Development of technical and economic parameters of experimental digital farms

V S Bocharnikov¹, N V Ivanova¹, N N Balashova ¹, M A Ovchinnikov ¹ and K E Tokarev¹,²

¹Volgograd State Agricultural University, 26, Universitetskiy Avenue, Volgograd, 400002, Russia
²Volgograd State Technical University, 28, Lenina Avenue, Volgograd, 400005, Russia

E-mail: tke.vgsha@mail.ru

Abstract. The article deals technical and economic parameters of new-generation farms based on intelligent digital technologies. The proposed technical and economic parameters of digital farms meet the criteria for effective use of existing resources of the regional agro-industrial complex, reducing losses and improving the quality of agricultural products.

1. Introduction

In accordance with The national project «Digital economy of the Russian Federation» and the departmental Program «Digital agriculture», the priority tasks for the development of the Russian agro-industrial complement are the transition to intelligent production of integrated digital solutions that can provide a strategic breakthrough and significantly increase the efficiency of the industry. The Russian Federation's agriculture has huge opportunities for digital transformation and innovative development, while the available expert data indicate the potential for increasing the efficiency of agricultural production by 3-5 times as a result of adaptation and implementation of digital processes and technologies in crop and livestock production, increasing labor productivity and fully using the capabilities of modern digital platforms for managing macro-, meso- and local levels of agricultural production in an end-to-end digital environment «from field to counter» [1].

The innovative model of agricultural development in Russia is characterized by the formation of digital technology platforms, the expansion of the knowledge economy, and the digital transformation of production and management systems. High-tech manufacturing is an innovative process of creating products or services that are competitive in the target market with a high share of added value based on the use of advanced digital technologies, «intellectualized» means of labor and highly skilled labor [2-3].

At the same time, today the share of the digital economy in Russian agroindustrial complex is small. The country ranks only 15th in the world in terms of digitalization of agro-industrial complement. According to experts, the main reasons that hinder digital transformation are: outdated technologies, the lack of specialists and teams with the necessary competencies and skills, the lack of integration of existing and new technologies and data, which requires a significant restructuring of infrastructure, technology, scientific approaches, principles, and methods of organizing production. At the same time, it should be noted that the digital transformation of the agricultural production organization has both positive aspects - new breakthrough digital technologies, artificial intelligence, the industrial Internet of
things, big data analysis, unmanned transport, mass information services, automation and robotization of labor, increasing the efficiency and standardization of services, digital identity and very negative consequences - dependence on borrowed imported technologies, degradation of their own competencies, the possibility of hidden «bookmarks» in hardware and software, the possibility of capturing innovative markets by companies in economically developed countries, job cuts, the elimination of certain specialties, unemployment, social tension, uncertainty in the legal sphere, the growth of fraud, ethical problems, social stratification, the disappearance of privacy, Intrusive advertising, leakage of confidential information of enterprises and personal data of citizens, external economic management, digital colonization, and other negative factors resulting from the globalization of possible risks. Comprehensive consideration of these factors when implementing digital tools in the practice of agricultural management will optimize the process of state regulation of the industry's economy by increasing its transparency and manageability, reducing management costs and making more rational government decisions [4-7].

2. Materials and methods

The main goal of the research is to provide theoretical justification and develop a basic set of processes and methodology for digital transformation of the agro-industrial complex based on the adaptation, diffusion and acceleration of digital technologies in the economic and financial activities of economic entities in the industry. Implementation of the proposed ideas can be a powerful driver of accelerated development scenario of the national digital system in agriculture, which will provide the opportunity to dramatically increase the efficiency of the sector and improve food security.

Digital transformation of agricultural enterprises should be based on fundamentally new high-tech approaches to creating products based on a multi-level matrix of targets and resource constraints, automation and a system of intelligent assistants in order to ensure a significant reduction in testing and reduce the time to bring competitive products to market. Within the framework Of the national program «Digital economy of the Russian Federation», a departmental project «Digital agriculture» has been developed and is being implemented to ensure a technological breakthrough in agriculture through the introduction of digital technologies.

![Figure 1. Integration of digital farms into the regional agribusiness structure.](image)

The goal of the project is to digitally transform agriculture through the introduction of digital technologies and platform solutions to ensure a technological breakthrough in the agro-industrial
complex and achieve a 2-fold increase in productivity at digital agricultural enterprises by 2024. The validity, innovation and relevance of the basic components of the project are not in doubt, however, it should be noted that they are poorly visible new models of economic behavior that allow you to switch to digital technologies, which makes it difficult to implement them in practice in the regions of our country [8-9].

Small agribusiness is experiencing considerable difficulties in promoting its products to the final consumer. For experimental basic digital farms, the problem of integration into the existing structure of the regional agricultural complex is solved using information technologies and on the basis of a network organization of interaction of economic structures using elements of electronic Commerce. The most important channels for integrating digital into the regional agro-industrial production system are shown in the diagram (figure 1).

The leading role in disseminating and replicating the experience of digitalization of small businesses in the agricultural sector is assigned to the Institute of local self-government, which should stimulate the development of integration of small businesses with large agribusiness and infrastructure enterprises in the region, which is reflected in the road map for organizing logistics channels for farms in the following diagram (figure 2).

![Figure 2](image-url)

**Figure 2.** Road map of the organization of the logistics channels of digital farms.

The network organization of interaction of economic structures will provide not only direct satisfaction of consumers in unique products, in which the final buyer and supplier interact directly, but
also help to establish an effective logistics of technical, technological, scientific and information support for each business sector [10-12].

The sequence of actions of subject representative offices is presented through the algorithm for implementing network interaction in the framework of the model proposed by the authors sample (figure 3, 4).

Figure 3. The algorithm for implementing network interaction of digital farms.

The information source for the research was the results of a survey of heads of farms and heads of small agricultural formations. The survey involved 427 Directors of farms in five natural and climatic zones of the Volgograd region [13-15].

Summarizing the results of the survey showed that in recent years there has been a significant decrease in the security of small businesses in all parameters:

- the level of job security decreased by more than 20% from 2014 to 2018;
- the machine-technological complex has also decreased over the past 5 years: the number of tractors per 1000 hectares of arable land - by 6,5% and combine harvesters per 1000 ha of grain sowing by 13,8 %;
- the share of extensive and outdated technologies in farms is more than 70%, intensive-less than 5%.

Peasant farms were the most susceptible to innovation. The author's methodology for calculating the «Innovation potential index», which contains an assessment of five indicators, was used to justify the study:
• education and qualifications of farm Directors and their employees;
• use of new agricultural machinery and equipment;
• introduction of agricultural innovations;
• use of computer equipment and information technologies;
• the level of marketability, processing and profitability of production.

Figure 4. Technical and economic parameters of digital farms in the Volgograd region.

Evaluation of economic efficiency of introduction of digital technologies in the production of whole milk in the animal farm with herds of up to 100 head of cattle gave the following results: the total scale of investment on technology, «smart» dairy farm, based on the use of digital technology to control the basic biometric, physiological and medical parameters of Pets, in terms of 100 cows was 1 243 thousand. This amount will be refunded to the first year of the project digital a dairy farm. The net discounted income of the investor by the end of the year will be 1 285 000 rubles (figure 5).

Figure 5. Payback period for the farm digitalization project.

The developed algorithm for implementing digital platform technologies and the roadmap for organizing logistics channels for farms will provide the greatest return in using the potential of rural areas (settlement, municipal district) and will allow small businesses to adapt to innovative development at the lowest cost through the introduction of digital processes and technologies in crop production and animal husbandry.
Practical application of the obtained results is possible by state, regional and local authorities in developing a strategy for digital modernization of small businesses in the agricultural sector of the economy, aimed at improving the efficiency of their activities.

3. Conclusion

Based on the results of the study, proposals are made to attract budget funding to solve the state task of attracting additional sources of funding to reimburse part of the cost of purchasing equipment and technical means for digitalizing production processes in crop and livestock production for experimental digital farms, as well as training highly qualified personnel with multidisciplinary competencies and practical skills.

Developed reference model of business processes farms engaged in crop production and livestock reference model digital farms into crop production, as well as algorithms for the integration of digital farms in the structure of distribution systems, prospects of creation of new logistics solutions aimed at optimizing commodity and resource flows, involving basic experimental digital farms. A computer program for analyzing and evaluating business processes based on Express analysis and an information system for accounting publications and patents of employees has been developed.

For replication and practical application of the experience of digitalization, the state, regional and local authorities are invited to use the results of the study in developing a strategy for digital modernization of small businesses in the agricultural sector of the economy, aimed at improving the efficiency of their activities. Practical application of the obtained results is possible by state, regional and local authorities in developing a strategy for digital modernization of small businesses in the agricultural sector of the economy, aimed at improving the efficiency of their activities.

Acknowledgments

The reported study was funded by RFBR and Volgograd region according to the research project № 19-416-343006. The research was conducted as a part of the grant of the President of the Russian Federation MK-592.2020.11

References

[1] Ovchinnikov A S, Ivanova N V and Balashova N N 2018 Espacios 39 36
[2] Popova L I, Demina I D, Stepanenko Y S, Tran, Q N, Meshkova, G V and Afonasova M A 2019 International Journal of Economics and Business Administration 2 176-88
[3] Kamilaris A, Kartakoullis A and Prenafeta-Boldú F X 2017 A review on the practice of big data analysis in agriculture Computers and Electronics in Agriculture 143 23-37
[4] Tokarev K E, Rogachev A F, Pleschenko T V, Rudenko A Yu and Kuzmin V A 2019 IOP Conference Series: Earth and Environmental Science 341 012212
[5] Kheneva S, Tsaregorodtsev E, Tereshina V and Sredina Y 2018 International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management 18 19-26
[6] Panganiban G G F 2019 Journal of Asian Public Policy 12 51-70
[7] Rogachev A F, Medvedeva L N, Timoshenko M A, Tokarev K E and Shiro M S 2019 Advances in Intelligent Systems and Computing 726 989–1004
[8] Kamble S S, Gunasekaran A and Gawankar S A 2020 International Journal of Production Economics 219 179-94
[9] Ivanov V V, Ovchinnikov A S and Kochetkova O V 2019 Proc. of the Lower Volga AgroUniversity Comp. 54 18-25
[10] Rogachev A F, Shokhnekh A V and Melikhova E V 2018 Espacios 39
[11] Korobeynikova O M, Korobeynikov D A, Popova L V, Savina O V and Kamilova R S 2017 Espacios 38
[12] Popova L V, Korobeynikov D A, Korobeynikova O M and Panov A A 2016 Journal of Applied Economic Sciences 11 1034–44
[13] Kruzhilin I P, Ovchinnikov A S, Kuznetsova N V, Kozinskaya O V, Fomin S D, Bocharnikov V
S and Vorontsova E S 2018 ARPN Journal of Engineering and Applied Sciences 13 4181–4

[14] Kruzhilin I P, Dubenok N N, Ganiev M A, Ovchinnikov A S, Melikhov V V, Abdou N M and Rodin K A 2017 ARPN Journal of Engineering and Applied Sciences 12 7118–23

[15] Timoshenko M A, Rogachev A F, Medvedeva L N and Tokarev K E 2019 The Leading Practice of Decision Making in Modern Business Systems: Innovative Technologies and Perspectives of Optimization 87-97