Precision agriculture in the Russian Federation: problems and directions in development

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Abstract. The paper is devoted to the analysis of problems and the search for ways to develop precision agriculture in the Russian Federation. The study analyzed the current state of precision agriculture and the level of digitalization of agriculture in the Russian Federation. The main problems for the development of precision agriculture in the Russian Federation were identified. The main problems in the development of precision agriculture include the lack of a legal framework governing the handling of data and information, the lack of government measures to support the methods of precision agriculture, etc. As a result of the study, a model for the interaction of factors in the development of precision agriculture was proposed, the implementation of which will accelerate the development of digital rural infrastructure locality, the widespread introduction of innovative technological solutions of precision agriculture, will increase the efficiency of state regulation of the industry and will contribute to the formation of a digital institutional environment in agriculture of the Russian Federation. The study concludes with key findings and results.

1. Introduction
Agriculture of the 21st century is a complex technologically highly risky branch of national and world economy. Wide variety and complexity of agricultural crops cause increasing variability and uncertainty in technological and production processes Parameters and conditions necessary for control are often distributed over a large area. Interaction with these factors, in the context of increasing food and biological security problems, brings a new type of agricultural development to humankind. At a time when digital and information technologies are gaining momentum, the transition to an innovative economic model for sustainable growth is impossible without the development of smart agriculture. The principles and methods of intelligent agriculture are now receiving special attention from national
governments and international organizations. Thus, in Russia the implementation of innovative technologies is becoming an important factor for further growth in production and profitability of agriculture and its sub-industries (figure 1 and figure 2) [1].

Figure 1. Volume of innovative goods and services in RUB billion.

Figure 2. Volume of innovative goods and services by types of economic activity in RUB billion.

Based on Bloomberg Innovation Index-2020 data, Russia ranks 26th, ahead of Malaysia. The Bloomberg Innovation Index calculates information on the intensity of research and development, the production of innovative services and goods, labor productivity, the activity of patent activity of the quality of education and the concentration of high-tech companies in the country. It should be noted that in some states the share of innovative products in the total volume of goods and work of agricultural production reaches two-digit values unlike Russia: Spain - 12.7%; Denmark - 11.6%; Netherlands - 9.2%; Russia - 1.4%. In Russia use elements of the Internet of things (Internet of Things - IoT) from 1-5% of agricultural producers. While in the USA and the EU these figures are more than 50% [2].

Since 2014, Russian agriculture has shown a generally strong growth in production (figure 3).

Figure 3. Agricultural products by category of farms in the Russian Federation in billion rubles [1].

The basis of this positive dynamics is not only the effects of the sanctions policy and import substitution measures in the Russian Federation, but also the gradual transition of Russian agriculture to an innovative development path. However, the policy of the Russian authorities and the external situation may radically change, which may pose a strong threat to the economic development of Russia and the competitiveness of its agriculture. In this regard, solving issues related to the development of the principles of smart agriculture in Russia becomes important.

Smart agriculture is an integrated system that widely uses automated and information decision-making systems, robotics and integrated production automation. The above methods minimize the use
of fertilizers, fuels and chemicals, maximizing and using renewable energy, organic fertilizers and biofuels. This approach to agriculture will reveal the high potential of crop yields. According to the UN FAO, it is about 30% [3]. Smart agriculture technologies contribute to environmentally sound pest management, soil and groundwater restoration and conservation, and to the implementation of organic agriculture standards and requirements. The introduction of smart agriculture methods will increase the average profitability of production by saving costs by more than 30% by optimizing the use of chemical and mineral fertilizers, economical use of petroleum products, reducing labor costs and maintaining fixed assets [4].

The growing challenges of food security, climate change and the search for ways to increase competitiveness are pushing national economies to develop and develop new approaches to address these challenges in the context of smart agriculture. One of these approaches that will be discussed in this paper is precision agriculture.

2. Materials and methods

The purpose of this study is to analyze the problems and find ways to develop precision agriculture in Russia. To achieve this goal, the following objectives are set:

- to characterize modern methods of precision agriculture in the Russian Federation;
- to identify the factors that hinder the development of precision agriculture in the Russian Federation;
- to construct and describe a model of interaction of factors of precision agriculture development in the Russian Federation.

The study used methods of descriptive, statistical, logical, comparative, and economic analysis, which allowed the authors to solve the research tasks. The information basis for the research was formed by data of state executive authorities, international reports, materials of scientific research, and regulatory acts.

3. Results

Precision agriculture is a comprehensive crop productivity management system based on the use of information, computer, satellite and digital technologies. Precision agriculture, along with accurate animal husbandry, is part of smart agriculture. The development and penetration of technology into agriculture allows farmers to quickly manage their resources and receive real-time information on their smartphones and tablets integrated with agricultural equipment.

The introduction of precision farming technologies allows us to apply new forms of production management, reduce the degree of influence of anthropogenic errors, increase the level of efficiency in the use of agricultural machinery, reduce production costs, as well as unlock the potential for agricultural crop yields.

Growth of harvest, growth of return on capital investments, reduction of negative impact on the environment and ecology are becoming leading aspects of development and adaptation of precision agriculture methods in Russia [5].

The most frequently used and widespread methods of precision agriculture in the Russian Federation: determination of field borders with the use of satellite navigation systems, parallel driving systems, differential fertilization, digital mapping and yield planning, Internet of Things (Internet of Things, IoT), unmanned tractors (combines), monitoring of crop condition with the use of remote sensing, monitoring of yield quality, local soil sampling in the coordinate system, differentiated soil tillage, artificial intelligence for agriculture, mapping of soil conductivity, differential spraying, differential application of growth regulators, big data (Big Data), neural networks, differentiation of sowing by area [6].

Below we will reveal the main directions and methods of conducting precision agriculture in Russia and in the world.
Agriculture is a key sector in which global positioning systems are widely used. Global positioning systems allow effective plowing of fields, point and differentiated introduction of fertilizers and chemicals, sowing of crops, creation of maps of yields and fertility of soils.

The use of GPS parallel driving systems makes it possible to significantly reduce fuel consumption due to a decrease in the field processing band and an improvement in the accuracy of equipment during agricultural work, which is especially relevant for steep and other crops [7].

The preparation of yield maps and mapping systems allows to determine and transmit with a high degree of accuracy through the software and hardware of harvesting equipment the exact number of agricultural products collected.

![Bottlenecks to precision agriculture in Russia](attachment:bottlenecks.png)

**Figure 4. Bottlenecks to precision agriculture in Russia.**

Telemetry systems are essential for good harvests. Telemetry is most often used in wireless weather stations and provides rapid and accurate data on weather conditions and soil condition.
Geoinformation systems in conjunction with Big Data and IoT are actively used to collect, store and analyze information from sensors for agriculture in real time. Such integration is called web-GIS [8].

Despite the emerging positive trends in the development of precision agriculture in the Russian Federation, Russian agricultural producers are experiencing a number of difficulties and problems that impede the development of precision agriculture and the growth of competitiveness. Figure 4 presents the problems that impede the development of precision agriculture [9].

Proceeding from the above mentioned problems of development of the principles precision’s agriculture in the Russian Federation, special attention should be paid to the lack of a state program of development and support of the industry, the weak interest of the national industry in the production of software and equipment for precision agriculture systems, the lack of qualified personnel to work in the precision agriculture. In addition, there is an urgent need to address institutional contradictions expressed in the significant lack of information among farmers about the benefits of precision agriculture and the high cost of equipment, technologies and software.

It can be concluded from the above that the challenges faced by agriculture in adopting precision agriculture practices are becoming a serious obstacle to the sustainable development of the industry and the national economy [10]. In this context, the decisions related to the development and improvement of models and mechanisms aimed at improving the efficiency and competitiveness of agriculture in the context of the development of precision agriculture methods are particularly relevant.

4. Discussion

In order to systematically overcome the above obstacles and difficulties of agricultural development, the authors below present a model of interaction of the main factors that have a significant impact on the development of precision agriculture in the Russian Federation.

The relevance of the description and analysis of the factors underlying this model is dictated by their importance, variability and uncertainty related to the implementation of precision agriculture methods and the digital transformation of agriculture. The existence and interaction of the identified factors in this model represents scientific relevance in the context of the problems and difficulties of introducing precision agriculture methods of the Russian Federation related to the inhibition of development and the introduction of innovative technological solutions, underdeveloped digital infrastructure, the presence of significant gaps and the backwardness of the regulatory and legal framework for digitalization of agriculture, etc.

The first factor involves the development and financing of activities to implement and protect the results of intellectual activity, based on international standards and best practices.

The second factor involves the use of loans and subsidies aimed at retraining personnel to manage devices and data of the Internet of Things.

The third factor involves financing the development and new methods of cryptographic algorithms aimed at improving the security of data storage and transfer for the Internet of Things.

The fourth factor is aimed at simplifying regulatory procedures for the construction of telecommunications data networks in rural areas 4G and 5G.

The fifth factor concerns the financing of the costs of providing land for the placement of telecommunications facilities on them.

The sixth factor should be aimed at the creation and development of technology parks and clusters based on the wide use of precision farming methods, which will motivate and stimulate the development of local production and development instead of foreign information software and equipment.

The seventh factor involves measures of state financial support for the digitalization of supply chains and the sale of agricultural products.

The eighth factor provides funding for the development of wireless access networks for the Internet of Things.

The development of precision agriculture in the Russian Federation, according to the authors, should be based on a model of interaction of eight main factors, the management and regulation of which, through a change in legislation and the development of the institutional environment, will make it
possible to make a qualitative breakthrough in increasing labor productivity and agricultural competitiveness. In addition, the use of this model in the future can have a positive impact on the creation and development of digital and institutional ecosystems in agricultural production, which will allow the adaptation and improvement of precision agriculture methods that affect the acquisition, processing and storage of information and data.

5. Conclusion
Thus, as a result of the study, a model of the interaction of factors for the development of precision agriculture in the Russian Federation was proposed. A description was given of modern methods of precision agriculture in the Russian Federation. At the present stage of the development of precision agriculture in the Russian Federation, methods of global satellite positioning and a system of differentiated application of fertilizers are most often in demand. The study describes the problems and obstacles to the development of precision agriculture in the Russian Federation. One of the main obstacles to the development of precision agriculture in Russia is the imperfection of the regulatory system in the field of agricultural subsidies and the inconsistency of the methods of state regulation of the industry. The model of interaction of factors of development of precision agriculture is proposed, the main factors of their role and influence on development of precision agriculture in the Russian Federation are described. It was concluded that the use of this model of development of precision agriculture will make it possible to qualitatively transform agricultural legislation, develop the institutional environment and improve state regulation of the industry to increase labor productivity and maximize farmers' profits.

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