Use of digital technologies in the agro-industrial complex

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Abstract. Digital technologies will continue to fill our world, creating new opportunities to change our lives. The world we live in is literally awash with digital technologies. They initiate and continue to initiate changes, running through all aspects of our lives, our environment, and the entire society of which we are a part.

The use of digital technologies in this paper is considered as a key factor in the complete transformation of the functioning methods of the agro-industrial complex and agriculture. The article examines the role of digital technologies in the agro-industrial complex, notes the benefits of using innovative digital technologies, and describes the factors that hinder the process of informatization of the agro-industrial complex (AIC). It also provides examples of how the use of digital technologies contributes to the improvement and functioning of agri-food systems efficiency.

1. Introduction

The deployment of the digital revolution on a global scale is increasingly immersing us in a new reality [1]. The variety of technical and technological innovations that change our lives has increased many times in the last decade, and in the most diverse areas of human life [2].

The concept of the digital economy, which appeared at the end of the XX century, is usually associated with the works of N. Negroponte and D. Tapscott [3]. As N. Negroponte noted a quarter of a century ago: being digital is more than just living in a situation that has all the characteristics of the digital [4].

The rapid development of new technologies for the transmission, management, collection and use of data in digital format has led to a complete transformation of the agro-industrial complex (AIC) functioning and agricultural practices around the world. Such transformations are brought to the fore in large commercial farms and are actively manifested today in the world, where many agricultural holdings use advanced digital technologies. Farms of industrial type with livestock complexes and land have management know-how and financial resources that allow them to apply and acquire the latest technologies. Some farms in the field of information technology employ experienced specialists who are able to develop digital approaches to solve issues related to the farm activities.

Digitalization of the agri-food sector will change the nature of the work itself and the structure of the labor market. It will redefine the role of rural entrepreneurs and farmers and change the requirements to skill set that is in demand in the agri-food sector. Digitalization can change the place where work is done and the very essence of work, and such changes, apparently, will have different
effects on men and women working in the sector due to different levels of skills in using digital technologies [3].

In such way, today there is an experience of using a satellite monitoring system. The use of hyperlocal weather information helps in making marketing decisions and encourages local activities. Information platforms enable farmers to monitor and plan the use of agricultural machinery, as well as find sellers and buyers of products and goods. Diseases and pests can be detected remotely (thanks to digital images from unmanned aerial vehicles (UAVs) and satellites) and timely take the necessary measures to combat them. To measure soil moisture, soil monitoring devices are used that optimize irrigation systems and assist in the application of new individual approaches to water management. Mobile phones send signals about the sequence of actions to agricultural equipment. Complex applications in the field of management are used to plan the work of farms. Harvesting and production monitoring tools control the quality of agricultural products. In this regard, the main component of the farmer's toolkit is the Internet [4].

2. Methods and types of the Earth’s remote sensing

The paper uses both methods based on generalization and identification of the experience of expert specialists, and methods of formalized representation of management systems, including statistical and analytical research methods.

3. Analysis of the main ERS data sources for the DEM development

There are significant gaps in digital economy development in different countries. Thus, the share of ICT in Russia's GDP is 2.7%, and in value added in the business sector - 3.4%, which is 1.6 times less than in the countries of the Organization for Economic Cooperation and Development. According to this indicator, the Russian Federation lags behind the leading countries (Finland, Korea, Sweden) by 2-3 times. According to experts, the Russian Federation lags behind developed countries by 5-8 years in the level of information technologies application [5]. In the Russian Federation itself, the infrastructure of innovative enterprises is very unevenly located by region, which increases the differentiation in the levels of digitalization between depressed regions and developed territories [6]. The results of the study show that rural areas, as usual, lag behind in acquiring skills about digitalization (Figure 1) [7].
**Figure 1.** Digital skills of the population in urban and rural areas: 2019.

Digitalization of rural areas and agriculture will require a lot of work. At the same time, it is necessary to take into account particularly important factors:

- low marginality of the industry (developing segment);
- unattractiveness for technology and infrastructure investors;
- disadvantage of adapting the proposed solutions for small and medium-sized farms;
- small amount of open, regular data about the activities of enterprises that developers can use to create applications and services;
- underdevelopment of "paperless" public services and services required in the agro-industrial complex;
- complexity of integrating digital technologies with all other business processes in the enterprise;
- lack of ready-made integrated digital solutions on the market, which implies the need for additional integration of individual digital tools into a single system;
- need for significant expenditures for creation of a national digital infrastructure, as well as the formation of a specialized information system in each subject of the federation, its integration into other information bases.
Many rural households, especially small and medium-sized ones, do not have permanent access to the Internet and do not have the skills and abilities to take advantage of technology. Many small farms do not have the know-how and equipment to apply digital technologies, make a profit and move to a qualitatively new level of activity.

It is necessary to quickly increase the computer literacy of the population group that does not have the skills to work with specific digital technologies: information and communication technologies are developing at an incredibly progressive pace, and accordingly the pace of knowledge acquisition should not lag behind.

It is necessary to develop a model of farmers training, which will improve the skills of working with digital technologies, so that students correctly learn how to implement and evaluate advanced technologies and best practices in their farms.

Also, the introduction of digital technologies is often hindered by the corporate culture of companies — conflicts of interest between functions, non-transparency of processes, territorial fragmentation of business.

Another factor hindering the implementation of digital technologies is the lack of regulatory control of data collection and receipt. Especially when it comes to small and medium-sized farms - this is a high-risk and low-margin business. Most often, there are not enough funds for serious investments in innovation.

Another problem is the significant gap in the implementation of digital technologies in the agricultural sector in developing and developed countries.

In 2017, according to the Rosstat, the amount of investments in ICT amounted to 3.6 billion rubles, or 0.5 % of the total investment in fixed assets. This is the lowest indicator in the industry, which demonstrates the low digital literacy of the domestic agro-industrial complex and the competitive advantage of foreign producers.

Figure 2. The share of IT specialists in agriculture from the total number of agricultural workers (according to the Analytical Center of the Ministry of Agriculture of the Russian Federation).

Further development of agribusiness is not possible without the use of information technologies in this area. As domestic and international practice shows, the most important drivers of digitalization of agribusiness are the following:

- technologies can support farmers by responding in a timely manner to pests and disease outbreaks, climate change, crop failures: farmers can receive messages that prompt them to take appropriate actions in advance, taking into account the weather forecast;
Elements of the Internet of Things (IoT) already use up to 0.05-5 % of agricultural producers in Russia (Agrophysical Research Institute). For comparison, in the United States of America - up to 60 %, in the European Union - up to 80 %. Domestic farmers are far from such indicators, but the demand for the "figure" is increasing.

Consciously or not, in a varying degree, about 10% of Russian agricultural enterprises, farms and holdings use solutions related to precision farming. These are the results of a survey of more than 200 market participants conducted in 2017 by the magazine "Agroinvestor".

![Figure 3. Share of farmers who have mastered precision farming (%).](image)

The intelligent agricultural sector makes it possible, on the one hand, to reduce large volumes of external resources (pesticides, fuel, inorganic fertilizers), and on the other – to ensure the growth of the use of local production factors (renewable energy sources, biofuels, organic fertilizers). Modern technologies for the use of intelligent agriculture contribute to the restoration and preservation of the useful properties of soils and groundwater; ensure environmentally effective and safe control of harmful insects; In general, the digital economy brings good results.

In the field of precision agriculture in recent years in the Russian Federation, parallel driving systems, monitoring and informatization, yield mapping and differentiated fertilizer application have been most used. Many farms and agricultural holdings are switching to creation of electronic field maps.

The use of unmanned aerial vehicles (UAVs) and the variable rate technology (VRT) reduce the consumption of pesticides and water, reduce the cost of resources and labor costs;

In recent years, technologies that are based on the use of artificial intelligence (AI) have contributed to improving the management efficiency of many farms in the agricultural business. Companies that own artificial intelligence technologies give farmers the opportunity to assess the state of the field and monitor each stage of the production cycle. Artificial intelligence technologies are transforming the agricultural sector: to assess the economy, the physical presence of a person is no longer needed, he can be guided by data obtained from satellites and unmanned aerial vehicles. Artificial intelligence technologies optimize the use of resources, justify timely decisions based on predictive modeling and ensure the round-the-clock operation of monitoring systems.

In the near future, agricultural robots ("agrobots") may have a strong impact on agriculture. Already today, field agrobots help farmers to optimize irrigation and measure water consumption. Fleets of light small robots are replacing heavy equipment, which makes it possible to gradually reduce soil compaction, increase the efficiency of their functioning and return them to the ability to saturate with air.

The above examples explain how the use of digital technologies can ensure the functioning and efficiency of agri-food systems:
According to the results of the study, some priority areas for further work in the field of digital technologies can be noted:

- promote the collection of more comprehensive data on digitalization and digital technologies at the district and population level, in particular by rural and urban areas;
- create sustainable business models that enable viable digital solutions to engage small-scale enterprises in the digital transformation of agriculture;
- create an index that reflects the development of digital agriculture in the context of the educational, cultural and institutional dimensions of individual states, both in terms of the existence of accompanying and basic conditions for the implementation of digitalization, and in terms of the potential impact of the process on society, environment and economy. It can be based on the "Index of readiness for the introduction of digital technologies in the agricultural sector", which was created in 2015 by the FAO Regional Office for Central Asia and Europe. This index will provide an opportunity to determine the context for the future development of agricultural digitalization strategies of FAO member states; first of all, these strategies should provide states with support for the concept of e-agriculture and awareness of the importance of information and communication technologies for the agri-food sector, and then suggest steps to implement the process of agriculture digitalization.

4. Conclusion

In the near future, digitalization in the agricultural sector will entail a significant shift in food production and agriculture in general. It can bring environmental, social and economic benefits, but at the same time it can provoke many problems. Unequal access to digital services and technologies contributes to the risk of a digital divide [8].

Today, digitalization covers most areas. Agriculture is no exception - a strategic industry for our country. The Ministry of Agriculture of Russia is implementing the project "Digital Agriculture", which sets ambitious goals - digital technologies should ensure double productivity growth in agricultural enterprises by 2024.

In this way, digitalization in the Russian agro-industrial complex is at an early stage. The approved programs at the legislative level on informatization of the industry and the economy as a whole are currently not sufficiently developed and are mostly focused on automating already established processes, but do not contribute to a radical economic transformation.

According to the "law of technological breakthrough", technologies change exponentially, while social and economic changes are linear and do not keep up with technological ones. It is particularly important to work on ensuring the necessary conditions for digitalization in the villages.

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