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OPPORTUNITIES FOR DIGITAL TRANSFORMATION OF PRODUCTION PROCESSES ON FARM

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Abstract

The paper identifies the prospects for digital transformation of small and medium-sized agribusiness plant growing industries and opportunities for the digitalization of production processes in accordance with climatic, organizational, financial and other factors. It investigates the main areas and objectives of the digital transformation of the main agricultural industries in general and in small forms of management, and proposes to distinguish three areas at the level of digitalization of agricultural enterprises. Using the example of the crop production digitalization, when introducing precision farming processes, the authors have proposed a mechanism for mastering these processes in order to systematize preparatory and implementation work, which includes three main blocks and two blocks related to the infrastructure component. The paper pays a particular attention to the integration of agronomic programs with the 1C accounting software, which will allow quickly tracking fluctuations in production efficiency indicators when external and internal factors change. We determined that in order to solve the problems that the authors have identified concerning the introduction of digital technologies in small businesses, which largely depend on the possibility of financing innovative projects, we proposed to use the advantages of cooperative-integration formations that combine small and medium-sized agribusiness. It is noted that Internet resources are actively used in the activities of consumer agricultural supply and marketing cooperatives.

Keywords: Cooperative formations, digital economy, precision farming

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1. Introduction

Digitalization is one of the main areas of current innovative development of the agricultural sector in Russia included in the list of priority tasks determined in the Federal Digital Economy Program. The state programs define the main areas of digitalization of the agrarian sector of the economy both at the federal and regional levels (Panov et al., 2019) and at the level of individual agrarian business subjects. Currently, according to the Ministry of Agriculture of the Russian Federation, Russia ranks fifteenth in the world in terms of digitalization of the agricultural sector, and the market segment of agricultural information and computer technologies is estimated at 360 billion rubles. By 2026, it should grow at least five times, including the growth through the support of agricultural startups. Digital technologies have evolved and become much more affordable in terms of the cost of their acquisition and implementation. They have advanced to such a level that for the first time in the history of the agriculture development it has become possible to obtain data about each agricultural facility and its surroundings, to calculate mathematically accurately the algorithm of actions and predict the result (Khabarov & Volegzhanina, 2019). Regarding individual agribusiness subjects, three areas of digitalization can be conditionally distinguished: the first two areas are subdivided according to the sectoral characteristics of crop and livestock production, and the third one is associated with the digitalization of infrastructure components.

2. Problem Statement

The departmental project titled “Digital Agriculture” assigns a special place to the development and use of the “Effective hectare” system for optimizing the management of production processes in field cultivation (Digital Economy of the Russian Federation Program, 2017). The system includes the use of digital technologies: to study the state of soil resources, their structure and composition; to control the state of crops, yield, the prevalence of pests and diseases; the formation of crop rotations taking into account natural and climatic conditions based on created digital soil maps and digitized matrices. An “Efficient hectare” may also include the use of digital technologies in sustainable agriculture and green production, as well as the integration of digital analysis and regulation tools to reduce overlapping and strengthen control over land use. In the transition to a digital economy, it is necessary to take into account the level of development of the sectoral economy as a whole, the level of education, the degree of development of the regulatory and legal system, and the existing technologies for the development of information systems (Ognivtsev, 2018).

It seems that when developing and implementing digitalization at the agribusiness level, it is necessary to take into account the size of agricultural production of the agribusiness entities to be studied. Large enterprises and organizations will more easily adapt to the digital economy. Since they have significantly sufficient resources and availability of loans, it is much easier for them to implement these systems than for small and medium-sized businesses. And according to statistics, some regions, such as Saratov region, concentrate most of agricultural product facilities in small and medium agribusiness. So, the small and medium agribusiness production of grain and sunflower accounts for more than fifty percent, and its production of milk and meat accounts for more than 60% of the regional volume.

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Therefore, the study of the possibilities of digital transformation of production processes for growing crop products in current conditions of development is the most urgent task.

3. Research Questions

Based on the revealed problem, the research questions have been identified, which are as follows. First, it is the task of developing a mechanism for introducing digital technologies in the of crop product manufacture (e.g. cereals and industrial crops) with the allocation of stages and blocks. Second, it is the identification of the advantages and economic effect of the development of digital technologies in field cultivation. Third, it is the analysis of the real financial possibilities of digitalization of production processes for field cultivation of small agribusiness. Fourth, it is defining the role of agricultural consumer cooperatives in the development of small business digitalization.

4. Purpose of the Study

The research questions are the study of the opportunities of small and medium-sized agribusiness for the introduction of digital technologies in crop production using the example of the Saratov region and the development of a mechanism for their use.

5. Research Methods

During the research, the general scientific methodology of factorial and logical analysis and comparison and generalization, as well as an expert-analytical method of the initial information processing were used. Based on the monographic method, the implementation of individual components of digital technologies at peasant (farm) enterprises of the Saratov region was analyzed.

6. Findings

The results of studying the experience of farms implementing such systems made it possible to propose the following mechanism for introducing digital technologies in plant growing enterprises of small and medium agribusiness. Currently, the “Effective hectare” digital technology discussed above is integrated with the 1C accounting software and allows, in addition to regulating the control of production processes, obtaining economic indicators of the agribusiness development and track their fluctuations when changing certain initial parameters and data (Skvortsov et al., 2018). The mechanism for the development and implementation of a digital program for managing crop production processes based on precision farming can include three main blocks: assessment of farmland resources, technological and technical blocks, and two blocks related to the investment and training infrastructure component (Fig. 1).

The first block includes an assessment of the farmland resources, while the following algorithm of actions can be proposed:

1. Determination of field outlines, landscape, and their electronic imagining using satellite navigation systems. Introduction to the program of the existing crop rotation system.

2. Imaging a digital field elevation model using satellite navigation systems.

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3. Analysis of crop rotation field and individual plot yields over the past 35 years based on satellite imagery data; study of the prevalence of weeds, pests, and plant diseases.

4. Conducting an agrochemical survey of the farm field soils involving laboratories and research institutes followed by the introduction of the results of the agrochemical survey into the program.

5. Identifying the correspondence of the obtained results to the real data of the farm. All data must be digitized and entered into the program.

According to the results of the assessment, the “dead or abnormal zones” are identified, i.e. those field areas, where an enterprise consistently receives low yields and low marginal income regardless of natural and climatic conditions, changes in technology and crop rotation. Only a correct assessment of farm fields, as experience shows, makes it possible to take off the turnover those land plots of “dead” zones, which accounted for 7% to 10% of all land for some agricultural enterprises. The second block allows identifying the capabilities of the available agricultural machinery at a given enterprise (Guzueva et al., 2020).

The possibilities of computer control of technical means are determined. Thus, the possibility of using GLONASS / GPS, certain types of computer hardware equipment, and the possibility of purchasing and installing various types of equipment fitted with a digital interface is being investigated. The capabilities of tractors, seeders equipped with computer-controlled seeding rates, cultivators, agricultural fertilizing and crop cultivating machines, the capabilities of combines, etc. are carefully studied. If necessary, weight sensors and equipment are installed on the combines, which allow mapping the yield by field. Sensors for monitoring diesel fuel are installed on agricultural machines in order to prevent ineffective fuel consumption and unauthorized drain, etc. This is the costliest stage in the implementation of digital technologies, which is directly related to the investment block.

A very important block is that related to the training of personnel including the training of specialists, especially agronomists, in order to teach them in the use of digital technologies to ensure effective communication and interaction in online mode. A wireless connection is established between a specialist of the agronomic service and a machine operator, which contributes to the possibility of monitoring compliance with seeding rates, monitoring the route, the speed of the units, identifying the risks of machine breakdown and troubleshooting, regulating the application rates of fertilizers and pesticides, monitoring the consumption of fuels and lubricants, etc. Based on the data obtained during the preparation, an agronomic program of a particular farm is compiled, which is then integrated with the 1C accounting software (Karpuzova et al., 2021).

In order for an agricultural producer to join the introduction of smart technologies, the agricultural producer must be motivated. First of all, there is an economic justification: what the agricultural producer will obtain as a result of investing in this area? Thus, it is possible to highlight the advantages and economic effect of the implementation of the above described technologies (Maslova & Avdeev, 2018):

- Identification of abnormal (dead) areas in crop rotation fields, which, regardless of the technologies, varieties, hybrids used, give low yield rates and they need land reclamation associated with capital costs or their withdrawal from agricultural circulation

- Ability to monitor the state of fields and crops, daily analysis of prices, unit cost of production, its structure, salary level, depending on the labor input by each worker.

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- Possibility of regulation: seeding rates depending on soil and climatic conditions, soil bonitet; fertilizer and herbicide application rates depending on climatic conditions, types of weediness, spread of diseases and plant pests in fields and individual plots.

- Control of changes in the unit cost of production, structure in real time, depending on price fluctuations, demand, application rates of fertilizers, herbicides, seed consumption and other material resources.

- Monitoring and tracking changes in economic indicators in a real-time system depending on fluctuations in external and internal environmental factors, as a result, the possibility of optimizing the reception of timely management decisions.

- The ability to develop storage systems, sales, delivery of finished products to end users.

The study of the experience of introducing such technologies made it possible to increase the efficiency of agricultural production with an increase in profitability by 15%.

Currently, a sufficient number of companies have appeared on the market that are engaged in the implementation of digital technologies in agricultural production. The cost of these services in the Saratov region is approximately 240 rubles per hectare. However, based on the experience of other farms and the above-mentioned information, the acquisition of technology and equipment that meets the requirements of digital technologies requires significant investments.

The problem of mastering digital technologies in agriculture is aggravated by the fact that there are very few domestic models on the agricultural machinery markets that meet the requirements of the digital transformation of agriculture. Imported equipment that allows for use of digital technologies is expensive and not always available for purchase, especially for small and medium-sized agricultural enterprises that have limited financial capabilities and certain difficulties in attracting credit resources.

A survey of the management of many peasant (farmer) enterprises in the Saratov region showed that some of them already use the Internet resources in managing crop production processes (Kuznetsova et al., 2017). However, without systematic state support for the digitalization of the crop production processes, the integrated implementation of all components of these technologies is difficult due to insufficient financial resources. But individual components are widely used by peasant (farmer) enterprises. Thus, the use of a satellite navigation system by current agricultural machinery makes it possible to provide online control and analysis of process steps to be carried out directly in the fields, and to track performance, location, routes, travel speed, fuel consumption of each unit.

There is a possibility of timely repair in the event of a breakdown of equipment during operations. The terms of maintenance and repair are optimized, due to which downtime of equipment is reduced and the scope and quality of work to be carried out by each performer is determined. The installation of fuel consumption sensors and monitoring of fuel consumption in the online system allows preventing unauthorized drain of diesel fuel and timely adjusting the engines, which, according to the calculations, saves up to 15% of the cost of crop product output. The installation of weighing sensors on combines contributes to a significant reduction in losses during harvesting and optimization of logistics systems for crop transportation, storage, and marketing.

The opportunities for using digital technologies by small agribusiness enterprises expand when they join cooperative or integrated agro-industrial formations. One of the forms of such associations is

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agricultural consumer supply, sales, and service cooperatives, which are established, as a rule, at the initiative of peasant (farmer) enterprises and personal subsidiary plots (Kuznetsova & Ilyina, 2018). The activities of such associations are the provision of cooperation participants with means of production, the provision of services related to the sale of their products, marketing and other maintenance services. Integrated cooperative formations make it possible to combine the resources and efforts of cooperative members in order to introduce innovative digital technologies into production.

The development of digital technologies has contributed to the emergence of virtual forms of agricultural consumer cooperatives. Thus, supply and marketing consumer cooperatives that unite grain producers, while using the capabilities of virtual reality through electronic trading, sell a significant part of grain and sunflower through the Internet. Members of a cooperative, whose leader interacts online with a supplier or manufacturer of capital goods, increasingly jointly purchase fertilizers, spare parts, seeds and other goods and services via the Internet at most favorable wholesale prices.

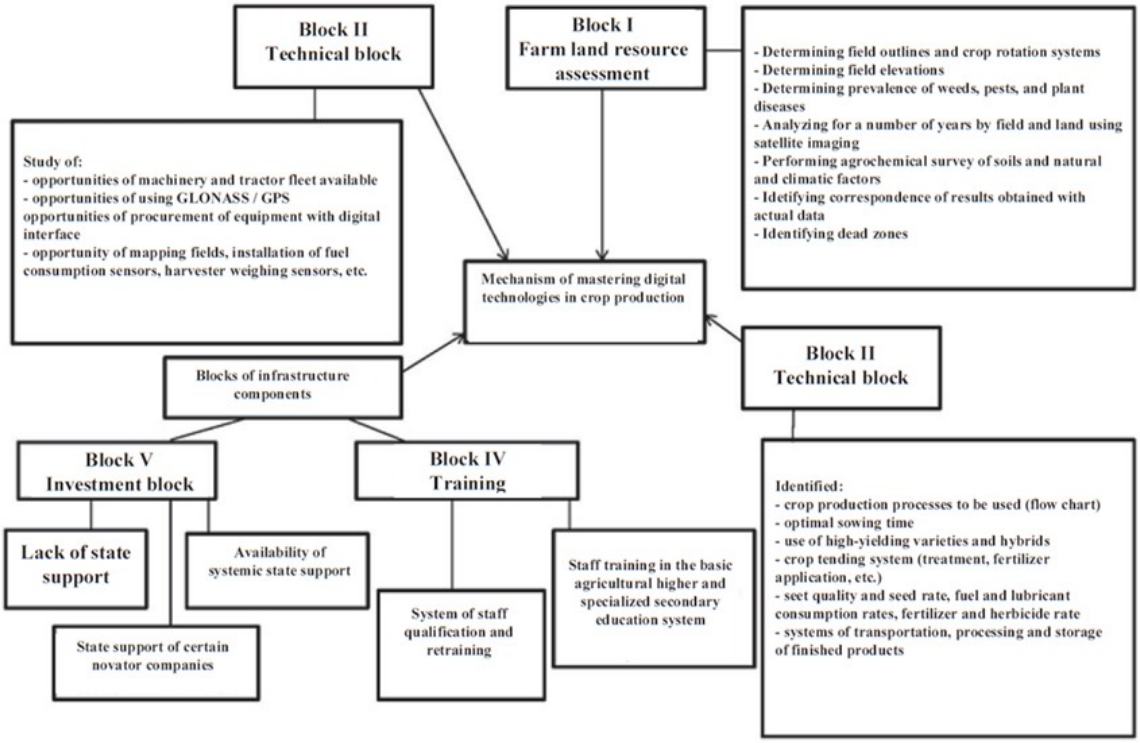

Figure 1. Block diagram of the transition of small and medium agribusiness facilities to digital technologies

7. Conclusion

Thus, digital technologies in agriculture are beginning to play a significant role in the innovative development of the country's agribusiness. We have investigated the need for digitalization of agro-industrial production, which is due to up-to-date requirements for the development of the world economy. We identified the impact of digitalization on the productivity of agricultural production, substantiated the need for digitalization in small and medium-sized forms of management, and studied examples of the

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application of certain components of digital transformation in peasant (farm) enterprises and their economic effect.

The authors, while examining the main areas and tasks of digitalization of the economy in the agricultural sector defined by the "Digital Agriculture" departmental project and the "Digital Agriculture" state subprogram, firstly, propose to differentiate them in relation to a specific small or medium-sized agribusiness enterprise in three priority areas, highlighting digital transformation of crop production, livestock production and infrastructure.

Secondly, the study of the experience of introducing digital technologies in peasant (farm) enterprises made it possible to determine the mechanism for their development while highlighting five constituent blocks. Thirdly, given the insufficient provision of financial resources for small and medium-sized businesses, it is recommended to introduce into production at the first stage less costly components of digital technologies. It is proposed to accelerate the digital transformation of crop industries to develop this area of development through cooperative formations that combine small and medium agribusiness.

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