# Digital Transformation: Problems and Trends in the Development of Agricultural Startups

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*Abstract*—**The article deals with modern aspects of digital transformation in the agro-industrial complex of the Russian Federation. Recently, the global application of digital technologies in the agro-industrial complex has become a modern global trend. This study presents country ratings of agribusiness development. The analysis of implemented foreign startups in agriculture and functioning agricultural startups in the Russian Federation is carried out. Marked a major factor in the use of digital technologies in agro-industry and the main components of the digitalization of the agro-industrial complex; provided that the trends of agribusiness development moving to a new stage of development due to the fact that the preconditions fundamental scientific change and discoveries; considers the factors that influence the development and transformation of the paradigm of development of agroindustrial complex. An example of the formation of the stages of an effective production chain in the agro-industrial complex of the Russian Agricultural Bank is given. The prospects for the development of the scientific and technological trend are noted. The departmental project "Digital Agriculture" and its financing, as well as the stages of an effective production chain in the agro-industrial complex and the directions of development of agro-startups with IT technology "smart farm"are also presented in detail. The conclusion of the article is that it offers state support for agro-startups and the use of digital technologies in the agro-industrial complex of Russia.**

*Keywords—agro-industrial complex, agrarian startups, artificial intelligence, agriculture, smart agriculture, digitalization, digital transformation, digital technology. agro-industrial complex, agrarian startups, artificial intelligence, agriculture, smart agriculture, digitalization, digital transformation, digital technology.*

## I. INTRODUCTION

The article examines the digital transformation of the agro-industrial complex, including problems, trends, and prospects for the development of agrarian startups in the Russian Federation.

The aim of the article is to identify the real prospects for the agro-industrial complex of the Russian Federation in the direction of digital transformation and transition to a new stage of development using agrarian startups, innovative and information technology in applying elements of artificial intelligence. The following economists, such as A.I. Altukhov, G.V. Bespakhotny, A.Ya. Kibirov, L.F. Kormakov, A.R. Kulov, L.S. Orsik et al. have made a great contribution to research on topical problems in the theory and practice of development of the agribusiness complex of the country. Currently, the modernization of agriculture and the transition to digital transformation are reflected in the studies of A.V. Alpatov, A.A. Belostotsky, V.V. Maslova and others.

Results. The article analyzes the degree of digitalization of the Russian agro-industrial complex. It was revealed that digital technology, and agro-startups, are being gradually introduced, which contributes to the further development of agriculture and the promotion and implementation of the digital transformation programme in the agro-industrial complex.

It was concluded that the further development of the Russian agro-industrial complex, taking into account the introduction of digital technology, agro-startups, and artificial intelligence, would contribute to the development of agriculture.

## II. RESEARCH METHODOLOGY

The research methodology is a combination of several groups of methods, including monographic method and data mining, processing the data obtained using macroeconomic and econometric indicators, interactive validations with

economists, key experts in certain segments of the agro-industrial complex.

## III. RESULTS AND DISCUSSION

Analyzing the world practice, there are currently more than 150 start-ups in the agrarian sector that have managed to form a large business with capitalization of more than 1 billion dollars [9]. Digital innovations to improve agricultural efficiency include software, electrical meters, sensors, aerial surveying mechanisms, Internet-based marketing resources, technological research tools and equipment. For clarity, let us present the country ranking on agriculture in Table 1.

TABLE I.        FIVE LEADING COUNTRIES IN THE AGRICULTURAL SECTOR

| Technological areas | Ranking place | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Agriculture | USA | China | India | Brasia | Japan |

Source: R&D Magazine

It should be noted, however, that there are problems of entrepreneurship in agriculture, such as the lack of a system for the introduction of new digital technology and solutions into practice. Startups often do not get from the development stage to the stage of implementation in the business. But, despite this, the digitization of the agrarian sector is gradually gaining momentum, and agribusiness entrepreneurs do not yet have much experience in scaling up business strategies in the markets. Therefore, specialized skills such as advanced digital training or agricultural business courses are needed to speed up these processes. Let us present foreign agro-startups in Figure 1 as an example that will allow achieving large-scale use in agriculture [12].
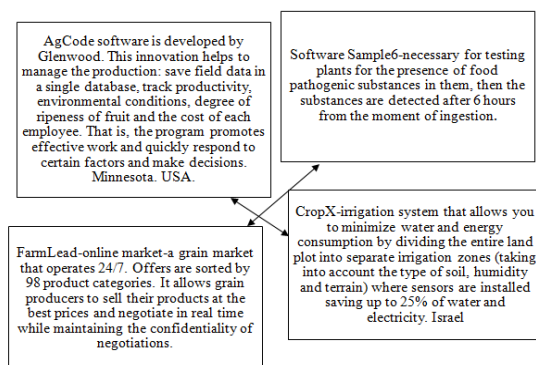


Fig. 1.    Foreign experience of startups in agriculture

Investment is necessary for the long-term and sustainable development of Russia's agro-industrial complex. As has already been noted, agricultural start-ups are a modern investment activity. If we analyze the development of agro-startups according to the data of the "Agrotekhnika i tekhnologii-Agroinvestor" Journal, we will see that in the Russian Federation the economic effects of the introduction of innovative digital technology in agriculture can occur in 2025 [6]. Agriculture in Russia is still technologically lagging behind Western production standards, but agricultural production, especially grain, is in demand worldwide.

Agro-industrial holdings are recognized as important clients of new startups in agriculture and contribute to their development and application. For example, the AgroTerra company cooperates with startups and helps to implement them. Since 2015, the AgroTerra Research Center has tested

262 technology elements and 95 crop varieties. At the moment, the main part of the digital technology market in agriculture is about 360 billion rubles, there are more than 200 startups operating in different segments of agricultural technology, and in the forecast for 2026 it should increase by 5 times, including through the support of agricultural startups [2].

The main feature of rural startups is the lack of guarantees of return on investment. Consequently, the agro-industrial complex has the potential to develop, but there are risks that affect planning in the long term. It is the need for cheap and "long" investment resources that significantly limits the number of startups in Russian agriculture.

Innovative projects in the Russian Federation are supported, for example, by the Skolkovo Foundation, which in 2015 supported startups in the agro-industrial complex. Thus, currently investments have been made in 3 projects, and several agricultural startups operating in the Russian Federation are presented in Figure 2. [5].

Fig. 2.    Agro-startups operating in Russia
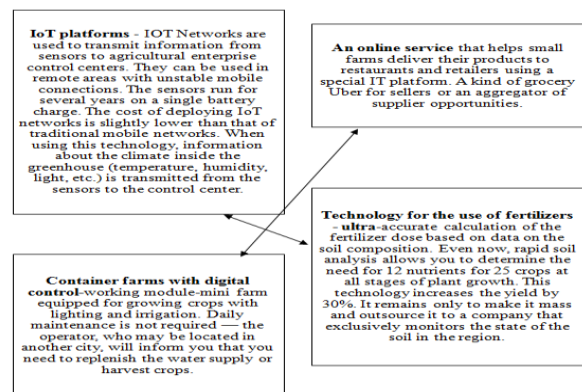


Newly established farms or peasant farms, all of which are called small businesses, are recognized as an important link in digitalization and contribute to the development of agriculture.

Currently, the percentage of employees with higher education in the agricultural sector is increasing, which means that the industry is becoming intellectual, and, therefore, there is an interest in urban youth with innovative thinking. More recently, young personnel are being recruited in the agrarian industry to form an innovative, ecological, and automated businesses. The concept of training the personnel of agro-industrial companies to develop their skills with digital products and digital technology in the digital economy is being developed in higher education institutions [4]. Effective competition in the agricultural market therefore requires accelerated training programmes and courses and government support (financing), which will contribute to create favourable conditions for attracting and cooperating investors in startups.

It should be noted that the trends in the development of of the agro-industrial complex are moving to a new stage of development by creating prerequisites for fundamental scientific changes and discoveries.

Many researchers believe that the impact of certain trends will transform the paradigm of agribusiness:

- a factor of transition to a new techno-economic paradigm: in the long term, the implementation of food

production should more than ever depend on the technological tools used to increase yields and productivity and prevent losses, but less than ever, on the impact of external factors of climatic and biological orientation;

- a factor of changes in value chains: added value will increasingly be seen in science-intensive sectors (genetics and breeding, IT-sector, industrial design and engineering);

- a factor in the growth of influence of integrator companies that perform control functions in large areas of food systems. Such systems are the driving force behind the introduction of innovative technologies and form global value chains;

- the factor of the shift in demand from traditional food raw materials to products that correspond to the value trends of the new generation, who prefer ready-to-eat food, products with preset preferred parameters. At the same time, increasing importance is given not only to the property of benefit and security, but also to the property of "origin", technology and ethics of production;

- the trend towards the growth of certain standards and certification systems, which in the future may act as a tool for regulating of international trade;

- transition to the knowledge-based economy: the development of digital transformation and robotization will significantly change the structure of employment. On the one hand, reducing dependence on low-skilled labour and focusing on relevant professions in demand, on the other hand, forming a list of rapidly changing requirements for core competencies. All this may lead to the formation of education model, which will focus on rapid adaptation to new conditions.

Trends in innovation processes in the agro-industrial complex are not static, for example The Russian Agricultural Bank, JSC has formed stages of an efficient production chain in the agro-industrial complex, which are subdivided into blocks and presented in the diagram form in Figure 3 [10].
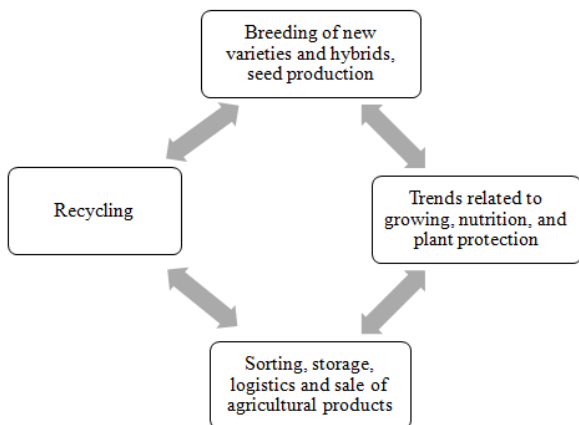
Fig. 3. Stages of the production chain in the agro-industrial complex

Consequently, the digitization of the agro-industrial complex contributes to the promotion and scaling up of innovations and inventions in agriculture. A clear focus on the

effectiveness of each element of the operation, as well as the use of digital farming equipment, sensors and other digital systems, also contributes to this. In manufacturing, we see high yields at relatively low costs.

But the main scientific and technological trend in the future will be the use of information technology and artificial intelligence in agriculture, that is, the formation of "accurate" and "smart" agriculture (Figure 4) [1].

Fig. 4. Stages of the production chain in the agro-industrial complex The model of implementation of "Smart farm" IT-technology, optimizing the economy

After analyzing the implementation of IT technology in the agro-industrial complex, we came to the conclusion that the main goal is the introduction of artificial intelligence (AI) or Internet of Things (IoT) in the agri-business as well as standardization and digitalization of production, improving the environmental situation, reducing production costs and increasing productivity [11].

Robotization of planting is being actively introduced in foreign countries. In the Russian Federation, IT-systems that aim at automation of mechanism of production, accounting and estimation of quality and quantity of agricultural products, creation of a recipe of feed, analysis and monitoring of soil have acquired maximum promotion.

Many tech companies grown out of startups can answer the main requests of agricultural producers of collecting, aggregating, and analyzing data. American agro-startups are demonstrating the use of new and very effective technology: artificial intelligence, computer vision and machine learning. Russian enterprises also use such technology, especially on an industrial scale for the analysis of NDVI images (map of indicators of the amount of photosynthetically active biomass) of tens of thousands of hectares of arable land, counting the number of apples per thousand hectares of orchards. The use of digital technology makes it possible to timely and precisely solve many problems, for example, the problems of poor plant germination, insufficient green mass, identifying foci of the spread of diseases and pests, making a forecast with a

sufficiently high degree of harvest accuracy and, as a result, more accurately planning harvesting, transport, storage facilities and / or work.

Considering the market overview, the market for "agricultural" unmanned aerial vehicles (UAVs) is at an early stage of development at the beginning of 2017. However, experts believe that in the future, agriculture will become one of the largest market segments for UAVs. Even 5 years ago, Markets and Markets estimated the market for "agricultural" UAVs at $ 864.4 million, predicting a steady annual growth of the industry at 30% (up to $ 4.2 billion) by 2022. According to experts from Markets and Markets, the active growth of the market will be facilitated by the gradual improvement of the regulatory environment, which is now observed in various countries of the world.

The assessment of the PwC analytical agency makes a forecast that in a few decades the market for some "agricultural" drones (not including aircraft-type drones) may amount to around of $ 32.4 billion. The growth trend will be driven by the growth of the world population. In order to feed everyone, innovative agricultural technologies that increase yields are indispensable.

The following countries are actively using "agricultural" drones: USA, China, Japan, Brazil, EU countries, etc.

Major players in the global market for UAVs are such representatives as AeroVironment Inc, AgEagle, DJI, Yamaha, etc. These companies make a benchmark in agriculture. Research by Goldman Sachs predicts the agribusiness sector will become the second-largest drone sector. According to Gartner researchers, the increase in unmanned aerial vehicles is 30%, in the total volume of 7% falls on agribusiness.
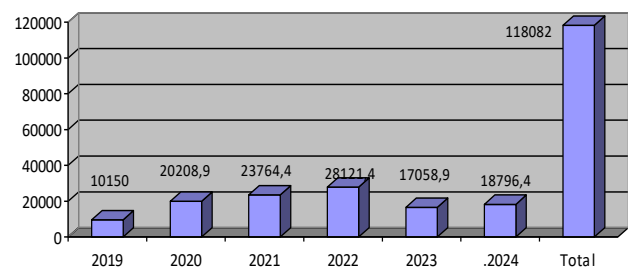
The Ministry of Agriculture of the Russian Federation provides active financial support to agricultural enterprises, which introduce digital solutions and promote the development of competence and skills in the field of digital solutions among specialists in the agro-industrial complex [5].

| The «Simple Solutions» artificial Intelligence is an analytics and forecasting program for dairy farms that combines data on the milking parlor, management system and feeding system and makes forecasts for 80 indicators. | Mustang drones – the use of digital tools significantly increases the profitability of production and the accuracy of data and forecasts for the future, which include both ground-based drones and unmanned aerial vehicles and multicopters, as well as winged drones |
|---|---|
| | DIGITALIZATION IN THE AGRO-INDUSTRIAL COMPLEX |
| The Internet of things is a system of interaction and exchange of information between various devices and machines, which allows you to automate the management and control processes through various «smart devices» and significantly reduce human participation in them. Areas of application of Iot technology in agriculture. Precision farming is the use of «smart» devices in managing crop productivity, taking into account changes in the plant habitat, as well as more efficient use of land. «Smart farms» - allow you to increase the productivity of pets and the quality of products, as well as re duce costs. «Smart greenhouses» - allow you to spend fertilizers, chemicals, water more efficiently, as well as optimize the number of personnel needed to care for crops, and reduce losses due to the human factor. «Smart» storage for vegetables and fruits allows you to monitor the condition of products during storage with. | «Kau pro» – herd management system. It provides detailed data on milking, feeding, growth, reproduction, treatment of each animal is one database. Electronic trading platforms for farmers are used for operational communications of agricultural producers with purchasing and trading organizations, which reduces the time of product delivery from the field to the counter and reduces its losses associated with intermediate storage |

Fig. 5. Applications of digital technology in the Russian agro-industrial complex

In the Russian Federation, the main factor in the use of digital technology in the agro-industrial sector is increasing agricultural productivity and reducing production costs. Therefore, through digitization, it is possible to manage the agro-industrial complex and optimize production processes, and it will reduce the costs of agribusiness, increase production rates in terms of raw materials and agricultural products received, and raise the indicators of financial and economic performance.

Due to the state support and introduction of the "Digital Agriculture" Departmental project, for which financial support was allocated, several directions of transformation of agriculture were developed (Figure 6, Table 2) [3].

Fig. 6. Financial support, million rubles

It should be noted that the digitalization of the agro-industrial complex includes 4 main components, including a digital base (for example, digital maps), digitalization of production (the use of programmable "smart" field equipment), analytics and Big Data (forecasting of yields based on climatic data) and digital sales (traceability of products along the entire chain, from farm to table). All these components work in close connection with each other [8].

TABLE II. FINANCING OF THE "DIGITAL AGRICULTURE" DEPARTMENTAL PROJECT [3]

| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | Total |
|---|---|---|---|---|---|---|---|
| The Federal budget | 16 100.0 | 26 000.0 | 29 000.0 | 35 000.0 | 23000.0 | 22900.0 | 152 000.0 |
| Budgets of the regions of the Russian Federation | 350.0 | 500.0 | 1 000.0 | 2 150.0 | 2 000.0 | 2 000.0 | 8 000.0 |
| Extra-budgetary sources | 5 000.0 | 7 000.0 | 15 000.0 | 22 000.0 | 35 000.0 | 56 000.0 | 140 000.0 |
| Total | 21 450.0 | 33 500.0 | 45 000.0 | 59 150.0 | 60 000.0 | 80 900.0 | 300 000.0 |

The implementation of the "Digital Agriculture" Project requires high costs and the development of a clear execution mechanism, as well as state support in the form of subsidies and development of the legislative base. Creating of conditions for the introduction and training of specialists in this field will enable digital transformation of agriculture to ensure technological breakthroughs in the agro-industrial complex and efficient agricultural productivity.

## IV. CONCLUSIONS

In recent years, the application of digital technology in the agro-industrial complex has become the modern global trend. In the agricultural sector, digital transformation includes innovative and information technology, robots, artificial intelligence. The introduction of digitization in the agro-industrial complex requires the functioning of economic systems, the modernization and renewal of fixed assets, the transition to a digital economy, including by identifying the degree of readiness of enterprises of the agribusiness and the mechanism of sectoral management for digital transformation, as well as actively conducting forums where the startups of the latest development of material and technical resources will be explained.

Thus, further development of agro-startups in the agro-industrial complex requires the continuous development of public programmes, while creating a favourable business environment and investment climate, enhancing the macroeconomic role of agro-industrial complex in the national economy [13].

## ACKNOWLEDGMENT

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