

THE ROLE OF THE IMPLEMENTATION OF DIGITAL TECHNOLOGIES IN THE DEVELOPMENT OF THE AGRICULTURAL SECTOR IN THE REPUBLIC OF MOLDOVA

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Abstract

Digital technologies represent a new direction increasing the efficiency of the agro-industrial sector and the sustainable development of agriculture. At the current stage, we can note the role of the transmissibility of new technologies and innovations in the agri-food complex, vis-a-vis regional improvement and development, the need for economic-financial and human sources for the implementation of innovations, as well as the efficiency of their implementation in practice. Management efficiency is treated through the complex and synergistic approach of economic, financial and ecological efficiency of enterprises. The purpose of the present article is to propose the digital assurance chain and to analyze the importance of current digital services in the development of intelligent management in agriculture. In the process of developing the objectives proposed in this article, the authors used the following methods, such as: analysis and synthesis, the statistical and mathematical method, the comparative method, the survey, the interview that would ensure the development of the entire economy by ensuring the sustainability of the agri-food sector. The proposed proposals will be used by agricultural entrepreneurs, not taking into account specialization and fields of activity, as well as by certain state institutions in the Republic of Moldova.

Key words: agri-food sector, development, Industry 4.0, farmers-innovators, digitization.

INTRODUCTION

One of the impediments to new digital technologies and innovations is the inefficiency of management at the level of the region and of economic agents in the agri-food sector. The innovative agricultural sector is connected to the leading field of environmental verification in close connection with production standards. In our view, improving management through the use of new digital technologies is the future of agriculture, and attempts to ignore them lead to the stagnation of the development of this sector [1].

We state this hypothesis because there are already international studies that prove the fact that the Internet of Things, robotics, artificial intelligence and big data are already there applied by agricultural entrepreneurs and these modern tools are essential contributors to streamlining the management of production

processes in this sector and contributing to ensuring a sustainable development of the economy [5]. In the foreground, in this context, the problem of making the management of the sector more efficient appears agricultural, because according to international estimates, the world population will reach the figure of 9.2 billions until 2050, and to satisfy the population's demand for agricultural products, farmers must produce 70% more (FAO) [10].

At the same time, the progress achieved at the global level has caused the pollution of the environment and the depletion of natural resources, and the continuity of mankind could be undermined by poor management of land and water resources, as well as pollution of the environment. The current conditions of activity, the global economic and health crises impose producers to implement new models of agricultural business management instead of those traditional, to preserve sustainability in

agriculture. Globalization, which affects the agricultural sector, imposes a new strategic vision regarding the digitization of agriculture.

Literature review

Romanian, Russian and native scientists and researchers: Amarfii [1, 2], Parmacli D., [11], Bajura T, Stratan A. [4], Todorova and Zaharco [15] and others, present several approaches to the problems related to the implementation of digital technologies in the economy, agriculture, service sphere. Todorova and Zaharco [15], Boincean [7], examine the development of the agricultural sector through the application of ecological technologies, the creation of processing enterprises on principles of "green economy". The complex approach to economic, financial and ecological efficiency is supported by researchers Perciun and Amarfii [13], Studies by researchers Beluhova-Uzunova and Dunchev [6], examined the implementation of innovations and digital technologies of regions and industry entities. The application of digitalization-based mathematical models for estimating business efficiency, including in the agricultural sector, was mainly examined by Russian researchers: Hedley [8], Hirsch-Kreinsen [9], Angelova and Stoyancheva [3].

In this context, the aim of the paper is to propose the digital supply chain and evaluate the role of modern digital products in increasing management efficiency in the agricultural sector.

MATERIALS AND METHODS

In order to achieve the objectives proposed in the research, the general scientific methods were applied: analysis, synthesis, history and logic, critical analysis of materials, clustering, but also methods of analysis and economic-financial diagnosis, survey, statistical processing of empirical data and official data, the method of graphs, indicators and indexes, comparison, grouping, etc.

The studies that have been carried out denote the theoretical and conceptual part of the effectiveness of management in the agricultural field under the conditions of the

use of ICT, as well as the theory of improvement-economic development strategy Industry 4.0 in the digital age. The refinement of the theoretical term of industrial ecosystems in the agri-food field can serve as an example for the efficient management of the given field, financial flows, relations with customers and company personnel [12]. The innovation brought by Industry 4.0 consists in the fact that the product until the finishing process of production can interact with the production machinery so as to transmit the information for the following stages of the processing process. This communication between the product and the factors of production achieves the connectivity between the elements of the production process as a whole, giving birth to an intelligent production system, capable of making decisions and communicating autonomously [1].

RESULTS AND DISCUSSIONS

As seen in the streamlining of production and service management, Industry 4.0 focuses on creating intelligent and communicative systems, including machine-to-machine communication and human-machine interactions. Now and in the future, enterprises must deal with establishing effective data flow management that is based on the acquisition and evaluation of data extracted from the interaction of intelligent and distributed systems. The main idea of data acquisition and processing is the installation of self-monitoring systems that allow taking precautions before operating the system. Thus, companies sought the right adaptation of Industry 4.0 [3]. The development of digital agriculture could catalyze a radical transformation of all industries, because digital agriculture will not only change the way farmers work, but will fundamentally transform every link of the value chain in the economy. Digital agriculture will affect farmers' behavior and will also affect suppliers, processing, distribution and retailing of agricultural products to consumers. Digital technologies can be applied at all levels and sectors of activity and

reflect a radical change in resource management towards optimized quality, individualized, intelligent and anticipatory, real-time, hyper-connected and data-driven management [1].

Another international practice in the field of Agriculture 4.0 is the virtualization of agri-food supply chains (Fig. 1).

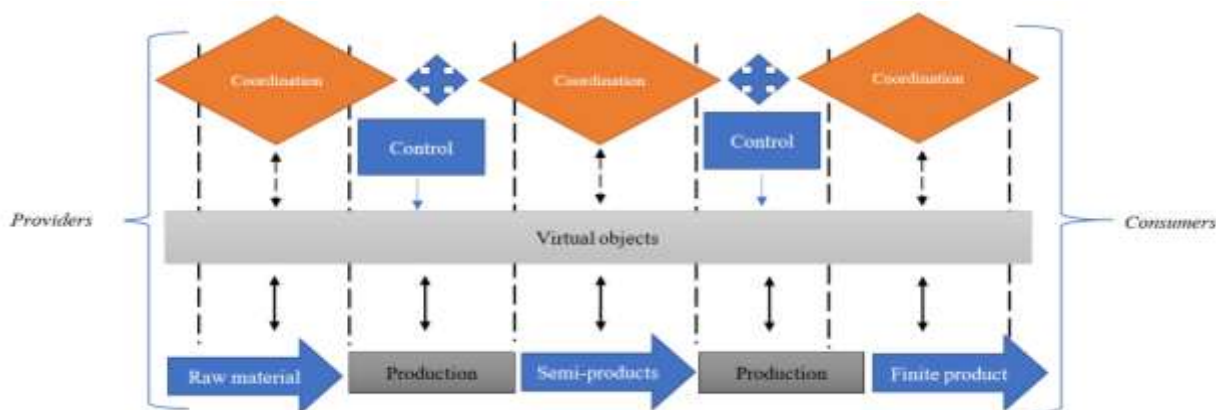


Fig. 1. Virtualization of supply chain management through the Internet of Things
Source: Elaborated by the authors.

The components of the supply chain are inputs (pesticides, fertilizers, mature agricultural products, crops, shipments and orders, packaging, etc.) that undergo transformation processes through agricultural producers, product processors, traders. The fourth industrial revolution allows enterprises to efficiently combine production capacities and speed of meeting consumer demands, based on a more productive and competitive management system. In the framework of digital agriculture, existing technologies enable the realization of smart farms. However, the acceptance of technologies by individual farmers depends on several factors, primarily financial capabilities, but also the ability to use and identify best practices in the given field. The importance of a change in farmers' mentality is crucial to enable an efficient and sustainable production system. Although considerable research efforts have been devoted to the development of intelligent models in the agricultural sector, their application to individual farms is limited, despite the many advantages that intelligent agriculture can bring; how these might be achieved in the dimensions of productivity, compatibility and sustainability remain unclear [4]. A structural approach, legislation appropriate to the technological environment,

improvement techniques and new qualifications are decisive for agriculture 4.0. Industry 4.0 in agriculture represents a new stage of development of this sector. Information products and technologies allow not only the creation and maintenance of databases, but also provide high speed of adaptation to changes, building algorithms that can automate decision-making processes [1]. The premises of the digitization of domestic agricultural enterprises and the implementation of Agriculture 4.0 are determined by international and European trends in the field of business digitization, the potential for digitization of the national economy and the agricultural sector, but also the way entrepreneurs and managers in this sector perceive the need for digitization. Industry 4.0 is a political, economic and social challenge for the whole world, the aim of which is to absorb digital innovations in products, processes and business models. Many developed countries in Europe, America and Asia have included the concept of Industry 4.0 in their long-term development plans. In Europe, more than 1,300 billion euros will be financed over 15 years in the improvement of digital technologies. Many enterprises from Europe, the USA and Asia have been accepted into the

team for the use and promotion of Industry 4.0 components in their work. The digital systems currently owned by international companies are evolving rapidly, and information is being stored in the cloud to increase availability and accuracy [12, 11, 9]. All this allows greater flexibility to changes (both anticipated and unexpected) in the production process. Strengthening cooperation between machines and people will enable manufacturers to improve product quality by reducing manual work and increasing the use of real-time data to detect errors. Automation also increases the efficiency of logistics in the enterprise. Production processes will become more flexible. Robots, smart machines and smart products that communicate with each other and make certain autonomous decisions provide this flexibility. Digital agriculture is the most effective and necessary approach to achieve all these transformations by using computing and communication technologies to increase profitability and sustainability in agriculture. Therefore, technological innovation in the field is considered a solution for agro-industrial countries. Agricultural technologies, based on IT products, automation and robotization, used on a large scale will catalyze the increase in productivity and profitability of agricultural activities. The digitization of agriculture improves working conditions for farmers, reduces the negative impact of agriculture on the environment, but also ensures a much higher profitability of agricultural enterprises [4, 7].

In a short time, digital agriculture will take the place of the traditional one, the producers, understanding that by investing in technology, they can achieve effective results, such as the economy of raw materials and other resources either material or financial.

Results of the survey with entrepreneurs and managers in the agricultural sector

One of the basic stages of recognition of economic agents in agriculture is the need to digitize agricultural businesses, the priorities of making financial investments for the modernization of the given sector. Calculation of the degree of perception of economic agents in agriculture, of the need to modernize

the agricultural business, an empirical study was conducted on the degree of digitalization of agricultural enterprises with the help of digital survey tools. The electronic survey was applied to a representative sample of 200 entrepreneurs and managers active in the field of plant breeding, animal breeding and the provision of services in agriculture.

The Survio digital platform was used to conduct the electronic survey, 2022 [14].

The study carried out, applying the clustering tool, allowed us to group entrepreneurs and managers in the agricultural sector, according to the degree of perception of the need to implement IT in their activity into four basic types of farmers:

a. *farmers-innovators*, who develop new innovative products to make the production process more efficient in agriculture, represent 7% of those interviewed;

b. *advanced farmers in the use of IT* products, those who use modern sensors, satellite images and other products to increase agricultural performance, represent 12% of the total;

c. *farmers who are interested in the implementation of IT* in agriculture and are experimenting with some products (trying to apply some IT products because they understood their usefulness) - 33%;

d. *conservative farmers*, who give up the use of new technologies in agriculture (they consider the technologies to be expensive and ineffective) - their share is 48% (Fig. 2).

The existing gap between the 4 categories of farmers and the large share of conservative farmers (48%) has a negative impact and stagnates the implementation of information technologies in agriculture.

Among the interviewed farmers, 63% mentioned the lack of financial assistance and government subsidies for the implementation of ICT in agriculture, as well as the lack of fiscal incentives for agricultural enterprises that make investments and apply digital technologies in their activity.

In the empirical study, the tendency of farmers for the widespread use of sensors, drones and high-performance monitoring systems, which require access to the Internet, was found.

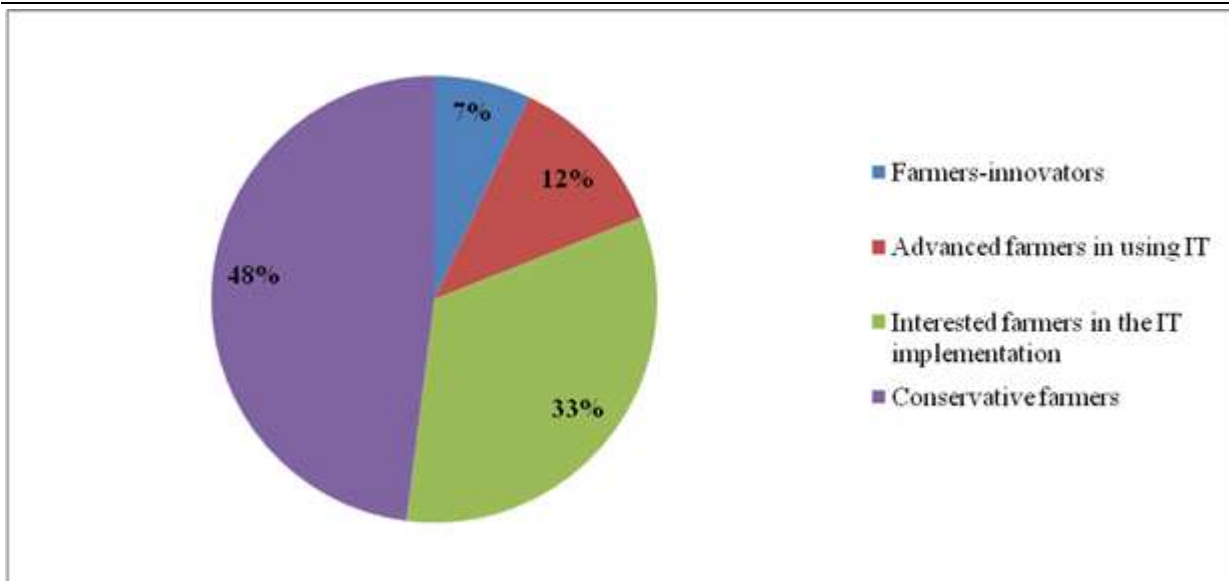


Fig. 2. Classification of the entrepreneurs and managers dealing with agribusiness, according to the degree of perception of the need to implement IT in their activity
 Source: Own results.

According to the survey, 18% of the interviewed farmers rated the WI-FI network as "good quality", 23% called the access to the wireless network "problematic", and for

9% of the farmers the Internet is of "bad quality". The other respondents rated the quality and speed of the Internet as "satisfactory" (Fig. 3).

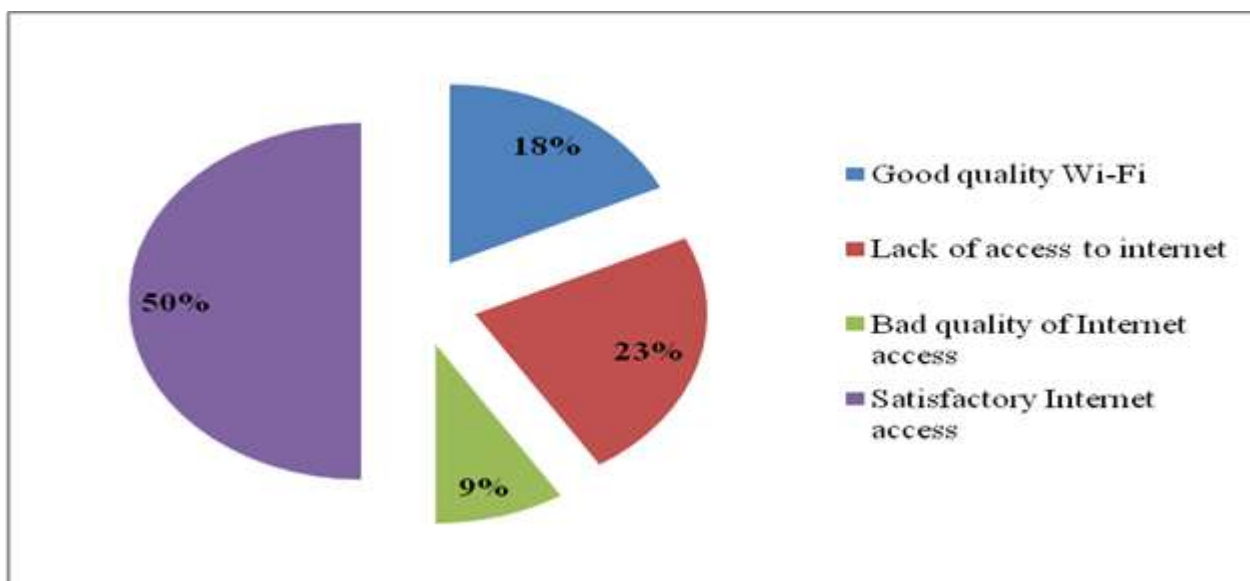


Fig. 3. The respondents' answers regarding the Internet and Wi-Fi access
 Source: Own results.

If certain information is not received in time and there are connection problems, the value of precision agriculture is reduced. The survey in question had Moldovan farmers who are active users of the 4G network as respondents.

The farmers interviewed also referred to the diversification of remote management capabilities of agricultural processes in the research. In our view, this is an important step in the development of digital agriculture.

Table 1. Perception of the need for digitization of agricultural businesses

Answer options	Answers	%
Very necessary	103	51.5
Necessary	65	32,5
A medium need	23	11,5
It is not necessary	6	3
I do not know	3	1.5
Total	200	100

Source: Own calculation.

As a result of the assessment of the degree of perception of the need for business digitization by entrepreneurs and managers in the agricultural sector, 51.5% of respondents mentioned the implementation of information technologies in the business they manage as "very necessary" and 32.5% as "necessary", 11.5% consider the digitization of business "an average necessity", and 3.0% consider that agricultural businesses should not be digitized

Mobile applications have capabilities for setting and changing technology parameters. For example, the app can change settings on an unmanned tractor or a garden robot without interrupting the work process.

Mobile applications for parallel guidance and fertilizer and soil moisture monitoring systems are popular among ICT-advanced farmers.

Therefore, there is a tendency among farmers to intensively use ICT products, creating favorable conditions for the development of digital agriculture.

So, the involvement of digital technologies in the field of agriculture of the Republic of Moldova will increase the growth of economic and financial indicators by reducing and optimizing the costs of human factors and the optimal distribution of means and successes achieved will reflect on sustainable development, the development and rational use of natural resources.

CONCLUSIONS

In the opinion of the authors, for the development of the potential of digitization in the field of agriculture in the country, the need for marketing services to promote digitization ideas in rural localities, i.e. agricultural

entrepreneurs, the improvement of digital knowledge for the development and use of digital technologies in the field of agriculture and the formation of a sufficient innovation environment is opportune. to attract investment and external funding for the development of digital services in agricultural businesses. Digital technologies in agriculture must be applied based on the strategic approach of the state, the systematic development of innovative programs aimed at the branch of plant and animal breeding in the regions of the country.

The empirical study carried out allowed us to validate the hypothesis regarding the need for digitalization of agricultural businesses in order to make management more efficient, perceived by trainers and managers in this sector of activity. For the practical use of Industry 4.0 innovations in agriculture, it is necessary to meet the economic, technical, environmental and personnel criteria. The efficiency of information technologies in agriculture is proven economically in international practice, regarding the Republic of Moldova, the authors analyzed the agricultural sector and determined the connection between the use of ICT tools and the efficiency of the management of economic agents in agriculture.

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