Digital Technologies in Agriculture

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Abstract: One of the priority directions of the development of the state at present is the formation of the digital economy. Currently, the country's regions have practically exhausted the possibility of intensive development of agriculture, since land and other resources have quantitative and territorial limits. New digital technologies for microclimate control, tillage and cost optimization are an opportunity to increase the yield and quality of manufactured products. The subject of the study is digital technologies in agriculture. The purpose of the work is to study the problems and prospects of the introduction of digital technologies in agriculture of the Russian Federation at the present stage. The analysis of the state of the agricultural complex in the context of innovative development is carried out. In modern agriculture, there is an increasing need for the use of modern technologies, including data collection, storage and processing systems. The use of IT technologies contributes to increasing the yield and profitability of agriculture, reducing material costs, and more efficient allocation of funds. In general, if certain conditions are met, digital transformation will ensure the sustainable development of agriculture and increase its competitiveness. The introduction of digital technologies should be consistently implemented at all levels of agricultural management, including state, regional and local.

1 INTRODUCTION

The Russian agricultural industry needs the process of introducing digital technologies in order to increase the efficiency and sustainability of its functioning, through a complete transformation of the management apparatus, technological production, and strategic decision-making system. These processes should take into account the introduction of innovative production methods and analysis of the state and forecasting of possible changes in control elements and subsystems, as well as the economic situation in agriculture.

For the successful implementation of the process of introducing digital technologies in the field of agriculture, it is necessary to compare the features of digital technologies and agriculture within the economic and managerial categories (Table 1).

Table 1: Features of digital technologies and agriculture as economic and managerial categories*.

Features of agriculture	Features of digital technologies
Due to the participation of animals, plants, environmental factors and human resources in the agricultural process, the parameters of the agricultural process are unstable	The ability of the process to change, transparency of operations
Diversity and complexity of processes	Unlimited amounts of data, accounting of information through a set of software tools that allows you to manage economic objects and processes
Technological diversity of	Automation of work

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agricultural spheres	processes, consisting of robotic workplace automation, robotic process automation, machine learning and artificial intelligence.
Managed processes placed in small parts on the territory	Accessibility, absence of territorial dispersion of natural factors

*compiled on the basis of (Kolotkina, 2020; Bronson, Knezevic, 2016; Carolan, 2018; Carolan, 2017; Eastwood, Klerkx, Nettle, 2017; Fraser, 2018)

The comparison of digital technologies contributes to the definition of all sub-sectors of agriculture within the framework of digitalization.

Currently, the introduction of digital technologies is being gradually implemented in all areas of the agricultural industry, taking into account the following areas (Figure 1) (Bryant, Higgins, 2020; Carbonell, 2016; Carolan, 2017; Fielke, Garrard, Flemning, Wiesman, Taylor, 2019):

1. Digital technologies in the process of regulation by the agricultural sector. The management process in the field of agriculture includes the development and implementation of a specialized data set for software, hardware and information support for the management of this industry (Voronin, Loretc, Mitin, Chupina, Voronina , 2019).

2. "Smart Land Use", which represents the use of an automated system of intelligent planning and analysis of the characteristics of land resources in the agricultural sector.

3. "Smart Field" is a digital direction for classifying data on the characteristics of land resources in the framework of identifying its fertile features, as well as digital technologies for reading the characteristics of the plant and natural environment.

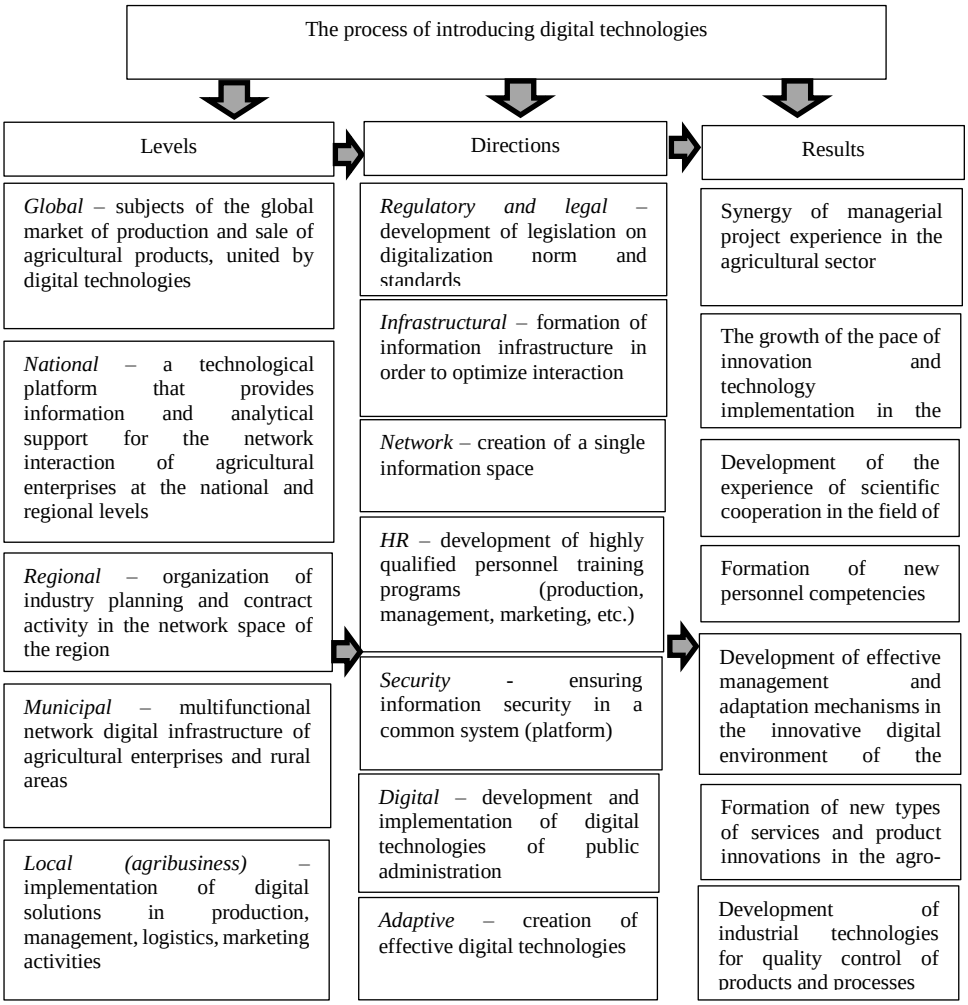

Figure.1: Key directions of implementation of digital technologies in the field of agriculture (developed by the author).

4. "Smart Garden" is an intelligent garden greenhouse, which implements the preparatory and production process for growing plants based on intelligent automated systems, such as robomobiles and combines equipped with an automatic control system.

5. "Smart Greenhouse" is an object of agriculture on a robotic and automated basis, functioning independently within the framework of plant production in the most optimal growing conditions.

6. "Smart Farm" — represents an agricultural facility operating on a robotic and automated basis within the production of livestock products with the highest level of quality and environmental characteristics.

The effective implementation of the presented directions on digital solutions in the agricultural sector is carried out in a phased mode. The implementation of measures in accordance with these directions provides for several stages:

1. Creating optimal conditions for agricultural workers within the framework of providing them with preferential state support opportunities for farmers to receive state support through a single national digital platform at all levels of farming.

2. Development and implementation of the digital module "Agricultural Solutions", the purpose of which is to increase the profitability of the agricultural sector, reduce costs and increase labor productivity.

Training of professional and competent workers with digital competencies for effective activities in the field of agriculture. Domestic agricultural universities are developing programs for the training and retraining of specialists of agricultural enterprises for the development and assimilation of digital agricultural competencies (Fomin, 2019).

The international and domestic experience of the

effective activity of the subjects of the agricultural sector confirms the positive effect of the use of digital technologies, which is expressed in the following directions:

- creation of optimal soil-agrotechnical and organizational-territorial conditions that contribute to significantly increase productivity and labor productivity throughout the life cycle of agricultural products (Ognivcev, 2019);

- reducing the costs of raw materials, electricity, phytosanitary products, wages and other types of expenses, preserving the ability of the soil to meet the needs of plants for nutrients, moisture and air, and protecting the environment.

Thus, the most popular technologies in the agricultural sector will be digital technologies for monitoring and managing modern technological equipment and innovative methods in agriculture using the latest technologies to improve the quality of the crop (Gorlov, 2018).

The following areas will contribute to the active development of digital technologies in the process of agricultural production: support and representation of scientific communities of the benefits of the latest scientific achievements and technological progress among the population, training of professional human resources with the competencies of agronomists with information technology skills, specialists engaged in breeding, keeping, feeding and exploitation of agricultural animals of the IT level (CHebotaryov, 2018).

Thanks to the implementation of the presented directions of modern digital technological achievements, the level of agriculture, profitability and productivity of this industry will increase at all stages of the life cycle of the production process.

Modern digital transformation processes in the production sector of the agricultural sector are aimed primarily at the phased automation of all production processes, reducing manual labor and costs, as well as increasing profitability and productivity.

Currently, large agricultural producers need a diverse range of specialized equipment, with the help of which it will be possible to process large volumes of agricultural land and produce competitive agricultural products (Skvorcov, Skvorcova, Sandu, Iovlev, 2018). In this regard, production should be automated as much as possible to obtain the maximum effect within the productivity of agricultural products, which requires the use of modern digital technical equipment, studying the presented range of lifting mechanisms and choosing the optimal vehicle for transporting products and fertilizers, selecting high-quality seed materials, irrigation and harvesting equipment (Izmajlov, Godzhaev, Grishin, Grishin, Dorohov, 2019).

To date, the use of information technologies in the agricultural sector involves not only the use of computer digital technologies, but also monitoring of the full life cycle of crop production or animal husbandry, where the properties of soil, plants, climate features and so on are determined and transmitted using digital devices. All these data obtained from sensors, unmanned aerial vehicles and other modern equipment are analyzed by special programs (Vanyushina, 2019).

Mobile or online applications help farmers and agronomists determine the optimal period for sowing or harvesting, calculate the schedule for fertilizing, calculate the projected *yield*, and so on.

The development of digital technologies in the field of agriculture is a long and time-consuming process, the implementation of which must take into account the following factors:

1) expansion of system official data on the process of digitalization in the agricultural sector, due to the fact that most of the data, such as possession, a minimum set of knowledge and skills of working on a computer and with digital technologies is available only at the country level, and accurate data on individual regions and rural areas are not available.

2) the lack of information on state support and the regulatory framework for the digitalization process, which has so far been indirect, including the availability of electronic public services and regulatory control of data security.

3) a significant discrepancy in the parameters of the implementation of digital technologies in agriculture in developed and developing countries, large and small rural companies, as well as community, family farms. The introduction of modern agricultural technologies is due to the availability of financial resources and the level of education. In this regard, small farmers in rural areas are disproportionately disadvantaged because their access to infrastructure, networks and technology is limited.

4) taking into account the factor of reducing average production costs and, accordingly, the cost of a unit of production with an increase in production volumes. The larger the production of an agricultural enterprise, the fewer problems with the introduction of modern digital technologies, the easier it is to implement such technologies. Therefore, it is easier for large enterprises to carry out this process in this regard. Thus, an unequal position is formed between large and small agricultural industries, developed and developing countries (Fedorov, 2019).

Consequently, the process of digitalization and implementation of innovative technologies in the framework of the transformation of the agricultural sector, involves mainly interaction with large agricultural producers.

Further prospects for the implementation of digital technologies in the agricultural sector are associated with the development of the following areas:

- creation of optimal conditions for the collection of full-fledged data not only at the country level, but also at the level of regions and rural areas;
- formation of sustainable business models that provide effective digital solutions for the involvement of small farmers in the digital transformation of agriculture;
- creation of an index illustrating the development of digital agriculture in the context of cultural, educational and institutional dimensions of individual countries.

It is also necessary to note the problems of the agricultural sector related to the lack or abuse of mineral fertilizers and plant protection products, violation of biological diversity, prolonged water scarcity, land degradation in arid areas and long-term changes in average climatic indicators. According to experts, up to 33% of the crop is lost during planting, cultivation, storage and transportation.

In order to preserve a larger share of the harvest, it is of great importance to develop the technology of "smart" agriculture or "smart farming", which ensure the rational use of available land, water, logistics and labor resources.

"Smart" agriculture is based on the use of automated decision-making systems, integrated automation and robotization of production, as well as technologies for designing and modeling ecosystems in order to increase yields and reduce costs.It consists in minimizing the use of external resources (fuels and fertilizers of chemical or biological origin intended for plant nutrition) while maximizing the use of local factors of production, such as renewable energy sources, fuels of plant or animal origin, top dressing, which contains plant nutrition elements mainly in the form of organic compounds.

Smart agriculture technologies are very effective in environmentally safe pest control, restoration and preservation of useful properties of soils and groundwater, as well as remote integrated management of compliance with the requirements of organic agriculture in accordance with certification standards. Thus, the digitalization of the agricultural industry is a priority direction in the framework of increasing the profitability of agricultural production due to point optimization of costs and more efficient allocation of funds.

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