Agriculture 4.0. as a new vector towards increasing the food security in Russia

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Abstract. This study is aimed at assessing the quality of the transformations taking place in the structure of the national economy in the light of the transition to the philosophy of Industry 4.0. The fourth industrial revolution, which has affected all countries and all spheres of human life, is aimed at increasing labor productivity in conditions of deteriorating environmental conditions. The goal of the study is to solve the following objectives: to review the ongoing changes in the environment, to assess the scale of an impending biological catastrophe, to analyze the forecast for the reduction in the production of foodstuffs, to assess the scale of digitalization in the agro-industrial complex, to develop recommendations for the transition to the philosophy of Agriculture 4.0 in modern conditions.

1. Introduction
Modern humanity is constantly faced with crises of the most diverse nature, from political to economic. Some crises are caused by the growth of social instability, but a number of crises are directly caused by the deterioration of the climatic conditions of life on the planet and the reduction of biological and natural resources. Along with the growth of the Earth's population and the demand for agricultural commodities, especially in the countries of Africa, Asia and Latin America, which do not have sufficient potential for food production and the provision of social conditions of life, there is a reduction in agricultural areas suitable for land use and grazing animals. If serious measures will not be taken to equalize the situation, a world social crisis caused by the struggle for survival between developed and poor countries may occur. Therefore, it is essential to identify innovative mechanisms for the future development of the global agro-industrial complex and the transition to the Agriculture 4.0 model.

The branches of the agro-industrial complex have high strategic importance, in which food security is a significant aspect of ensuring sustainable growth of the country's economy. The modernization of industries will allow them to be highly competitive and adapted to the modern requirements of the global food markets. The maintenance of high competition is possible only through the restructuring of the
traditional agro-industrial complex model and its transition to a new digital level of management that is the formation of the Agriculture 4.0 philosophy.

The main modern trend of this millennium is the deterioration of the quality of people’s food diet, which affects the dynamics of health and demographic growth of the population in the most negative way, contributes to the growth of nutritional diseases among the young working-age population.

The statistics of nutritional diseases show a steady increase in certain types of diseases (figure 1).

Figure 1. The structure of the cases of alimentary-dependent diseases in Russia in 2019, percentage.

Morbidity rates for the main classes of diseases indicate an increase in the density of food-dependent diseases. Cases of diseases, which are not influenced by the quality of nutrition remain at the same level or tend to decrease.

Moreover, all over the world there is a decrease in the level of food security of the countries, which manifests itself in various forms: an increase in the economic inaccessibility of high-quality food, an increase in global famine, a decrease in the quality of food products, the emergence of synthetic and artificial food products. All this entails an increase in a chronic demographic crisis, which requires a revision of the agricultural production management policy in the modern context of digitalization [1].

Innovative technologies of the 21st century have enormous potential for increasing food security of the population, as they are based on the accurate forecasting and planning the harvest, on the automation of mechanical processes and the replacement of heavy manual labor with mechanized one, on the possibilities of remote control of production processes [2].

The level of innovative activity of Russian companies demonstrates the presence of a big problem in the commercialization of innovative developments in the country. The low level of this indicator is a serious obstacle to maintaining the competitiveness of Russian goods in the world food market. The main problem lies in the absence of close and effective interaction between the state, business and the sphere of science and education. In Russia, innovations in agriculture are introduced passively and fragmented at the level of individual large agricultural holdings as testing grounds. To activate the innovative development of the agro-industrial complex, the Forecast of scientific and technological development of the agro-industrial complex of the Russian Federation for the period up to 2030 was developed and approved, within the framework of which two development scenarios “Local growth” and “Global breakthrough” were adopted. The ultimate goal of the listed development scenarios is to increase the share of Russian exports of agricultural products to a level from 1.5% (Local growth) to 3-4% (Global breakthrough) [3, 4]. After 2020, these scenarios will differ significantly in the dynamics of the industries’ development. The scenarios will ensure the high competitiveness of Russian products through the application of the latest scientific achievements and innovative developments. Due to the growth of the competitiveness of the agro-industrial complex, the following objectives will be solved:
• expansion of external food markets for Russian products,
• reduction of the country's import dependence on foreign food,
• increasing the level of food security of the country,
• creation of new jobs in the agro-industrial complex, which entails an increase in the quality of life in rural areas,
• growth of investment attractiveness of the Russian agro-industrial complex, including for foreign investors,
• additional funding to the state budget.

The transition to Agriculture 4.0 should not be an end in itself, but should be a new paradigm for the agro-industrial complex, in which the future planning and forecasting of activities should take place. The UN forecasts for the growing population of the Earth prove and dictate the need to modernize existing production processes, transfer them to a new technological structure and remote control of the main processes.

At the state level, a number of federal documents that regulate digitalization in the agro-industrial complex have been adopted. According to them sufficient funding for these activities is provided from the state budget. In addition to the direct state financial participation in the transition to information platforms, a number of measures are also envisaged: measures aimed at stimulating entrepreneurial initiatives in rural areas, at creation of processing infrastructure, and at stimulating scientific research on improving the genetics of agricultural plants and animals.

2. Agro-digital 4.0. as a new technological structure and vector of development of the agro-industrial complex of Russia

The new technological order that is emerging all over the world is based on the philosophy of the fourth industrial revolution, which has made significant adjustments, including in the industry of the agricultural complex. New agricultural tools and approaches have proven their effectiveness and productivity in many countries specializing in the production of food commodities. A parallel deterioration of agro-climatic conditions on the Earth's surface, a reduction in agricultural land and high yield losses contribute to the transition to new information platforms for planning, production and forecasting of agricultural production. A new direction in agriculture, Agriculture 4.0, has emerged, which is understood as all new innovative technologies being introduced in the agro-industrial complex around the world.

For several years, many academic economists have paid significant attention to the issues of digitalization and innovative development of agriculture and the development, implementation of instruments of remote control and production modeling [5].

The modern domestic agro-industrial complex in the conditions of the formed geopolitical confrontations of the world powers and the application of restrictive sanctions in the food sphere needs state support for stable and dynamic development. Agriculture is a high-risk industry, which is highly dependent on natural and climatic conditions and the seasonality of production. The set of government support instruments includes soft loans, direct subsidies, protectionism of the domestic food market, crop and animal insurance programs. Recently, digital technologies have been widely used in the branches of the agro-industrial complex in many foreign countries.

As an example, we can cite the EU countries that intensively use ICT; in fact, they are building their own information society in the face of a deteriorating earth climate and recurring natural disasters. The information society is a network interaction of all farms with Internet access, through which many issues with partners, contractors, credit institutions, and public authorities are resolved. The advanced digital instruments today are sensors for animal control, crop monitoring, sensors for forecasting weather changes and assessing the future harvest, electronic shepherds, UAVs, etc.

A leader in innovations is Japan, which has developed artificial intelligence drones to monitor agricultural arable land and defend them against wild animals. The United States has developed sensors
to monitor the health of pigs. There are many similar examples, which prove the involvement of the agro-industrial complex in the process of global information restructuring [6, 7].

To strengthen its own agricultural positions and to increase the competitiveness of produced agricultural stuffs in the world market, Russia is conducting a scientific search and practical implementation of existing information tools. Therefore, in 2016, the Strategy for Scientific and Technological Development of the Russian Federation was developed and put into practice. It determines the directions of scientific and technological development for the next 10-15 years. The assessment of target indicators for the implementation of this strategy demonstrates the main trends in the development of the agro-industrial complex for the period up to 2025: monitoring and control of crops and farm animals; preserving the harvest and minimizing losses during harvesting and storage; development of innovative technologies for the production of high-quality and functional food products. To achieve them, there are not enough conditions for the creation of scientific and technical developments in agriculture and for their prompt transfer to production and economic circulation in Russia.

![Figure 2. Financial support to the Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025, thousand rubles.](image)

The Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025 provides for the implementation and financing of three activities (figure 2):

1. Creation of scientific and technical results and products.
2. Transfer of scientific and technical results and products to production.
3. Commercialization of scientific and technical results and products.

The listed activities are included in each scientific and technical project and represent the potential for revitalization of innovative development of agriculture [8].

An assessment of the amount of funding for the program's activities shows that it is planned to increase funding until 2022, and from 2023, it will stabilize. The main financial sources of the program should come from the federal budget, from the budgets of the constituent entities of the Russian Federation and from extra-budgetary sources.

The developed and approved departmental project of the Ministry of Agriculture of the Russian Federation is designed to implement the main strategic goals of sustainable development of the national economy through the intensification of agricultural production of foodstuff. In addition, thanks to the
updating of informational base, the agro-industrial complex will be able not only to increase productivity, but also to provide the world food market with commodities. According to the project, all decisions will be made in the information intellectual environment, which will unite all state structures involved in the agro-industrial complex and all producers of food commodities. Thus, the efforts of all participants in the food market will be accumulated, combined and aimed at modernizing existing agricultural enterprises by introducing the most advanced information instruments and intelligent solutions.

The established practice of application of digital technologies in individual large agricultural holdings in Russia has proven that the most popular solutions are:

1) Industrial Internet of Things (IoT), which will save about 469 billion rubles by 2025 as predicted by PricewaterhouseCoopers (PwC).

2) Robotics. The leader in the implementation of robotics is the dairy industry – systems for feeding, cleaning, milking, robots for grazing livestock.

3) Virtual reality (VR, Virtual Reality).

4) Big data analytics and forecasting (Big Data technologies).

The listed computerization tools are not exhaustive, since the implementation of greater projects requires investment resources that most of Russia's agricultural enterprises do not have.

Thus, the study carried out in this article made it possible to systematically and comprehensively present all the changes taking place in the structure of the agro-industrial complex; to assess the scale of computerization and digitalization in agricultural production, not only in Russia, but also in the world; to assess the prospects for the introduction of artificial intelligence technologies in the agricultural sector in order to meet the needs of the growing population of the planet in food; to conduct a review of the most effective foreign practices for the introduction of digital technologies in the agro-industrial complex and an overview of the achieved results of the implementation of technologies in the agro-industrial complex of Russia; to list the main problems that prevent the widespread use of these solutions.

3. Conclusion

In summary of our study of digital transformation in the agro-industrial complex, taking place in the modern period, we focus on the fact that the importance of these industries stems from the sustainable development goals for which they are intended. Let us recall that the main purpose of the agro-industrial complex is the production of food raw materials for the qualitative satisfaction of the growing needs of the population for nutrition and development. Produced food items should be not only of high quality, but also affordable for every citizen of the country, since high-quality nutrition will determine the demographic structure of the population, the quality of the emerging human capital. The population should not spend more than 10-15% of their income on food, only in this case we can talk about the quality of life in the country.

To produce a sufficient amount of food and to reduce the threats to food security, it is necessary to introduce digital technologies widely in all sectors of the agro-industrial complex, and qualitatively rebuild the production system. The practice of using digital instruments in many countries has proven their high efficiency and profitability in the production of agricultural products, even in the face of deteriorating agro-climatic conditions and shrinking agricultural land.

The requirements of the fourth industrial revolution and the concept of Industry 4.0 make it possible to determine the main development trends of the agro-industrial complex in modern conditions of market economy and of its entry into new world food markets, to determine new global challenges to food security in our country. The transition of agriculture from analog form to digital one opens up new perspectives and opportunities for the formation of network interaction between agricultural producers, processing enterprises and consumers of finished products, that is, in fact, a transition to the philosophy of Agriculture 4.0.

Among digital technologies, the most promising are control and monitoring systems for precision crop production and precision animal husbandry. Popularization of scientific insights of the benefits of
the latest achievements of science and technology among the population, training of IT agronomists and IT animal specialists will also contribute to the activation of the processes of introducing digital technologies into production processes in the field of agriculture. In this situation, it is necessary to develop a comprehensive digital platform for the agro-industrial complex, which includes four areas: 1) industries that provide the agro-industrial complex with agricultural machinery and equipment, and fertilizers; 2) crop and livestock production; 3) food and processing industry; 4) industries responsible for the storage and transportation of agricultural goods.

The implementation of throughout digital transformation of all processes in the agro-industrial complex will allow overcoming the existing barriers to the introduction of information instruments in the agricultural sector of the Russian economy. Only cooperative efforts of public authorities, scientific institutes, private investors and representatives of the agro-industrial complex will make it possible to activate these processes and to make a breakthrough in overcoming the negative trend of decreasing profitability in agriculture.

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