Analysis of the use of robotics in the agricultural industry

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Abstract. The article analyzes activities of the agricultural sector. An analysis of the state and problems of the agrarian industry in Russia showed that it is extremely important to keep up with the developed countries in implementing the latest technologies to overcome problems in the agricultural sector and ensure the sustainable socio-economic development of the country. The global problems such as the growing population and the need for more food, the limited areas of arable land and the need to minimize environmental damage caused by the agricultural sector make digitalization-and automation-based development of the agricultural sector relevant.

1 Introduction

Today, the process of transition to digital technologies is being updated in all areas of activity, including agriculture. In agriculture, robotization and the introduction of these technologies into all production processes are actively developing. The use of robotic technology makes it possible to eliminate the loss of working time associated with staff absenteeism, illnesses and delays. Automated machines can increase the annual fund of working hours and the volume of additional production.

The use of automated technology is considered profitable if the conditions for the release of two workers and its full payback for a period of up to three years are met. The economic potential from the implementation of a robotic machine to perform only one technological task is much lower than the result of a comprehensive program intended to automate the entire technological process [14]. The greatest labor costs require the installation of one robotic machine. Labor productivity in the agricultural sector can be improved using robotics based on the full automation of algorithmic operations in intellectual and human production activities with integrated automation of flexible production subsystems [2].

The current models of robotic technology cannot be applied to manipulate the flow of objects, loading, unloading and transporting agricultural products. It is important to use dustproof and moistureproof specially equipped gripping and actuating devices. The equipment of individual nodes of the actuators of agricultural automatic manipulators with robot nodes makes it possible to use microprocessor systems developed in the agricultural industry [3].

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2 Materials and methods

To analyze the use of robotics in the agricultural industry, statistical data were used. A study of the application of robotics in the agricultural industry was carried out. The goals were set, and the main aspects of robotics application in the agricultural industry are described.

3 Results

The agricultural industry is a system of several interconnected sectors of the national economy that deal with production, procurement, storage, processing and marketing of food products, construction of enterprises and villages [4]. The final products of the agricultural industry make up 75% of the retail turnover of the state and cooperative trade, including more than 95% of food products [1].

Every year, the power supply is growing especially in the agricultural sector. Over the past 20 years, the energy capacity has increased three times, and electricity consumption – seven times [2].

A significant level of mechanization has been achieved in the production of grain and industrial crops. However, the mechanization in the cultivation of vegetables and fruits is lagging behind.

Labor productivity in mechanized livestock and poultry farms is significantly improving. By the installed capacity and the number of operating electric motors, these farms are not inferior to large industrial enterprises [5].

Despite the mechanization and automation of production processes, it is necessary to further improve the machinery and equipment produced for the agricultural industry, since the shortage of labor remains one of the limiting factors for further increasing the volume of production of food and raw materials. Figure 1 presents the share of robotization in the agricultural sector.

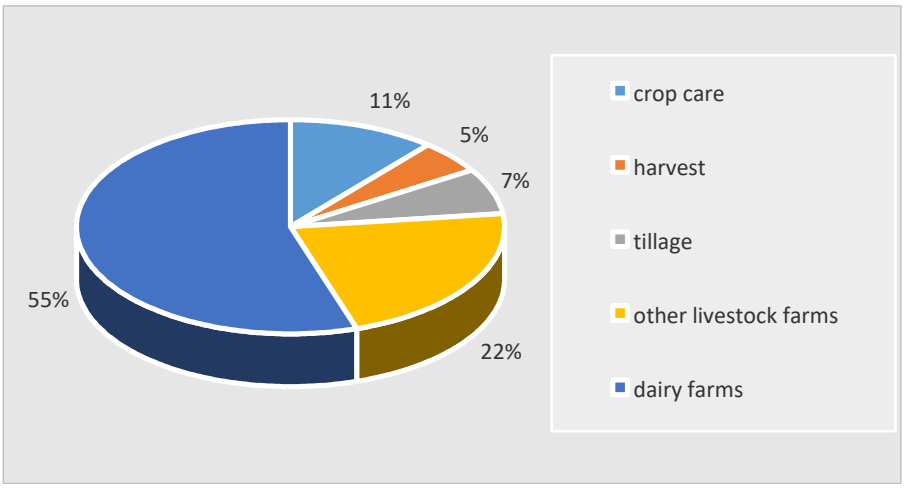

Fig. 1. Market of agricultural robots, %.

Figure 1 shows that the largest share of robotic equipment falls on dairy farms, the smallest percentage is observed in the harvesting sector. Therefore, it is necessary to implement robotic equipment in this sector.

As of April 2022, robotics is used in 28 Russian regions by 103 agricultural enterprises, mainly in the dairy sector (figure 2).

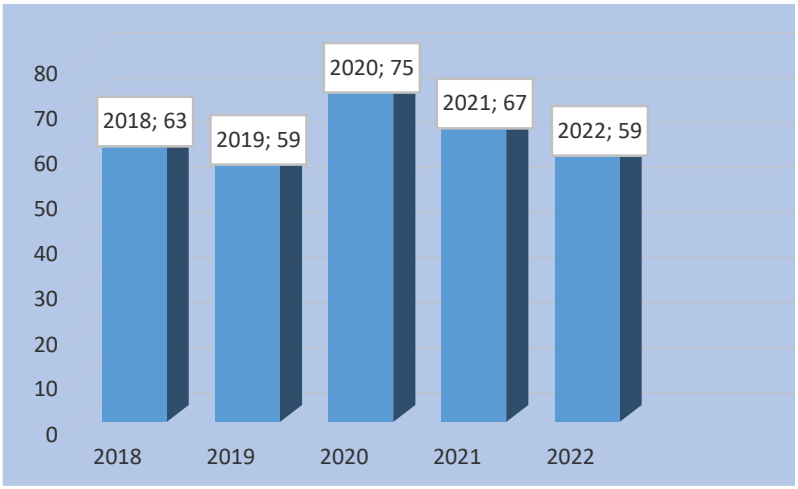

Fig. 2. The dynamics of the introduction of robotics in the organizations of the agricultural industry of the Russian Federation

The data presented in figure 2 show that 393 units of robotics were implemented by agricultural enterprises of the Russian Federation from 2018 to 2022. The largest number of robotic machines was implemented in 2020, but then the pace of implementation decreased slightly. Compared to 2019 and 2020, in 2022, the number of units of robotics amounted to 88.6 and 72.2%, respectively. This is due to the fact that all robotics used in the Russian Federation is imported [6]. Due to changes in the exchange rate and an increase in the equipment cost, it has become difficult for many agricultural enterprises to purchase these machines.

The main problem for the widespread use of robots in the agricultural industry is poorly developed technology for their widespread use. In 2018-2019, most agricultural robots designed for individual farms are still being tested or at the proof-of-concept phase [12]. Figure 3 shows the cost reduction before and after the implementation of elements of the digital economy in the agricultural industry.

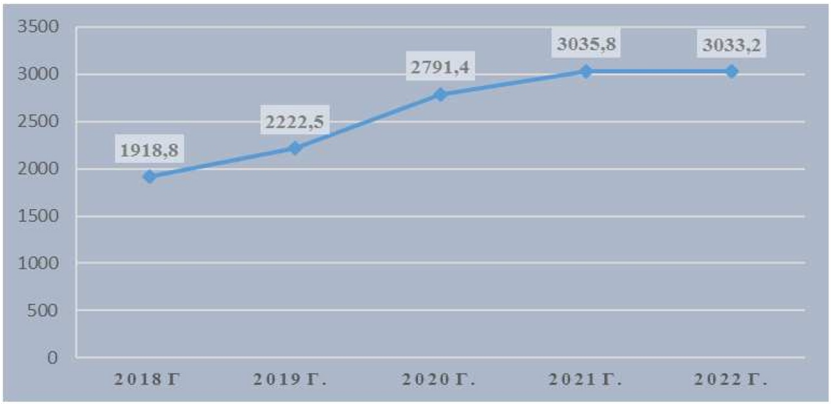

Fig. 3. Agricultural products, (billion rubles)

Currently, most agricultural robots operate in experimental modes, when they have constant access to technical specialists and engineering support [9]. The challenge is to create a business robot that is reliable and self-sufficient, easy to operate and inexpensive.

The potential for modernization of the industry is enormous. The need to ensure the national food security and develop export potential requires transforming the agricultural sector into a high-tech industry that can provide food for many countries [7]. It is necessary to create opportunities for implementing innovative technology, to adopt advanced management decisions that can provide the population of Russia with high-quality and safe products

4 Discussion

Robotization of the agricultural industry can reduce production costs, improve product quality, and increase safety by reducing the human factor. Unlike humans, robots can monitor the state of plants, animals and the environment around the clock and correct deviations from the specified parameters [8].

The transition of agricultural organizations to digital, intelligent technologies and robotics must have a certain focus [13]. The following goals can be pursued:

- More economical consumption of resources, including water and electricity, compared to traditional technologies.
- Reduction of harmful environmental impacts and soil compaction compared to traditional technologies due to the optimal size, weight of the robotics and spot treatment of crops.
- Reduced manpower requirements and savings in labor costs.
- Reduced damage associated with the adverse effects of human factors on the process and results of production, including non-compliance with production technology, theft, purposeful and accidental risk-taking behavior.
- Reducing costs for occupational health and safety and prevention of occupational diseases.
- Obtaining objective information in a timely manner to make the most informed managerial decisions.
- Economical consumption of seeds, fertilizers and chemicals through the use of precision farming technologies.
- Improving the quality of products through the use of modern technologies of quality control.

Based on the above goals, it is possible to identify the main aspects of robotization in the agricultural industry. These aspects are presented in figure 4.

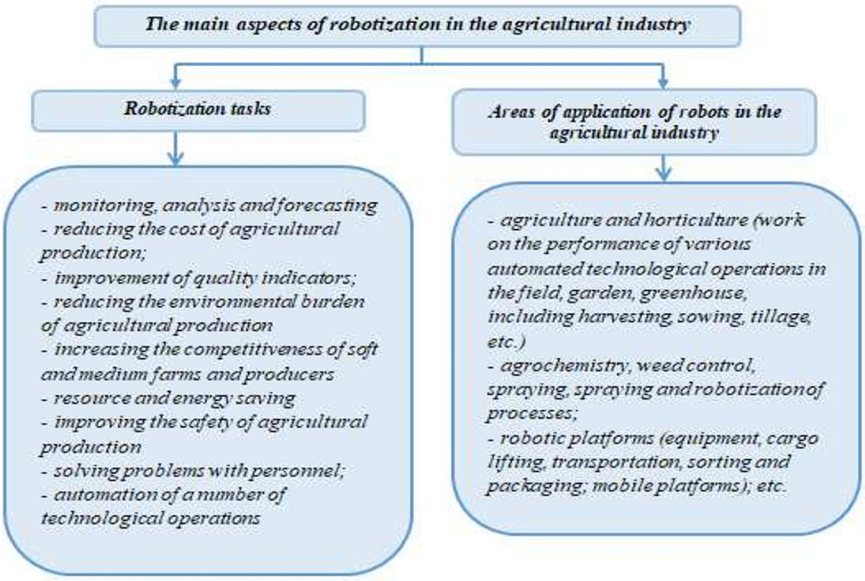

Figure 4. The main aspects of robotization in the agricultural industry.

Thus, the robotization of agricultural enterprises should be a priority, since there are objective prerequisites for the use of robots and significant advantages of using them compared to traditional technology [10-15].

Robots used in the agricultural industry are classified as “field robots”; this category falls into the category of service robots. There are also drones, robots for precision agriculture – agrobots, robots for animal husbandry – milking robots, etc. Along with agricultural robots, milking robots are sometimes referred to a separate sub-category of field robots [16-21].

The "agricultural robot" or "agro-robot" can be defined as a machine that uses hardware and software to perceive the environment, analyze crop data and perform actions in real time based on this data without human intervention.

There are also robots designed to perform repetitive tasks in gardens or fields. They are a four-wheel self-propelled machine with front and rear attachment systems for processing tools. The direction of movement is changed by turning the front, rear or all four wheels or by the “crab” method.

5 Conclusion

Thus, according to the results of the study, it was found that the introduction of digital technologies in agriculture makes it possible to streamline the work of the agro-industrial complex, increase its efficiency and reduce production costs. New technologies will make it possible to obtain high yields with minimal total cash costs and maintain a balance between the preservation of human activity and the biosphere.

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