustainable agricultural activities must make full use of technology, research and development, albeit with a much greater integration of local knowledge, specific to each locality, than in the past. This will require new and stronger partnerships between technical, investment-oriented and investment institutions [15].

The analysis should focus on both production systems and basic natural and socio-economic resources.

Everyone knows the fact about the problems of existing reserves and utilization rates of available natural resources. In addition, these needs are increasingly exceeding the individual capabilities of both enterprises and individuals.

Thus, there is a need to organize and implement regional, national and international mechanisms and processes for everyone to work together to support sustainable growth and the equitable sharing of benefits in all agricultural sectors, protecting natural resources and discouraging collateral damage.

The aim of this research is to identify opportunities for sustainable development of the agricultural enterprise by managing agricultural activities through the implementation of information technologies on the farm, taking into account the fact that many routine processes can be easily automated.

MATERIALS AND METHODS

The field of study of this work is determined by the economic informatization of agriculture, which is studied and analyzed from the point of view of its impact on the financial statements of companies. Within the framework of the study, scientific works of agricultural production specialists, as well as reports and studies from international agencies and national institutions were used.

In a conceptual aspect, the object of this study is specified at the level of agricultural enterprises. In their activities, the introduction of information technology is given a particularly important place, and as a result, particularly high expectations regarding economic efficiency arise.

For modern research, the methodology of data processing and the introduction of information technologies in agricultural production is divided into several directions [9]:

1) Electronic maps of agricultural land are formed using images that are received continuously from the satellite. This allows you to control and effectively manage agricultural activities. In addition, volumetric electronic maps of agricultural land contribute to more efficient control of the entire territory of the agricultural enterprise.

2) Visualization, that is, photo and video filming by drones, which is carried out as planned throughout the entire crop growth cycle. This is necessary, since the obtained objective data contribute to a more accurate assessment of the plant growth process and the identification of emerging deviations and threats. Also, it allows you to analyze the quality of sowing work, to assess the degree of damage to crops in a certain period of the year.

3) Online monitoring of agricultural machinery. The satellite coverage system, as well as data transmission via GPRS, the GPS tracking device allows you to track the necessary parameters of a working vehicle: speed, distance traveled, cultivated and uncultivated area in the field, etc.

4) Audit of agricultural land - the process of accounting for industrial land allows you to collect complete information about land relations within the company. This module includes agricultural land, required documents and maps that reflect the respective lease periods. Color-coded plots make it easy to identify an area that has already expired and immediately find all the information you need about the owner of that plot.

5) Weather stations providing the necessary data on weather conditions for appropriate plant growth. The necessary, more accurate information on the amount of precipitation, as well as timely forecasts of non-volatile factors that limit the use of herbicides, frosts, data on soil temperature conditions, the supply of productive moisture in various soil layers, can qualitatively improve the management of the production process of agricultural enterprises of any format.

6) Agrochemical analysis of fields - at present, there are various methods of chemical research of soil and analysis of crops. In this process, the vital parameters present in the soil are established, such as: soil acidity, the amount of organic matter in various layers, the content of permitted forms of nitrogen, phosphorus, potassium, calcium, magnesium and iron.

The solution of the object set in this scientific work was carried out on the basis of the application of general scientific research methods in the framework of comparative and statistical analysis, as well as through the analysis of the structure and dynamics, graphical interpretation of data on the informatization of agricultural enterprises at the international and national levels.

RESULTS AND DISCUSSIONS

Historically, agriculture has undergone a series of revolutions that have determined efficiency, yield and profitability to unprecedented levels. Market forecasts for the next decade suggest a "digital agricultural revolution" will be the latest change, which could help ensure agriculture for the needs of the global population in the future.

The digitalization process affects and changes every part of the agri-food chain. The control and management of resources in the entire production system can become highly optimized, individual, intelligent and proactive. If successfully implemented, it will be efficient in real-time with hyper-connectivity and appropriate data management [11].

And as a result, value chains will become transparent and easily coordinated at the most detailed level. At the same time, the development of crops and animals can be precisely controlled according to their own optimal parameters and recipes.

Agriculture in digital format will create in the future various high-performance and predictive systems that can adapt to changes such as climate change. Going forward, this will lead to increased and sustainable food security and profitability.

Within the framework of the Sustainable Development Goals [2], digital agriculture can result in and cause economic benefits through increased agricultural productivity, increased profitability and improved market opportunities that will lead to social and cultural benefits.

All this will subsequently contribute to the expansion of communication and integration, which, in turn, will entail environmental benefits as a result of the use of economic resources and timely adaptation to climate change.

Even today, the potential benefits of digitalization of the food sector are clear, although this will require major changes and transformations in agricultural systems, in the entire rural economy, as well as in communities and natural resource management [13].

At the same time, it is becoming clear that this is not an easy task and will require a systematic, comprehensive and holistic approach if there are to be many potential benefits.

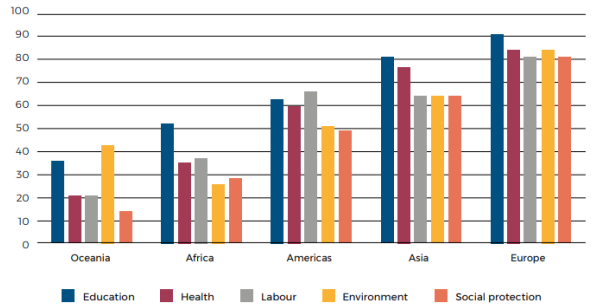

Fig.1. Government services provided by e-mail, SMS or RSS, % of field by continent
Source: UN Department of Economic and Social Affairs, 2018.

The spread and development of e-government services is generally very slow in the agriculture sector, and only a few frequency spectrum allocations are for radio frequencies that belong to other industries for communication between countries whose airlines provide e-agriculture services [6].

It is worth noting that countries and regions that pay significant, even priority attention to the introduction and development of information and communication technologies in the agricultural sector, have an improved business environment, the necessary regulatory framework for the agri-food industry. And this is most often associated with the use of information technology, and not with the quality of human capital or the contribution of the main sectors of the economy to the country's GDP.

Therefore, we analyze the results of the development and implementation of successful programs and strategies for digital agriculture in developed countries. This is achieved, most often, due to the fact that this sector is one of the key development goals in the respective national digital strategies, the task of which is to transform not only industry, but society as a whole [16].

Whereas, in developing countries, the basic services of technologically equipped agriculture are included in e-government programs and strategies. In addition, they are part of information and communication technologies, through which only the main parameters of e-agriculture are provided, which are related to early warning and general information about the state of agricultural land [6].

Today, the use of information technologies is important, which contributes to the need for policy development and effective regulation of the data generated [7].

In addition, standardization is important, the absence of which in many aspects, such as the format and ownership of the data provided, can provoke inconsistencies. Such situations arise when large multinational companies are skilled in digital agri-food production, and their partners in the form of smallholders and farmers can simultaneously use the same technologies, but at once to solve several problems that are important for both rural society and agriculture [8].

There are well-known predictions that as the world's population grows to 9.8 billion in 2050, living standards are also expected to

rise in some regions and incomes in developing countries, which will provoke overall demand for food to increase by more than 50%. And the demand for animal products will grow by almost 70% [2].

But we must not forget that hundreds of millions of people are already starving today, and the agro-industrial sector already uses almost half of the world's land covered with vegetation. At the same time, agricultural production and general land use account for more than a quarter of annual greenhouse gas emissions.

In these circumstances, it is important not only to ensure the effective implementation of information technologies and to benefit from agricultural discoveries, but also to create conditions that would enable the world to achieve a sustainable food future by meeting the growing demand for food. In this direction, it is necessary to include such measures as: prevention of deforestation and reforestation, restoration of abandoned and unproductive lands, so that all this contributes to climate stabilization, and ultimately leads to economic development and stability, as well as poverty reduction.

A comprehensive solution to these problems requires the introduction of many innovations. It can be noted that the researchers have demonstrated good creative innovation potential in all required areas.

There are research findings that include crop characteristics and properties or additives that reduce methane emissions from rice and cattle, improved fertilizer forms and crop properties that reduce nitrogen leakage, solar-powered fertilizer manufacturing processes, organic sprays that keep food fresh for a longer period of time, and grass-fed beef substitutes [8].

The revolution in molecular biology opens up new possibilities for crop reproduction. Progress on the scale required will require significant increases in R&D funding and flexible rules to encourage private industry to develop and market new technologies [3].

Regulating the implementation of information technologies in the Republic of Moldova

In order to supervise and ensure the observance of the rights of all citizens of the Republic of Moldova according to the Constitution, the legislation and normative acts of the relevant agencies are to establish various mandatory requirements, restrictions and regulations. Currently, the Air Code of the Republic of Moldova no. 301/2017, in force since March 23, 2019, created the primary regulatory framework for unmanned aerial vehicles [1]. Thus, the Code expressly introduced the notion of unmanned aircraft, and Article 33 established that their flight may take place only with the permission of the Civil Aviation Authority, unless the flights take place in the specially reserved space, in accordance with the procedures in place for the allocation, reservation, segregation of areas of national airspace in which flight operations take place.

Also, in accordance with the provisions of art. 4 Law 143 on airspace control, the use of airspace of the Republic of Moldova for aerial photography and filming is carried out with the written permission of the Civil Aviation Authority and the mandatory approvals of the Ministry of Defense and the Intelligence and Security Service of the Republic of Moldova [10].

The principle of the use of remotely piloted aircraft (drones) must ensure a level of security equivalent to that of manned aerial operations and strict control over the protection of personal data and privacy.

The legal planning and conduct of remotely piloted flight activities is conditional on the written approval of the Civil Aviation Authority, the sole purpose of which is to ensure flight safety, aviation security, privacy and personal data [10].

Over time, it has been shown that the regulation of computerization is carried out last, after the exploitation of technologies for a period of time. Given that information technology is a new step in the development of society, computerization is a largely unknown field, many aspects are to be defined, implemented and capitalized at fair value. Thus, the state reacts late to the evolution of information technologies implemented in agriculture, intervening with certain standards, recommendations and

restrictions for each technology implemented or to be implemented.

Information technologies are being implemented in agriculture at a particularly frantic pace, including in the Republic of Moldova, where implemented technologies include:

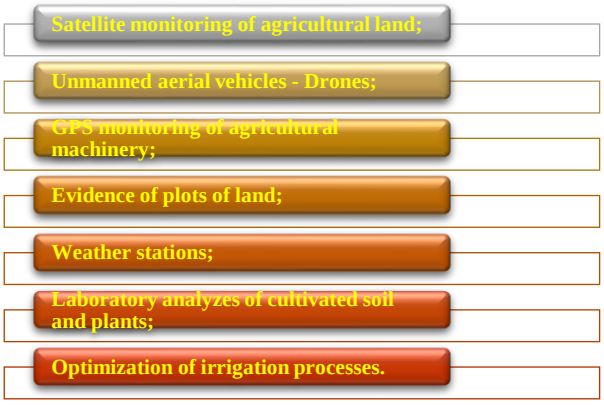

Fig.2. Digital technologies implemented in the agro-industrial sector in the Republic of Moldova
Source: Prepared by the authors.

Satellite monitoring allows you to quickly assess the state of agricultural land using satellite images based on a standardized indicator of vegetation differentiation for each field. With this indicator, you can assess the condition of each crop and adjust fertilizer plans. Thanks to high-resolution images, the quality and uniformity of plants that have emerged in the field can be remotely assessed, and then, if necessary, they can be moved to problem fields for further research.

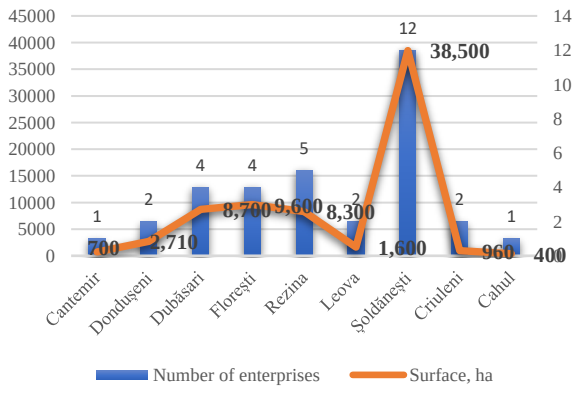

Fig.3. Territorial location of the entities in which the computerization is implemented in the Republic of Moldova in 2019
Source: Prepared by the authors on the base of SAS MD.

The uneven distribution of vegetation in the field from year to year indicates the presence of a biological problem. Also, the history of electronic maps of agricultural land allows a comprehensive analysis of world production obtained through the introduction of plant protection products and fertilizers. To access the monitoring platform, a farmer from the Republic of Moldova has to pay $2.5 per hectare.

The afore mentioned technologies are successfully implemented on a total area of 71,470 ha in the Republic of Moldova. The territorial location of the agricultural land areas is represented in Figure 3.

In addition to the parameters mentioned, an important aspect is the actual fuel consumption. Thus, with the help of an additional device, it is possible to control the actual operation of the engine of technical means by setting the actual fuel consumption and engine operating time. Connecting an additional device makes it possible to view on the electronic map all the moments when the combine used for harvesting is unloaded.

Another device used in agriculture in Moldova is an RFID assembly consisting of an RFID reader and an RFID tag. Thus, the personal card of the operator who has to perform a specific job is inserted into the RFID reader, and each RFID tag is tied to the serial number of the equipment. As a result, the kit allows you to visualize in the software the number of hours worked by the operator, the machined surface, the hours of use of the machine, the machined surface of the machine, etc.

But, one of the most important problems is that the equipment of a unit of agricultural machinery costs of an entrepreneur from the Republic of Moldova are in the amount of 500 US dollars.

This means that in addition to the advantages offered by the implementation of informatization in the management of agricultural activities, there are a number of shortcomings of the process. The ability of entrepreneurs to exploit the strengths of their technology enterprise for sustained economic development will depend on how quickly and

efficiently the weaknesses of the company's digitalization will be anticipated and taken. The following weaknesses were identified as the biggest obstacles to the implementation of computerization in order to meet the development challenge of agricultural entities:
-Outdated management supporters, organizational frameworks and human resource strategies of many agricultural and private sector producers in the agricultural field;
-Insufficient investment in employment training and poor continuing education and quality, especially at the enterprise level;
-Weak investments of Moldovan companies in production processes, installations and competitive equipment;
-Lack of civilian research and development intensity of economic activity and insufficient breadth of the civilian research and development portfolio, including reinvestment in high-risk or difficult-to-increase productivity technologies for individual farmers;
-Insufficient knowledge and interest in originating technology outside the companies researched by many agricultural enterprises;
-Lack of a strong institutional structure for technology policy in support of national economic development.
Today, farmers need to open up to the endless possibilities that technological advancement can bring to agriculture. Cultivation of agricultural crops according to traditional planting strategies is not enough, there is a need for involvement in researching new and improved cultivation methods, implementing good practices obtained during the study of aspects of crop development. Today's society can benefit from agricultural advances and live sustainable lives by improving production, harvesting methods and the distribution of agricultural goods. All these effects are possible through the successful combination of computerization also the agriculture, this is one of the reasons why farmers are increasingly encouraged to take part in this change of humanity.

CONCLUSIONS

The potential environmental, economic and social benefits are significant, but there are also associated challenges that may be some specific priorities for future work are:
• Facilitate the collection of data on digital technologies and digitization at local and national level and of the population, in particular to show differentiated information about urban and rural areas;
• Creating sustainable business models that provide viable digital solutions for the inclusion of small-scale farmers in the process of transforming digital agriculture;
• Creating a legislative framework in order to protect the data of agricultural enterprises;
• Creating a national indicator that takes into account the development of digital agriculture in the context of the cultural, educational and institutional dimensions of a given locality, both in terms of availability of basic conditions and for activators of digitization and potential economic, social and environmental impacts of the process. Such an indicator would help to create a context for the development of future digital agriculture strategies for the whole state, which begins with raising public awareness of the concept of digital agriculture and the importance of digital technologies for the food sector and continues with steps towards transforming digital agriculture. The analysis of these challenges is not intended to be exhaustive, but rather to outline and clarify some of the most widespread policy concerns at the sector level, in a way that is useful to a wide range of decision-makers and decision-makers. scientists. In particular, we note the value of open, cooperative, publicly funded and locally funded data systems and technologies as first steps in supporting solutions that contribute to data justice for farmers. Greater economic barriers in agriculture certainly limit the extent to which digitalization can support the interests of marginalized farmers and food producers. Then we need to work much more learned and pragmatically if we are to better understand what data justice means to the agri-food community and how it can be done sooner.

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