Effective technologies for automation and robotization of the agro-industrial complex

O V Korchevskaya and R Sh Makhmudov
Reshetnev Siberian State University of Science and Technology, 31, Krasnoyarsky Rabochy Av., Krasnoyarsk, 660037, Russian Federation

E-mail: okfait@gmail.com

Abstract. The issues of increasing the productivity and competitiveness of the agricultural sector through the transition to digital technologies are considered. Despite certain successes in the agricultural sector associated with state support for the digitalization of agriculture, there are still a number of unsolved technological problems. Today, the main trend in the use of digital technologies in this industry is to automate all processes of growing crops from sowing to harvesting. The article presents the results of the analysis of automation and robotization of the agro-industrial business and identifies the main directions of competitive technologies. The functional of intelligent control information systems is considered. Special attention is paid to the possibilities of using unmanned aerial vehicles. Along with its undeniable advantages, agricultural robotics is characterized by high expectations and exaggerated expectations and has a number of disadvantages. The issues of legal regulation of the process of digitalization of the agro-industrial complex are considered. The analysis of the market and technologies of the agricultural sector revealed the key methods of increasing the efficiency of agriculture. Among them, one can single out the development of fundamentally new methods and approaches to agriculture, greening, design and implementation of intelligent systems and the development of robotics, training of new specialists for the development and implementation of innovative technology.

1. Introduction
For a long period of time, the use of information technology in agriculture was limited only to document management and the use of Internet resources. Weak development and implementation of computer technologies for data processing is associated with the specifics of this industry: a long production cycle, natural risks, poor formalizability of biological processes.

However, the actions of the Russian authorities, together with decent funding in recent years, have led to positive dynamics in agriculture. The state regulation of digitalization of agriculture is being carried out. The Ministry of Agriculture of the Russian Federation is implementing the Digital Agriculture project, the task of which is to double the productivity of agricultural enterprises by 2024. Agribusiness in Russia has begun to reach a certain level of maturity.

Today we can note the stabilization of the level of investments in agriculture, the growth of competition among agricultural producers, the increase in the volume and quality of modern information technologies. Data from satellites, sensors, operating and transactional systems are analyzed. Smart devices have appeared that transmit and process the current parameters of each object and its environment (equipment and sensors that measure the parameters of soil, plants, microclimate,
characteristics of animals). At the same time, both the volume of data and the need for their high-quality processing increase.

Despite the positive trends in the agricultural sector, there are a number of pressing problems that need to be addressed.

Population growth, an increase in the need for the consumption of high-quality environmentally friendly products entails the need for the introduction of new solutions, a radical rethinking of agricultural methods, the development and application of effective technologies for automation and robotization of the agro-industrial complex.

The aim of the study is to identify the features of the use of digital technologies in agriculture, the prospects for the use of robotic technologies.

2. Research results and discussion

The main purpose of the application of automation and robotization of agriculture is to ensure a stable growth in agricultural production through the introduction of digital technologies for collecting, processing and using an array of data on the state of soils, plants and the environment [1].

To do this, it is necessary to introduce existing technologies and create domestic competitive technologies in the following areas [1 - 4]:

1. Monitoring and control of indicators of sown fields and assessment of the state of crops.
2. Development of intelligent systems, IoT for monitoring agricultural performance.
3. Development and implementation of automation and robotization systems for work in the agro-industrial complex:
   - creation of robots that autonomously work in the field and perform various specialized operations or work with one or more specific crops;
   - development of solutions for the autonomy of existing equipment. Automatic driving systems for combines, tractors and other agricultural machinery.

It is obvious that in the modern world, increasing the development of agriculture has become impossible without the development of new effective mechanisms for managing agricultural production based on advanced management and information technologies, intelligent multi-agent systems with built-in robotics.

There are many companies on the market today that have already developed agricultural land monitoring systems. These systems use satellite imagery, and the resulting data is analyzed and provided with recommendations.

An example of a new generation of automation systems is the intelligent information management system Smart Farming. It has the following functionality: multilevel continuous monitoring of the state of crops in real time, the development of solutions and recommendations for action, the construction of plans and assignments of specialists, taking into account the available resources, accounting for work performed and expended resources.

GLONASS software helps to implement the proper level of agricultural control in various areas of agriculture. She creates electronic maps of fields, thanks to which further processing of crops is carried out and all work carried out on the cultivated areas is monitored.

Remote control system for agricultural land Cropio. It includes operational monitoring of the state of sown areas, auto-documentation, forecasting and planning of agricultural operations, i.e. the coordinates of the fields, information on the crops grown, methods of soil cultivation, applied fertilizers, etc., as well as retrospective information (crop rotation, yield, etc.) are loaded. Based on this information, the system provides a customized analysis model with daily forecast updates.

There are six main directions of digital transformation of agriculture, implying the introduction of a number of innovative projects "smart agricultural enterprise", "smart field", "smart farm", "smart greenhouse", "smart garden". They are based on modern competitive domestic technologies, methods, algorithms and samples of circuits and devices. The introduction of information technology in such
projects is based on assessing the effectiveness of agricultural policy, forecasting and regulation of agri-food markets at the federal and regional levels of agribusiness management.

Today, the main trend in the use of digital technologies in agriculture is to automate all processes of growing crops from sowing seeds to harvesting.

In particular, the world's first robotic farm, Hands Free Hectare, grew crops without human intervention using modified tractors and drones.

The robotization of agriculture is a means of increasing the efficiency of production and is especially relevant for large farms [5]. Robotization and automation of the agricultural industry entail a number of advantages, which can be achieved unambiguously through the use of spot farming technologies, reduced dependence on weather and climatic factors, etc. [6].

Drone technology is constantly expanding across a wide range of disciplines such as agriculture, healthcare, and the military.

Agricultural drones allow you to create electronic maps of fields in 3D format, calculate the Normalized Difference Vegetation Index (normalized vegetation index) in order to effectively fertilize crops, take inventory of the work being done and protect farmland.

Examples of work that can be performed by agricultural drones:

- Analysis of the condition of the soil. With the help of cameras and sensors specially installed on the UAV, farmers analyze the state of the soil on various participants and determine on which of them it is most expedient to plant seeds [7].
- Planting seeds. On the market, you can find a number of startups that offer to plant plants using special drones that shoot capsules with seeds into the soil [8]. An example of such a startup is BioCarbon Engineering, which made a big splash in the spring of 2015 when it announced plans to plant up to 1 billion trees a year in the future.
- Monitoring the state of the crop [9]. It is very important for farmers to timely detect pests that kill farmland in order to quickly take the necessary measures. By installing infrared cameras on the UAV, farmers can timely learn about the beginning of the loss of the crop.
- Harvest processing. Another potential application of UAVs in agriculture is uniform spraying of crops with pesticides and special fertilizers. With the help of drones, farmers will be able to carry out such work remotely [9].
- Yield forecast. The data collected during monitoring can be used to construct various analytical reports [9]. In this case, the drone will be used as a platform for collecting data, while the main scope of work will fall on specialized software that processes the collected information. Many experts even believe that the future of agricultural drones lies with this development model.

The agricultural drone market has been booming since 2017 year. According to the analytical agency PWC, in a few decades the market for some agricultural drones (not including aircraft-type drones) could amount to about $ 32.4 billion., allowing you to increase yields, is indispensable.

Among the largest players in the global drone market that are focused on agriculture are such representatives as AeroVironment Inc, AgEagle, DJI, Yamaha, etc.

Goldman Sachs predicts that by 2021 year, the agricultural sector will become the second largest drone use.

UAVs are developing in the agricultural industry and in our country. Among the most active market participants are such players as Unmanned Technologies (Novosibirsk), Geoscan (St. Petersburg), Autonomous Aerospace Systems - GeoService (Krasnoyarsk) and [Zala Aero] (Izhevsk). The range of services provided by these companies for agriculture is quite large.

The expansion of drones from a military to a civilian perspective has also created regulatory hurdles that must be overcome in order to exploit the full potential of drone technology [10].

The dynamics of the agricultural robotics market is characterized by extremely high expectations on the demand side with equally inflated supply promises [11].
The weak points of using drones in agribusiness are the following [12]. Trained and certified professionals are required to fly the drone. On the one hand, this can lead to the loss of jobs. On the other hand, the recruitment of new employees and their training [13].

In [14], it is noted that it is necessary to improve technological solutions that would improve flight duration, reliability, ease of use and the ability to more effectively use cameras and other sensors. One of the main reasons for the increased attention to the reliability of robots in agricultural production is associated with the difficulty of organizing maintenance and repair, with the lack of technical means and specialists.

The issues of legal regulation of the process of digitalization of the agro-industrial complex remain open. Among them are the following [15]:

- development of a training program for training personnel for work and service in various areas of the digital economy;
- ensuring confidentiality and entering only objectively reliable information into information bases;
- creation of structures for the development and maintenance of software for the digital economy in the agricultural sector.

3. Conclusion
The lack of proven methods for solving NP-complete problems hinders the effective decision-making for a diverse class of cutting-packaging tasks, which determines the need to develop new methods and approaches.

Digitalization has covered all spheres of social and economic life of society. This is a key factor in the development of the agricultural industry, since digitalization today is a vector that provides an increase in productivity and efficiency of the production process in the agricultural sector.

The task of effective use of IT is the maximum automation of all stages of the production agricultural cycle. This should lead to a reduction in losses and an increase in the quality of agricultural products, an increase in business productivity, and optimal resource management.

Further digitalization of agribusiness represents a higher level of digital integration. These changes can dramatically affect the digital economy of Russia. The development of intelligent information solutions that process data in real time will revolutionize farm decision making. For the digital transformation of agriculture, an urgent issue is the training of specialists with new knowledge, as well as new "smart" solutions.

The experience of introducing innovative digital technologies in the agricultural sector makes it possible to identify key methods of increasing the efficiency of agriculture:

- development of fundamentally new methods and approaches to farming;
- development of innovative projects;
- rational organization of work processes through the use of automation and robotization;
- greening agriculture;
- design and implementation of intelligent systems and development of robotics;
- training of new specialists for the development and implementation of innovative technology.

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