Regional Activity in Agriculture Digitalization

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Abstract. The digitalization of production in agriculture is a global trend. The national priorities of modern Russia to be determined by the program documents of the country's socio-economic development for the period up to 2030 imply the use of the wide possibilities of digital technologies to ensure the entry of the Russian Federation into the largest economies in the world. A departmental project is being implemented within the framework of the Digital Economy national project. Digitalization is identified as an important factor in strategic competitive advantage in the medium term, which is difficult to implement without government support. The regions have been identified that are leaders in the field of digitalization of agricultural production and pay great attention to this process. The experience of these regions can provide investments in the development of other regions, as well as ensure the development and modernization of agricultural enterprises. Therefore, information on successful practices in the application of information technologies should be popularized for wider dissemination among farmers.

1. Introduction

Digitalization is a global trend, it is changing the structure of the economies of countries and regions while the competitiveness of the country's industries in world markets is increasing and this contributes to the growth of their national economies. At the same time, digitalization determines the growth prospects of companies, industries and the economy as a whole [1, 2].

The level of agricultural production today is also determined by the degree of intellectualization of production and the provision of modern technologies. Agriculture is becoming a “demonstration platform” for Industry 4.0 up-to-date technologies. These are digital platforms, ecosystems, in-depth analytics of big data, and such technologies as 3D printing, robotization, the Internet of Things, etc. [3, 4]. According to MarketsAndMarkets, the volume of the global market for solutions based on artificial intelligence in the agricultural sector is growing by 25.5% per year and reached USD 1 billion in 2020 and will grow to USD 4 billion by 2026 [5, 6].

Reputable international organizations in the field of food and food security, such as FAO, World Bank, OECD, have been monitoring the level of digitalization of world agriculture for many years and declare the high potential of Agriculture 4.0 technologies [7, 8, 9].

The modern model of technological development of the Russian Federation provides for the advanced development and modernization of the economy by replicating the basic innovations of the
fifth and forced transition to the sixth technological paradigm, which is based on nano-, bio- and
digital technologies [10].

2. Problem statement
The level of penetration of digitalization into the agricultural production of the Russian Federation is relatively small as compared to the developed countries. To speed up the process, a Digital Agriculture departmental project is being implemented, the ultimate goal of which is to ensure a technological breakthrough and achieve productivity growth in digital agricultural enterprises by developing and launching replicated end-to-end the Country, Region, Agricultural enterprise, and Field (Farm) intelligent systems based on domestic methods, algorithms, IT technologies and prototypes of systems and devices. The total economic effect from digitalization could be more than 4.8 trillion rubles in annual terms, the labor productivity growth could be 3-5 times, and the growth of IT-technologies consumption due to digitalization of the agribusiness could be 22% [11, 12]. Regional digitalization programs have been developed and are being implemented within the framework of the departmental project, the effect of which is extremely heterogeneous. Since the government has set a task to transform agriculture through the introduction of digital technologies and offers government support within the framework of the Digital Agriculture departmental project, the study of regional activity in the field of digitalization of agriculture is very relevant.

3. Research questions
Since the digital transformation of the agribusiness is part of the federal strategy having a resource provision of 152 billion rubles, where 85% of the project budget is a specific state support to stimulate the implementation of projects [13], then the regional activity on the digitalization of agriculture is also of interest. The question is: What aspects of agricultural production do producers consider to be the most important and paramount for the implementation?

4. Purpose of the research
The purpose of the study is to analyze the level of regional activity in the field of digitalization, including training of personnel for the penetration of digitalization into agricultural production, to determine the prospects of the process within the framework of the tasks set by the government, and what effects can regions receive with an integrated approach to the implementation of digitalization strategies.

5. Materials and methods
The material for the study was the Digital Agriculture departmental program, scientific publications on the problems of digitalization of the agribusiness, and data on Russian developments in the field of digitalization of agriculture. The monographic, comparative and systems analysis methods, methods of idealization and mental modeling, as well as a logical approach method were used.

6. Results of the research
The agricultural IT market size in Russia reached 360 billion rubles in 2019. It is projected that the market will increase more than 5 times by 2026. Agriculture ranks fourth in terms of the possibility of automation among all sectors of the economy ahead of construction, insurance and trade [14, 15, 16].

The Center for Forecasting and Monitoring of the Kuban State Agrarian University conducted a survey on the digital transformation of agriculture, in which 81 experts took part (56% of respondents belonged to the category of science and education, 26% belonged to the category of business, 11% belonged to the category of administrative bodies, and 7% were others) from Germany, Angola and 28 regions of Russia. According to the survey, 91% of experts believe that agricultural enterprises that do not use digital transformation technologies will lose out in competition to more modern companies. Experts attribute the elements of precision farming to areas of high importance for implementation in
2021-2030. The most relevant among them are the digitization of fields, differentiated fertilization, weed spraying and satellite monitoring of vehicles.

According to experts, in 2026-2030 especially important for the implementation in animal husbandry will become monitoring of herd health, quality of livestock products, identification and monitoring of individual animals, and an electronic database of the production process (table 1) [17].

Table 1. Promising areas implementation percentage.

| Promising area description                                                                 | Importance for the Russian Federation | Expected deadlines |
|------------------------------------------------------------------------------------------|--------------------------------------|--------------------|
|                                                                                         | High       | Medium   | Low     | Not relevant | 2021–2025 | 2026–2030 | after 2030 | Not performed |
| **Precision farming**                                                                    | 83         | 14       | 3       | –           | 38        | 47        | 12         | 3            |
| Digitizing fields                                                                        | 70         | 28       | 2       | –           | 45        | 37        | 15         | 3            |
| Parallel driving                                                                         | 73         | 23       | 3       | 1           | 56        | 30        | 13         | 1            |
| Satellite monitoring of vehicles                                                         | 76         | 17       | 6       | 1           | 31        | 45        | 19         | 5            |
| Differentiated weed spraying                                                              | 83         | 17       | –       | –           | 41        | 45        | 10         | 4            |
| Differentiated fertilization                                                              | 67         | 25       | 5       | 3           | 36        | 39        | 17         | 8            |
| Differentiated sowing                                                                     | 62         | 35       | 1       | 2           | 25        | 46        | 23         | 6            |
| Differentiated irrigation according to soil maps                                          | 61         | 28       | 8       | 3           | 25        | 42        | 25         | 8            |
| Monitoring the state of crops by remote sensing (aerial or satellite photography)        | 77         | 21       | 2       | –           | 72        | 23        | 2          |              |
| Preparing:                                                                              | 74         | 23       | 3       | –           | 30        | 49        | 18         | 3            |
| digital yield maps                                                                       | 47         | 31       | 17      | 5           | 21        | 38        | 25         | 16           |
| soil conductivity maps                                                                   |            |          |         |             |           |           |            |              |
| **Precision animal husbandry**                                                            | 83         | 15       | 2       | –           | 44        | 33        | 17         | 6            |
| Monitoring the quality of livestock products                                              | 73         | 21       | 1       | 5           | 30        | 46        | 18         | 6            |
| Electronic database of the production process                                             | 76         | 21       | 1       | 2           | 32        | 44        | 21         | 3            |
| Identification and monitoring of individual animals using IT technologies (feeding ration, weight gain, body temperature, activity, meeting their individual needs) | 85         | 12       | 2       | 1           | 41        | 34        | 22         | 3            |
| Herd health monitoring                                                                    | 65         | 29       | 4       | 2           | 40        | 31        | 19         | 10           |
| Milking robotization                                                                     | 71         | 25       | 3       | 1           | 36        | 43        | 13         | 8            |
| Automatic regulation of microclimate and control of harmful gases in livestock buildings  |            |          |         |             |           |           |            |              |

Source: E V Truflyak, 2021.

The personnel issue remains one of the most painful for most agricultural enterprises. As part of the implementation of digital agriculture, the professional specialists will be concentrated at large
agricultural holdings according to 79% of respondents, at foreign companies according to 46% of respondents, and at Russian companies according to 66% of respondents [17].

The information on the number of employees who underwent advanced training in the area of Precision Agriculture (Precision Farming or Precision Animal Husbandry) has been analyzed. The analysis also has considered the programs operating in the region for the development, support and implementation of IT technologies in the agribusiness [18].

The leaders by the number of farms are the Leningrad and Moscow regions, the Krasnodar Territory, and the Belgorod and Kaluga regions along with the Krasnodar Territory are leaders by the number of staff (table 2).

**Table 2.** Rating of regions for advanced training in the field of precision agriculture in 2018-2019.

| By number of farms (units) | By number of personnel (people) |
|----------------------------|---------------------------------|
| 2018                       | 2019                            |
| Trans-Baikal Territory     | Republic of Bashkortostan       |
| (35)                       | (500)                           |
| Leningrad region           | Belgorod region                 |
| (67)                       | (258)                           |
| Novosibirsk region         | Moscow region                   |
| (29)                       | (47)                            |
| Trans-Baikal Territory     | Trans-Baikal Territory          |
| (20)                       | (46)                            |
| Krasnodar Territory        | Krasnodar Territory             |
| (20)                       | (209)                           |
| Krasnodar Territory        | Krasnodar Territory             |
| (47)                       | (234)                           |
| Krasnodar Territory        | Krasnodar Territory             |
| (46)                       | (234)                           |

Source: E V Truflyak, 2021.

The largest Russian agricultural producers have joined efforts to digitize agriculture. They also have created the Smart Farming Club (SFC), a platform for eliminating problems in the digitalization of the agribusiness and exchanging best practices for shaping global trends in technological development. The work of this expert platform will accelerate the penetration of new digital solutions and make it more efficient.

SFC residents are engineering companies in the field of automation and digitalization of the agribusiness and more than 65 agricultural holdings, whose land fund is 2.6 million hectares, and the annual revenue is more than 500 billion rubles. According to the organizers, the total number of the club exceeds 1,000 participants from Russia, the CIS countries and other countries.

It is expected that the SFC will develop standards and prepare proposals for the formation of a regulatory framework for regulation in this area, analytical and research activities, as well as advising agribusiness market participants on digitalization issues (both on specific technical solutions, and on various relevant projects that provide for a large-scale implementation of IT solutions in the business of agricultural producers) [19].

Associations such as SFC emphasize that stakeholders in the process of their R&D cooperate to resolve issues arising from the mastering of new solutions, in particular, digitalization, which is actually an evolutionary leap and innovation of a qualitative level.

The analytical center of the Ministry of Agriculture of Russia is developing, within the framework of the Digital Agriculture project, a portfolio (catalog) of technological solutions for the needs of the agribusiness, including applied and promising Russian and foreign projects in the field of digitalization, automation, robotization, mechanization, electrification of agriculture, renewable energy, information and nanotechnology and food processing. As of 02/01/2020, it contained more than 500 digital solutions for the agribusiness [14].

According to the Ministry of Agriculture of Russia, the leaders in the rate of implementation of digital approaches in agriculture are Altai and Krasnodar Territories, Kursk, Lipetsk and Samara regions, the republics of Bashkortostan and Tatarstan. The level of digitalization of the agribusiness in the regions in the course of the study was assessed according to such indicators as the approbation of pilot solutions and their replication, the full-featured use of E-government and new digital
technologies, amendments to regulations that ensure the implementation of the Digital Agriculture departmental project, unification and the use of centralized solutions, as well as the ability to connect existing regional systems having a high level of development of IT technologies to agriculture.

For example, an information system for automating the processes of preparing documents for obtaining governmental support for manufacturers has been operating in the Altai Territory since 2015. Since 2017, the use of arable land has been monitored on the RusGIS platform of Rostelecom, where more than 94% of the arable land of the Altai Territory or about 140,000 plots with information about cultivated crops and users is recorded. More than 2,500 agricultural enterprises of the Territory use the system. In addition, the Altai State Agrarian University has established a Competence Center for the Digitalization of Agriculture, which solves the tasks of training highly qualified personnel, developing algorithms for digital platform services, advising agricultural producers, and improving the qualifications of agribusiness employees in the field of geoinformatics and processing remote sensing data [20].

The program of digitalization of the agribusiness is being actively implemented in the Tambov region. Here, Competence Center for Agribusiness Digitalization, an independent non-for-profit organization, was established in 2018, within the framework of which it was planned to receive grant support from the Skolkovo Foundation. The Center, together with the regional Development Corporation, is implementing a project to create a digital platform for the agribusiness [21].

Five projects have been selected among the participants in the Skolkovo Foundation projects (residents). For example, the Supply Chain Management System service, where buyers and sellers can sell and buy products and act as a SPL communicative provider (network logistics), contributes to the implementation of demand-oriented supply chains that are a modern concept of distribution logistics [22]. It is planned to establish one of the first business accelerators in the country in the field of digitalization of the agribusiness jointly with the ASB Agro-Holding and the Competence Center for Agribusiness Digitalization, an independent non-for-profit organization, which is enshrined in an agreement signed at the Open Innovations -2019 international forum. The business accelerator will be part of the Michurinsk Valley Innovation Science and Technology Center.

In 2018, Mielta was opened, the first Technology Park in the Tambov region in the field of information technologies, including IoT (Internet of Things) technologies, electronic instrumentation, information and telecommunication technologies, and GLONASS / GPS technologies. More than 80% of the area of the Mielta Technology Park is already occupied by residents; over 51.8 million rubles have been raised as investment. The total area of the Technology Park exceeds 10,000 square meters. The first residents were such companies as Mielta Technology, TN-Group, SmartAgro, and TSK.

Based on the Tambov State Technical University, Digital Engineering, a collective use center, has been opened, which studies advanced technologies in the field of mechanical engineering, metalworking and digital design. The Derzhavin Tambov State University has opened the Center for GIS Technologies and Precision Agriculture, which is an interregional platform for the training and retraining of specialists in the field of precision farming and geoinformation systems [21].

According to an expert survey, 63% of respondents believe that the implementation of a digital agriculture program without government subsidies is impossible, and 29% think that it is vice versa. Based on this survey, an analysis of the programs for the development, support and implementation of elements of precision agriculture operating in 12 regions has been performed (Arkhangelsk, Belgorod, Kostroma, Moscow, Nizhny Novgorod, Novosibirsk, Ryazan, Smolensk, Tambov, Tver, Yaroslavl regions, and Khabarovsk Territory) [17].

7. Conclusions
IT technologies are transforming modern agriculture into a platform for testing Agriculture 4.0 up-to-date processes. Digitalization is changing the appearance and structure of the regional economy, while the competitiveness of individual industries is increasing, which contributes to the growth of the national economy.
Digitalization of agricultural production is determined by experts and agricultural producers as an important factor of strategic competitive advantage in the horizon until 2030, while more than 60% of respondents believe that the implementation of a digital agriculture program without state subsidies is impossible.

Experts consider the most important innovations to be field digitization, differentiated fertilization, weed spraying and satellite monitoring of vehicles in crop production, monitoring of herd health and quality of livestock products, identification and monitoring of individual animals, as well as an electronic database of the production process in animal husbandry. The personnel issue remains one of the most sensible for most agricultural enterprises. The Leningrad and Moscow regions are leaders in the field of advanced training in terms of the number of farms, while the Krasnodar Territory, the Belgorod Region, the Kaluga Region and the Krasnodar Territory are leaders by number of staff. The level of regional digitalization of the agribusiness is more intensive where the process of digitalization covers more areas of economic activity, the electronic government is more functional, regional programs are being implemented, widely unified and centralized solutions are applied, and regional systems with a high level of development of IT technologies are functioning. The number of agricultural enterprises using IT technologies in crop and livestock production is growing. More attention is paid to the training of personnel for agricultural production than in previous years. All this determines the prospects for digitalization being feasible within the framework of the tasks set by the government.

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