Digital transformation of the agro-industrial complex as a transition to highly efficient production

Lyudmila Agapitova, *Galina* Butorina, *Nadezhda* Larionova*, and *Lyubov* Medvedeva

Northern Trans-Ural State Agricultural University, 7, Republic st., Tyumen, 625003, Russia

Abstract. Modern digitalization opportunities are very broad and cover the entire agricultural sector. The paper considers the potential of digital transformation of production, the goals and economic benefits of digitalization for agricultural producers. The authors studied the four main directions of digitalization of production processes in the agro-industrial complex. The financial support of the project of digitalization of agriculture, the structure of funding in the dynamics over a number of years, including at the expense of the region were analyzed. The paper identifies the problems of digitalization of small businesses, the digital divide between urban and rural areas. The authors formulated the main external and internal tasks of the digital transformation of the agro-industrial complex, which will provide a highly efficient production in the future.

1 Introduction

At the current stage of development of digital technologies, their active use in the regulation of agricultural processes has led to the emergence of digitalization and the formation of a digital environment, covering today the industrial and agricultural sector. The improvement of the efficiency of the agricultural sector is directly related to its digital transformation.

The possibilities of digital transformation of production and digitalization of production processes are very broad, they cover the entire agricultural sector and allow producers to monitor climate change, timely plan field work, reduce production costs through the efficient use of resources. After all, it is through a science-based approach to agricultural production that crop yields and animal productivity increase. And the revision of existing traditional technological processes, operations, optimization goals through the adoption of digital technology allows to optimize the consumption of production resources, monitor the production processes, to respond in a timely manner to the changes occurring due to the specifics of agricultural production.

In the context of its capabilities, digitalization provides fundamentally new opportunities for specialists in the agricultural industry.

Global experience shows that a significant trend in the digital transformation of agricultural business in the world is the spread of digital platforms and virtual assistants for intensive agricultural production among agricultural producers. At the same time, digital

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* Corresponding author: larionova_n_p@mail.ru

solutions are quite actively used in logistics and sales and include systems aimed at quality control of agricultural products, smart contracts and many other tools to promote agricultural products.

Digitalization of agricultural production contributes to the achievement of a significant range of agrarian objectives:

- – increase the productivity of crop and livestock industries (crop yields and animal productivity);
- – increase in labor productivity;
- – optimization of the use of production resources and the resulting savings in material and monetary costs;
- – preservation of the environment;
- – growth of the overall efficiency of agricultural production.

Thus, the growing interest in the processes of digitalization of agriculture is due to the need to ensure the sustainability of the industry.

In 2017, Russia developed the "Strategy for the development of information society in the Russian Federation for 2017-2030", while in other countries this process began quite a long time ago. Nevertheless, Russia has actively engaged in the process of developing its own digital technologies, possessing certain resources, including human resources capable to develop its own Internet applications, Internet platforms and other digital solutions, withstanding competition relative to other countries [1].

The processes of digitalization of agriculture are reflected in the works of many Russian researchers. According to modern scientists, agricultural production is no longer a traditional industry, the key task of which is food supply and the creation of food security at both the regional and federal level. Scholars determine the criteria of sustainability of digital development of enterprises of different organizational-legal forms and forms of ownership, the scale of business [2].

In the process of evolution, various organizational and legal forms of economic and commercial organizations develop adaptive functional structures that ensure their successful functioning in a certain market environment [3].

2 Materials and methods

In the process of research the following research methods were used: statistical, expert evaluations, abstract-logical and monographic. When processing the initial data and substantiating the results of the study methods of analysis and synthesis, statistical and logical analysis were applied.

The information base for the study included the previous work of researchers, data of the Federal State Statistics Service of the Russian Federation, Presidential Decrees and Resolutions of the Russian Federation Government, materials of the Ministry of Agriculture of the Russian Federation and the Department of Agricultural and Industrial Complex of the Tyumen region, as well as the authors' solutions to the problem under study.

In accordance with the departmental project "Digital Agriculture", the digitalization of the agro-industrial complex will create a unified information space, which will provide up-to-date information on the development of the industry and eliminate emerging problems [4].

3 Results

Digitalization of the agro-industrial complex should be divided into four main areas of "smart" technologies:

1) digital base (e.g., digital maps), which is the basis of precision agriculture (navigation systems, remote sensing and geographic information systems (GIS), differentiated fertilizer application);
2) digitalization of production (use of programmable "smart" field equipment, agricultural robots - UAVs, drones to monitor fields and harvesting, smart sensors);
3) analytics and Big Data (AIoT platforms/AIoT applications for monitoring data obtained from sensors, machinery and other devices, yield forecasting based on climate data, etc.)
4) digitalization of the sales process (traceability of products along the entire chain, from farmer to table).

All of these components work in close connection with each other.

For digital transformation in the agro-industrial complex, each agricultural producer must comprehensively assess the entire range of its production processes. In general, they can be structured as follows:

- agricultural production support processes;
- processes of main production;
- management and control processes.

Each process includes different types of work and results provided by certain digital technologies.

The process approach in the agro-industrial complex will:

- radically reduce the number of duplicate management decisions;
- eliminate factors contributing to contradictory management decisions;
- clearly distribute the functional duties and responsibilities of individual structural units within a single production process;
- perform a unified management of the production process and all resources used in it;
- optimize all existing production processes, taking into account the interests of all structural units of the business structure, etc.

The project of digitalization of agriculture involves the gradual transformation of the agro-industrial complex for a period up to 2025. Accordingly, the implementation of the project requires significant investments (Table 1).

Thus, for the last 3 years about a half of the planned volume of project investments has been financed (46.8%), the largest expenditure of funds is planned for 2022 (35000 million rubles or 23%), for the next two years the volume of financing will be significantly reduced. In the structure of funding areas the costs for the creation and implementation of a national platform for digital agricultural management prevail (77.6%), the second place is taken by the financing of the creation of experimental digital farms (12.3%).

However, the financing of the project involves three sources of financial resources: the federal budget, regional budgets and extrabudgetary sources. Let us consider the structure of funding in the dynamics of years (Table 2).

The analysis of the funding structure shows that almost a half of the financial support of the project consists of the federal budget, while their share in the dynamics tends to decrease, and the share of extra-budgetary sources is increasing.

In the Tyumen region, 1.7 billion rubles were allocated for the development of digitalization processes in the region (including digitalization of the agroindustrial complex), starting from 2020, in 2021 - 1.2 billion rubles, and further to 2025, this amount will be 1.1 billion rubles annually [5].

Table 1. Financial support for the project of digitalization of agriculture at the expense of the federal budget, mln. rubles.

Purpose of financing	Years						Total
	2019	2020	2021	2022	2023	2024	
1. Creation and implementation of the national platform for digital agricultural management	10150	20208.9	23746.4	28121.4	17058.9	18796.4	118082
2.Creation and implementation of the module "Agro-solutions", total	3275	2962.5	3775	5500	4562.5	2725	22800
2.1. Development of a system to ensure cooperation of the agricultural market participants	2500	1000	100	100	100	100	3900
2.2. Creation of experimental digital farms	675	1912.5	3675	5400	4462.5	2625	18750
3. Creation of a training system for specialists in the field of digital economy	1925	1828.6	478.6	378.6	378.6	378.6	5368
4. Project implementation	750	1000	1000	1000	1000	1000	5750
Total	16100	26000	29000	35000	23000	22900	152000
Specific weight, %	10.6	17.1	19.1	23.0	15.1	15.1	100

Table 2. Structure of financing of the project of digitalization of agriculture, %.

Sources of financing	Years						Total
	2019	2020	2021	2022	2023	2024	
Federal budget	75.1	77.6	64.4	59.2	38.3	28.3	50.6
Regional budgets	1.6	1.5	2.2	3.6	2.3	2.5	2.7
Extrabudgetary funds	23.3	20.9	33.3	37.2	58.3	69.2	46.7
Total	100	100	100	100	100	100	100

The practice of digital technology implementation in agriculture in the Tyumen region shows that the digital transformation has affected not only medium and large enterprises, but also small businesses (farms, individual entrepreneurship, private farms). IT solutions of both foreign and domestic developers are used. For practical application today, the products "Smart Farm", "Smart Field", "Smart Agrooffice" and others have been developed. Field farmers today are actively using: GIS-technologies (elements of precision farming in crop production) to manage agro-technological operations in the context of individual field areas,

drones for more detailed analysis and evaluation of agricultural land; combines monitoring using embedded services, through which the process of monitoring the route, speed mode, fuel consumption, which helps agribusiness to optimize transport flows, costs of equipment maintenance [6].

Livestock breeders use animal monitoring systems (allowing them to monitor health indicators, productivity, herd turnover, breeding work), automatic milk yield accounting systems, etc. For example, robotic farms are already functioning in Ishim and Tyumen districts of Tyumen region, where the production processes of milking, milk quality control, and milk transportation are carried out by robots. There are 50-70 cattle per robot [7]. A striking example is the introduction of digital technology in LLC "Tyumen Dairy Farms" (Table 3).

Small businesses, due to the rather high cost of IT solutions and their priority for larger agrarian business, have little use for digital technology so far, but positive changes can be noted here as well. For example, some farmers use navigators to track the location of animals during the grazing period, which reduces their losses, also use electric fences ("electronic" shepherds) on pastures, etc. Also, the lack of financial resources and managerial knowledge, the lack of digital competencies and skills increase the lag of small farms from agriholdings.

Table 3. Digital solutions of "Tyumen Dairy Farms" Ltd.

Digital Solution	Purpose
SMARTBOW	Real-time monitoring program for animals, individual control of their rest and activity, veterinary health monitoring
UNIFORM Agri	Herd management program
TMR Tracker	Feeding management software
HIBRIMIN FUTTER 5	Calculation program for cattle rations

To assess the impact of the digital transformation of the agro-industrial complex on the results of economic activity of enterprises, it is necessary to form a number of criteria evaluated in absolute and relative terms:

- increase in animal productivity and crop yields;
- reduction of labor intensity of production processes;
- reducing the level of losses, rejected products;
- reducing the time of monitoring the health of animals, the state of crops, the state of agricultural land;
- saving of production costs, reduction of production costs, etc.

4 Discussion

The digitalization process includes the creation of databases and monitoring of the following parameters of the agro-industrial complex:

- schematic layout of industries and enterprises of agriculture and processing industry;
- monitoring of the state of agricultural land fertility to obtain reliable information about the state of soils for subsequent management decision-making;
- forecasts of the state and development of major agro-food markets;
- assessment of the impact of agricultural policy on the state of agriculture, consumer incomes, the dynamics of foreign trade in food and agricultural raw materials;
- monitoring the receipt and expenditure of budgetary funds.

An important trend in the digital transformation of agriculture is the spread of digital platforms and virtual assistants for farm management among agricultural producers. These

solutions provide farmers with recommendations and practical advice on work planning, crop selection, economic feasibility of production, as well as accounting, business planning and financial management.

It was found that to date, digitalization in agriculture has been mainly reduced to the automation of certain activities (monitoring the state of crops, animal health, automation of harvesting, etc.) and processes of agricultural products sales (sales through marketplaces, etc.). Actual trends are sales of products by both large producers and farms through the system of marketplaces (for example, LLC "Soglasiye", Tyumensky Broiler, Indy, KFH "Druzhba", LLC "Tyumensky Plombir", etc.).

At the current stage of development the possibilities of "smart" automation and the use of integrated systems of precision agriculture, which collect data and make decisions on the management of production processes and agricultural machinery are expanding [8]. Scientific developments in the field of precision agriculture are carried out at the Northern Trans-Ural State Agricaltural University.

Due to its specifics, the digitalization of the industry in Russia in general and in the Tyumen region in particular is happening in leaps and bounds and is characterized by the implementation of individual elements of digital agriculture. For example, the most in demand are the technologies of satellite positioning of agricultural machinery and equipment, systems of monitoring and quality control of work performed, systems of accounting and control of resources [9].

One of the main constraints to the development of digital agriculture is the acute shortage of personnel with digital competencies in the industry. However, it should be noted that this problem is solved in the form of government programs to retain graduates of agricultural educational institutions and young professionals in the village.

5 Conclusion

Thus, the digital transformation in the agro-industrial complex implies not only the installation of modern equipment or software, but also fundamental changes in approaches to management and production. As a result, labor productivity increases, and the company acquires a reputation as a progressive organization. Also it promotes motivation and labor standardization of workers, improvement of the internal environment of the enterprise.

Since the state implements a set of measures to stimulate the attraction of personnel to the countryside, it is important to improve their digital literacy [10].

The results of the study show that in Russia and in the Tyumen region the processes of digitalization of the agro-industrial complex have a steady development trend. However, there are also problems that need to be solved.

Further digital transformation in the agroindustrial complex will ensure the fulfillment of the following internal and external tasks:

- increase in labor productivity, growth of production indicators of enterprises;
- improvement of the quality of technological processes in enterprises, quality of products;
- sustainable development of the agriculture industry;
- integration of information resources of the Ministry of Agriculture of the Russian Federation and the regions;
- provision of state services and portals for agricultural producers in order to form mechanisms and support measures;
- integration of the functionality of the digital agriculture platform, to provide access to state, banking and insurance products for agribusinesses and development of a reverse interaction scheme;

– creation of conditions for increasing the transparency of agricultural markets;
– stimulating domestic developments and providing access to various digital open platforms;
– introduction of online trading platforms and systems for the promotion of agricultural products;
– increasing the export potential of Russian agricultural products, ensuring compatibility of production processes and standards with global ones.

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