Digital technologies and automation in breeding and agriculture

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Abstract. The agricultural industry is one of the key industries that is related to material production. Large areas of fields, a huge fleet of vehicles, a large number of people employed in the industry, lead to the creation of innovative ways to manage the land resource base and production capacity in agriculture. After analyzing how digital solutions are used in the regional agricultural industry, it can be said that there is a need to carry out accelerated selection, use artificial intelligence, create new sources of raw materials, apply blockchain, unmanned aerial vehicles, the Internet of things, agroscouting, ERP systems, and train employees in the field of information technology for the agro-industrial complex. Agro-enterprises, where mechanization is at a fairly high level, suffer the greatest damage when they produce fruits and vegetables (about 57 percent), as well as root products (about 79 percent). In the production of cereals, the largest losses occur during processing (about 10 percent) and consumption (about 25 percent). In enterprises where mechanization is at an average level, the most problematic industry is livestock breeding with milk production where losses can reach 53 percent.

1 Introduction

More efficient management of an agricultural enterprise while introducing digital technologies into its work allows it to remain competitive. To make correct and effective management decisions, you need data obtained using satellite imagery, high-tech sensors, GPS systems and other digital technologies. To carry out the digital transformation of the agricultural industry, qualified personnel are required who are able to apply the new knowledge gained and innovative technologies that will help them in their work. It is necessary to develop infrastructure, train personnel and provide agricultural producers with

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modern equipment and technical facilities based on digital technologies. This makes it possible to effectively manage all information flows, as well as real-time processes, with the subsequent technological breakthrough in the field of crop production [1].

2 Problem statement

The modern agricultural industry, at this point in time, is actively implementing the latest information technology solutions that make it possible to reduce costs, with an increase in productivity and yield [1,12]. Now, information technologies, together with the automation of production in the agricultural industry, control the full cycle of growing plants. With the help of these devices, soil characteristics, plant parameters are measured and transmitted, a microclimate is provided, and so on. The main task facing digitalization is to reduce costs in the production of products, increase their quality, along with competitiveness, based on the efficient use of the resource base. With the help of digital technologies in the agricultural industry, it is possible to reduce the percentage of risk, with the exception of the human factor, reduce costs and increase the yield of various crops [2].

3 Research questions

The purpose of the study is to characterize modern digital technologies, as well as selection automation in the agricultural industry in order to assess how much the work processes have been improved.

4 Materials and methods

This study has been carried out using specialized literature, data from Internet resources were processed, electronic libraries have been used, scientific works of specialists who study automation of selection in the agricultural industry have been analyzed.

5 Results

The implementation of solving the problems that hinder the digitalization of the agricultural industry is part of the national project for the integrated development of territories for agricultural activities. According to this project, it is necessary to create (taking into account the territorial development of the state) a scheme according to which agro-industrial production will be located and specialized. This scheme will be based on a multi-level integrated information space, which will be based on modern digital technologies [3,10,11,13,14].

However, there are a number of problems that need to be addressed as soon as possible:

- lack of finances, which does not allow the full implementation of information and communication technologies (ICT) for most agricultural producers. In general, in the agro-industrial complex one can observe the formation of the so-called bipolar economy, in which one pole contains agriculture with high profitability, widely using new, efficient technologies, and the other - agriculture that barely pays off and uses old technologies;
- lack of qualified specialists. According to the information provided by the Ministry of Agriculture of the Russian Federation, our country has 2 times fewer IT specialists who work in the agricultural sector than in countries where the agro-industrial complex is highly developed. The Russian agricultural sector, at this point in time, according to experts, needs about ninety thousand IT specialists;

- digital infrastructure is not well developed in the villages. This area is changing dramatically, but, nevertheless, there is still a difference in the use of technology in the city and in the countryside;
- imperfect legislative regulation of the digital sphere in the agro-industrial complex. The development of state security in the field of information in the agricultural area is regulated by Article 17 of the Federal Law No. 264-FZ dated December 29, 2006 "On the Development of Agriculture", but this article shall be finalized.

To carry out government activities aimed at supporting agricultural enterprises, the Ministry of Agriculture of the Russian Federation has formed an Analytical Center. He is engaged in the formation of a portfolio of digital technological solutions intended for the agricultural industry, and this makes it possible to provide information to agricultural workers with great effect about what new opportunities, technologies and available practices have appeared [3].

6 Findings

After analyzing the main technological operations in production in the most common industries in agricultural enterprises of the Ural Federal District (UFD), which have different mechanization, one can see a big difference between the minimum and maximum losses (See table 1) [4].

Table 1. Analysis of losses in the main process operations of production by industries with different levels of mechanization.

Level of mechanization	**Production, industry**	**Share of losses at the stage, %**				
		Production	**After harvesting**	**Processing**	**Distribution**	**Consumption**
High	dairy	6	no inf.	2	no inf.	12
	meat	4	no inf.	6	4	10
	fruit and vegetable	25	5	2	5	20
	oil	2	no inf.	4	no inf.	4
	rhizomatous	25	8	15	6	25
	grain	2	2	10	2	25
Average	dairy	18	2	5	18	10
	meat	7	2	5	2	2
	fruit and vegetable	15	7	5	4	15
	oil	20	no inf.	5	no inf.	5
	rhizomatous	8	5	1	5	10
	grain	10	5	3	2	8
Low	dairy	2	no inf.	4	no inf.	2.
	meat	1	no inf.	1	1	no inf
	fruit and vegetable	10	5	2	3	1
	oil	18	no inf.	10	2	2
	rhizomatous	35	40	no inf.	5	5
	grain	20	2	10	10	6

In the production of root crops in rural farms with low mechanization, the level of losses reaches the highest values at the production stage, during processing after harvesting and during storage (up to seventy five percent). The level of production losses during crops processing in such enterprises is forty eight percent. It is not much more than the same figure for farms where mechanization is at a high level.

The highest level of losses during processing is ten percent and during consumption it is twenty five percent, at other stages the level of losses is not more than six percent. It shall be noted that the degree of mechanization of the economy has been assessed in general, but not for a separate production cycle. If the degree of mechanization for each stage in farms in which the overall degree of mechanization is quite high would be assessed more carefully, then the uneven mechanization of stages can be seen. Production and distribution are the most mechanized stages [6]. At other stages, mechanization has a low or medium level, and the greatest losses are formed at these stages.

The agricultural industry in the Russian Federation, which is a component of the agro-industrial complex, must use broadband, mobile LPWAN communication, all available information technologies (Big Data, artificial intelligence, management platforms), radio frequency tags, controllers, sensors, control components in its work in order to radically increase its' efficiency. This industry has great potential for modernization.

With the high relevance of the issue of providing food for our state and the issue of developing exports to other countries, all this makes it necessary to make agriculture a high-tech industry that will be able to supply food in full to domestic markets, as well as for export. It is necessary to implement innovative developments, to stimulate the adoption of new management decisions, which will make it possible to produce and supply the citizens of our country with high-quality and safe products. According to experts, during the season the farmer quickly makes various kinds of decisions that directly affect the economic performance of production.

The digitalization of the Russian agricultural industry at this point in time is very low: innovative modern agricultural technologies are not used enough, there is no global forecast for the cost of products, there are insufficient information technology tools and equipment, logistics, storage and delivery are poorly developed. All these factors lead to the emergence of large production costs. Only a small number of agricultural producers have the financial ability to buy new machinery, use IT equipment, and platforms. According to Decree No. 204 "On National Goals and Strategic Objectives for the Development of the Russian Federation until 2024" issued by the President of the Russian Federation on May 7, 2018, the President ordered to transform the most important economic and social sectors, including agriculture, by introducing digital technologies and platforms [7].

7 Discussion

Agriculture, initially, has features that allow to carry out the active use of information and communication technology solutions:

1. a large number of factors that determine the efficiency of production: natural and climatic, soil, biological, economic, and also social. Most of them can change in temporal and spatial terms and this leads to significant management costs in certain farms;
2. a large number of farms and their dispersal throughout the country, which greatly complicates the implementation of management decisions;
3. the presence of intensive and multilateral intersectoral relations of the agricultural industry with a large number of enterprises of the agro-industrial complex, a large number of farms that supply resources and buy products.

The implementation of measures to digitalize the agricultural industry in the Russian Federation is carried out in order to:

- carry out a technological breakthrough in the agro-industrial complex and significantly increase labor productivity at agricultural enterprises that use "digital" modern technologies that automate production, management and processing of products;
- transform the processes of state administration in agriculture, ensure the efficiency and effectiveness of decisions, forming a common information field with modern digital technological solutions that will ensure the availability of complete and reliable data for state land monitoring, land supervision, territorial planning, accounting of federal property values, information on cadastral registration and information on registered rights to land plots.

Work shall be carried out in two directions:

1. digitalizationof agricultural production;
2. digitalizationof public administration processes in the field of agriculture.

Artificial intelligence technologies have long been used for yield control, analysis and seed selection. Unfortunately, in this regard, our country is still lagging behind world projects, but interesting start-ups can also be found in Russia [8].

The possibilities of IT technologies are huge and are not limited only to the creation of digital equipment and industrial programs. In general, artificial intelligence can do any job for a person, and much more efficiently. Farmers are interested in using new varieties of plants that can only be obtained with the help of sophisticated technologies.

7.1. Russian startup «Plastilin»

The author of the project is our compatriot Dmitry Medvedev. Immediately a reservation that this is just a namesakeshall be made. The developer used domestic biotechnologies to create the «Plastilin» project, aimed at the accelerated selection of plant seeds.

Now Russian farmers are forced to buy high-quality seeds in European countries, and we need to gradually move away from this practice. The Plastilin project aims to decipher the plant genome and create accelerated breeding solutions for plants such as soybeans, wheat and corn.

7.2. Chinese AI farms

In fact, more than one project based on artificial intelligence is working in China. The Chinese in this regard bypassed many countries of the world, but the most famous are the AI Farms in Guizhouprovince. This territory has everything for the rapid creation of high-quality products and seed selection: cheap labor, technology and information processing centers.

The author of the project is an ordinary 20-year-old student who plays an important role in the development of agriculture in China. A young man works for Bainiaohe Digital Town, which is developing artificial intelligence (AI) and the digital realm for precision farming.

7.3. Projects of the Argentine company ACA

Association de CooperativasArgentinas is the oldest association of organizations in Argentina that has been dealing with the problems of agriculture and the agricultural industry since 1922. The company includes several thousand farms and more than 140 cooperatives.

ACA developers are currently developing a digital platform for precision farming in Argentina. Moreover, they use not only satellites and drones, but also machine learning (artificial intelligence for seed selection). The corporation develops recommendations for farmers in real time, and AI is responsible for creating new seeds.

Argentina has long been a breeding ground, where many large companies and organizations from all over the world work.

7.4. Israel Seedo technology

Urban farming is now developing in Israel. Several companies are developing AI algorithms to select optimal conditions for humidity, lighting, and creating a microclimate for plants.

In this case, the Seedo company is reviewed. It povides a unique breeding technology in small boxes. In fact, this is an analogue of vertical farms, which are now actively developing around the world. The developers are also engaged in the creation of the latest IT systems for seed selection.

7.5. Project from the company Isi Sementi

Isi Sementi is a small company from Italy, which together with Idromeccanica Lucchiniis engaged in an important project. The developers are conducting experiments aimed at growing vegetable crops suitable for hydroponics. The modern project was completely developed in Italy using IT technology.

Isi Company Sementi has been breeding for a long time and is now actively moving to work with artificial intelligence, which increases efficiency by several times. The main goal of the project is the development and supply to the market of new varieties with environmental sustainability [8].

Implementation of digitalization in the agricultural production sector is proceeding at a good pace, here it is impossible to accurately determine the appearance of internal or external industry in ten or twenty years [9].

8 Conclusion

Taking into account the main goal of the Digital Agriculture project (which is to carry out the digital transformation of the agricultural industry, introduce the digital technologies and platforms to ensure a technological breakthrough in the agro-industrial complex and increase labor productivity) it is necessary to increase the importance of automation in the formation of product prices.

Management decisions in the field of automation and digitalization of the agricultural industry are made taking into account the fact that all measures to transform it are aimed at reduction of all types of production costs during production of food and other agricultural products. The use of the modular principle of completion, taking into account the conditions of the agricultural industry, using wireless technologies that collect information from various equipment (sensors, meters and sensors), it is possible to track how resources move, while increasing productivity and reducing the costs.

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