

Digitalization in agriculture: experience and prospects

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Abstract. Agriculture is a specific industry that is particularly in need of digitalization. This is due to the fact that this industry is exposed to multiple factors, having a number of features, namely: the production process and its results depend on numerous factors, among them not only natural-climatic, biological, soil, but also socio-economic, etc. Moreover, there is a fairly significant variation of these factors in space - time coordinates, which leads to significant management costs; business entities, as a rule, are very dispersed, which, of course, also makes it difficult to develop uniform, equally effective management decisions; within the agro-industrial complex and its spheres, one can observe complex and strong in intensity connections that arise between industries. This is due to the fact that suppliers, buyers, and other counterparties are quite numerous and diverse. All this determines the high relevance of the issues that will be considered in this article. Thus, the following main issues are considered in the article: the essence of digitalization in the agricultural industry; the main problems of digitalization in this industry; experience and prospects.

1 Introduction

Today, digitalization is being carried out in all key areas and industries. Digitization can be viewed both as a process and, at the same time, as a consequence, a result. The agricultural sector is of key importance for the Russian economy. The Russian state, as well as a number of other countries, is developing, including taking into account the results obtained in connection with the functioning of this industry. Accordingly, digitalization in agriculture is becoming increasingly relevant. The purpose of the work is to reveal the specifics of digitalization in agriculture, to illustrate the existing experience and to try to identify possible prospects.

2 Methods

Such methods as generalization, comparative analysis, and synthesis were used. In addition, some statistics has been studied and applied.

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3 Results and discussion

3.1 The concept and prerequisites for digitalization in agriculture

First of all it is important to consider the main prerequisites that necessitate the introduction of digital technologies in the agricultural sector. Thus, due to high technologies, it is possible to ensure not only extensive, but also intensive production growth, in view of the fact that efficiency will increase significantly.

In addition, agriculture is an industry with significant potential. This industry is considered as a strategically important one in many states, among them: Russia, Belarus, Egypt, Italy, Nigeria, China, Germany, the USA, etc. Naturally, creating conditions in which the digitalization of such an important industry as agriculture will be possible is paramount task for most countries at the present stage.

It is also impossible to ignore the data provided by the UN Department of Economic and Social Affairs. The point is that, according to forecasts, by 2015 the world's population is expected to increase to 9.8 billion, and by 2100 the figure may increase to 11.2 billion. These forecasts indicate that the need for various resources (food, etc.) increase at least one and a half times compared to current indicators [1].

Finally, agriculture is a vulnerable area due to its dependence on a whole range of various factors, including weather and climate. Naturally, the digitalization of agriculture can prevent significant losses of resources: temporary, material, human, etc.

In essence, digitalization in agriculture means a new green revolution. Digitalization in agriculture is a transformation, transformation of the industry due to the fact that various digital tools are being introduced - technologies, platform solutions, etc., which are designed to generate, process and analyze information related to objects and subjects at a deep level agricultural industry, as well as, in general, to automate all the main and auxiliary processes. Digitalization is, in its essence, a significant technological breakthrough in the agro-industrial complex and its functioning.

Digital products, properly used in the agro-industrial complex, act as a catalyst for the growth of production capacities in agricultural enterprises [2].

Robots, drones and other digital technologies have been adapted in such a way as to most effectively carry out the tasks associated with the development of agriculture. So, for example, the removal of weeds is mechanized, the processes associated with fertilization and irrigation are automated, etc.

The digitalization of the agro-industrial complex entails, on the one hand, cost reduction, and on the other hand, it increases productivity. The digitalization of agriculture can also be defined as a process in which the quality of management activities is changing, production and technological processes are being improved. As a result, the functioning of agriculture becomes more sustainable and efficient. In other words, with digitalization, the entire production process is restructured in such a way that indicators increase significantly, this happens due to innovative solutions and digital technologies. With digitalization, the speed of production increases, while the quality of products not only does not deteriorate, but also increases.

If the forecast of scientific and technological development of the agro-industrial complex of the Russian Federation until 2030 is analyzed [4], it can be concluded that the level of digitalization of the industry in question in the Russian Federation is rather low. So, in particular, peasant farms, medium-sized agricultural enterprises, production cooperative's function and practically do not use innovative digital technologies. Computerization and automation are developed, in most cases, at a very mediocre level. At a high level, digitalization, as a rule, is observed only in large agricultural enterprises, agricultural

holdings. Moreover, this determines the export orientation of major players in the agricultural market.

3.2 Examples of the use of digitalization in agriculture

It is also important to consider some examples illustrating the effective use of digital technologies in agriculture. So, in particular, one can use special mobile applications with which it is possible to most accurately predict the course of production processes. For example, in Kenya, the M-Farm application is popular, with which you can change cultivation patterns and, accordingly, achieve better results. Also now, special agricultural robots are considered as the leading trend, with the help of which not only many processes are automated and errors caused by the human factor are minimized, but also the most effective control of all stages that make up the technological process is provided. Drones are actively used, which allow to investigate the state of landings in a short time.

In Russia, for example, in 2019, the departmental project "Digital Agriculture" was developed. In addition, there are various digital platforms that involve the integration of basic management functions. So, the following key goals of digitalization in agriculture can be identified:

- transformation of agriculture and doubling productivity through appropriate digital technologies by 2024;
- increasing the effectiveness of state support - point analysis of problems and their consistent elimination;
- organization of effective interaction (including interdepartmental) between all subjects: agricultural producers, buyers, public and government agencies regarding the implementation of measures to ensure digitalization in agriculture;
- creation of conditions in which the training of specialists with knowledge in the field of digital technologies and their application for the development of agriculture will be carried out [1].

The largest investment bank GoldmanSachs notes that by 2050 the productivity of the world economy could increase by 70%. Over the past five years, investors from different countries have invested in more than 1,851,500 technologies that can be used to digitalize agriculture. The total amount is over \$12 billion.

The digitalization of agriculture, among other things, has significant potential for most of the goals related to sustainable development to be achieved. For example, we are talking about clean water and sanitation, eliminating hunger, responsible consumption, etc.

There are the following main tools with which digitalization in agriculture is carried out: Internet of things; big data; ERP systems; RFID tags; BPTS, UAV; electronic and intelligent sensors; AI elements; robotics; cloud services; e-commerce.

With digitalization, not only production development indicators increase, but also conditions (agrotechnical, territorial) improve, the level of wages of workers employed in the industry, the level of soil fertility and other factors increase.

Further, we will characterize in detail the most common technologies used around the world in order to ensure digitalization in agriculture. So:

- technologies of precision agriculture - a set of navigation, geographic information systems, as well as systems that provide remote sensing and differential fertilization. Positioning systems - due to them, information about the processes in which agricultural machinery is used is recorded. For example, using sensors, you can understand how much time is spent on a particular process. In the United States, such sensors have been used since 2001.

Parallel driving systems is an agricultural technology which is automatically applied in previously created rows. As a rule, special course-indicating devices endowed with satellite

navigation are used. There are parallel driving systems with very high accuracy (from 5 to 30 cm), with their help, large vehicles can be driven under any conditions and visibility;

Telemetric systems are also used, thanks to which agricultural units work more efficiently. So, in particular, the use of such systems makes it possible to reduce the time spent on collecting and analyzing information about the specifics of the execution of technological processes. For example, there is the Telematics system from CLAAS, which analyzes working hours and makes the necessary adjustments to the settings. Due to this, in the end, the productivity of the entire fleet of vehicles grows. Russian firms also create such systems, for example, the companies Rostselmash, TECHNOCOM, AutoGRAPH, etc.

As for geographic information systems, they were originally developed and, accordingly, began to be used in the United States. At the same time, despite the fact that such technologies are presented on the Russian market, they are still not used so often, due to the fact that they are expensive;

- artificial intelligence is used primarily in agriculture in the form of agricultural robots. There are at least three ways or ways to use such robots: as drones, for example, to collect various kinds of information; as automated systems with the help of which crops are cared for (their cultivation and other important manipulations); automated systems that are used to manage farms, for example, dairy production [3].

Unmanned systems not only provide high speed and accuracy in the process of information processing, but also security. The point is that the risks associated with the theft of fuel or grain, fruits, etc. are minimized. The United States and the Netherlands are still leading in the production of unmanned systems. For example, Jonh Deere has created an innovative automatic driving system for absolutely any vehicle. In Russia, certain tests are also being carried out. For example, in 2016, machines with the C-Pilot computer vision system were tested. The AURORA ROBOTICS company has also developed a special project, within the framework of which the agro-industrial complex is supposed to use autopilots.

The market for unmanned aerial vehicles in the Russian Federation is also developing quite actively, even if we take into account the conditions of regulatory regulation that are not very favorable for this and the features inherent in Russian agriculture. After all, as a rule, it is necessary to analyze large agricultural areas. In addition, the territories are very diverse - different climate, soil and other factors affect. The most significant are the following: "Unmanned Technologies", "Geoscan", autonomous aerospace systems - GeoService and ZALA AERO.

Components of such solutions:

- peripheral devices - sensors, sensors;
- communication channels – GPS/GLONASS, LPWAN, LTE, 3G, GPRS, GSM;
- platforms where industry-specific applications and, in fact, the applications themselves are created [6].

For example, the well-known Canadian company Farmers Edge developed the Farm Command mobile application, with which you can not only calculate the amount of funds needed, analyze the soil, but also model and predict certain management decisions. Another American company has developed the ClearAg® mobile application, which is able to provide weather, water, soil and even crop forecasts;

- big data. Firstly, with their help, the tasks associated with the storage and processing of a huge amount of data are successfully solved. Secondly, special algorithms are being developed in order to extract valuable information. For example, Yandex Data Factory, Algomost, etc.

Thus, digitalization in agriculture entails the following positive consequences:

- risks are reduced, including those caused by the human factor;

- the ability to adapt to climate change, through the so-called point farming;
- increased crop yields;
- reducing costs and expenses;
- improving the quality and competitiveness of products.

We would like to dwell on the analysis of some Russian projects that are successfully implemented in the agricultural sector and can be expanded further. Table 1 provides basic information.

Table 1. Examples of digitalization in agriculture.

Company name	Project / Tecnology
CJSC "Plant of electrical equipment"	A system that allows diagnosing the condition of animals (primarily cattle) and the conditions of their keeping
Dataocean-online LLC	Information base in the agro-industrial complex
Perspektiva Group LLC	A system by which it is possible to control the health of cattle
CenterProgramSystem LLC	Agrometeorological support system
LLC "Farvater"	Technologies that can be used to provide remote control of the operation of agricultural equipment

3.3 Problems of digitalization in agriculture

It is already clear that digitalization entails a number of positive consequences. However, there are also problems in the way of the widespread digitalization of the industry.

If we analyze some statistical data [5], we can conclude that in the Russian Federation there is a noticeable differentiation in terms of the use of digital technologies in the agro-industrial complex. That is, in some regions, digitalization is at a higher level than in others. This uneven distribution and development represent a paramount problem.

Another problem is that there is an acute shortage of personnel. There are no qualified specialists who understand new technologies and are able to work effectively with them [7].

In addition, a unified approach to digitalization in agriculture has not been developed: different approaches may be used in different regions. There is also no detailed legal regulation of this area.

Finally, as it was noted above, the technical equipment of most small and medium-sized businesses is at a very low level. This is due to the fact that it is not advisable to acquire and master digital technologies: they are too expensive and pay off for a long time on small production volumes. In general, in some regions it is very problematic to place a digital infrastructure, since the agro-industrial complex production areas are predominantly rural areas where there is no stable Internet connection.

In order to solve all these problems, it is necessary to take the following main measures:

- determination and consolidation of special curators who control the processes associated with digitalization in agriculture (both at the federal, and at the regional and local levels);
- creation of a special unified information center that will summarize and broadcast information about all key digital innovations, positive experience of their use;
- ensuring the release of visual illustrated materials;
- development and launch of special training courses;
- compiling a list of manufacturers that have the necessary resources to carry out digitalization;
- formation of infrastructure [8].

The problems of digitalization in agriculture and ways to solve them are schematically depicted in Figure 1.

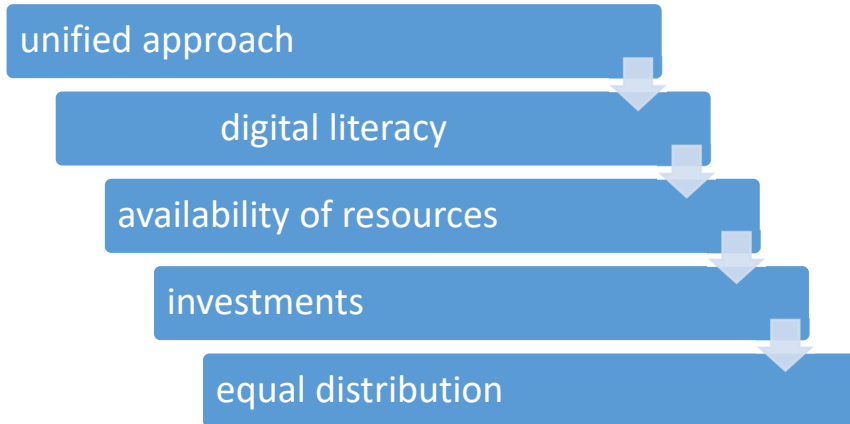


Fig. 1. Digitalization in agriculture.

The following main prospects for digitalization in agriculture can be also highlighted:

- further automation of production processes - main and auxiliary;
- deep analysis and collection of information;
- optimization of management processes;
- systematic interaction and cooperation of all involved entities;
- transition to sustainable development;
- use of platform approach.

4 Conclusion

It is possible to draw the following conclusions.

First, digitalization in the agricultural industry is extremely uneven. The point is that in some regions this process is much more intense than in others.

In addition, small and medium-sized businesses are not taking such active measures as, for example, large entrepreneurs, agro-complexes, etc. of a similar kind of entity. This differentiation is difficult. Without a doubt, digitalization in agriculture entails positive changes, production shifts. However, in addition to the positive consequences, there are many problems that need to be addressed consistently and comprehensively.

It seems that it is important to develop a unified approach (at the federal and regional levels), which will be adjusted, taking into account the conditions and needs of specific territories.

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