Application of modern digital technologies in the agricultural industry

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Abstract. The article analyses the global and Russian experience of digitalisation of agriculture. The article analyses the main directions of the development of digital technologies in Russian agriculture within the framework of the implementation of the departmental project of the Ministry of Agriculture of the Russian Federation "Digital Agriculture". The analysis of modern innovative technologies used by leading agrarian countries around the world for the digitalisation of agriculture has been carried out. It was revealed that one of the most acute problems that hinder the successful digital transformation of the agricultural industry in Russia today is the shortage of qualified personnel due to the outflow of able-bodied population from rural areas and the high average age of the existing working population.

Key words: agriculture, digitalisation, digital technologies, economy

1 Introduction

The digital transformation of the global economy provokes changes in all industries, including agro-industrial production [1-3]. The catalyst for the introduction of digital technologies in Russian industry was the approval of state development programmes focused on the digitalisation of various spheres (e.g., Order of the Government of the Russian Federation No. 1632-r of 28 July 2017 on the approval of the programme "Digital Economy of the Russian Federation").

The level of digitalisation of the economy in the world is assessed by several indicators (composite indices), among which the International Digital Economy and Society Index (IDESI) is the most interesting in terms of assessing the digitalisation of industries. The International Digital Economy and Society Index measures the progress of countries in the development of the digital economy and society according to the following components: connectivity, human capital, internet usage, integration of digital technologies, digital public services (for 28 EU countries and 17 other countries). Such component as "Integration of digital technologies" directly depends on the level of implementation of digital technologies in all industries, including the agricultural industry. Conditions for the introduction of digital technologies include: availability of qualified personnel, the latest equipment, and the availability of appropriate digital technologies [4-6]. Next, let us consider the prospects for...
the development of the agrarian industry in the framework of the transition to the digital economy.

2 Problem statement

2.1 Problem statement

The Ministry of Agriculture of the Russian Federation has developed a departmental project "Digital Agriculture". The project implementation period: 2019-2024. According to this project, Digital Agriculture is agriculture based on modern methods of agricultural products and food production using digital technologies (Internet of Things, robotics, artificial intelligence, big data analysis, e-commerce, etc.) that ensure increased labour productivity and reduce production costs. The aim of the project is the digital transformation of agriculture through the introduction of digital technologies to ensure a technological breakthrough and a 2-fold increase in labour productivity in agricultural enterprises by 2024.

Actual development areas reflected in the project: "Efficient hectare", "Smart contracts", "Agroexport from field to port", "Agro-solutions for agribusiness", "Land of knowledge".

The grounds for the development of the project were: the Decree of the President of the Russian Federation of 7 May 2018 No. 204 "On national goals and strategic objectives of the development of the Russian Federation for the period up to 2024" and the Doctrine of Food Security of the Russian Federation, approved by the Decree of the President of the Russian Federation of 30 January 2010 No. 120. However, in order to effectively implement digital technologies, it is necessary to analyse the global practice of digital technology application.

3 Research objectives

The research aims to:
1) identify the most effective digital agricultural technologies suitable for application in the Russian agricultural sector based on the analysis of global experience;
2) reveal the problems and prospects of digitalisation of agriculture in Russia.

4 Purpose of the study

Object of research comprises main directions of development of digital technologies in agriculture in Russia and abroad.

Subject of the study is to experience in the application of digital technologies in the agricultural industry.

Purpose of the research consists in identification of digital technologies promising for implementation in the agrarian industry in Russia based on the analysis of modern innovative technologies used by leading agrarian countries of the world for digitalisation of agriculture.

5 Research methods

5.1 Analysing global experience in the application of digital technologies in agriculture

Table 1 summarises the main examples of digital technology application by countries around the world in the agricultural industry. As can be seen from the table, Russia is developing in all areas of digitalisation of agriculture along with other countries and is developing its own
digital solutions in this industry. Russia's success in developing robotics technologies is particularly noteworthy.

**Table 1.** Use of digital technologies by the world's leading agricultural countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Robotics technology</th>
<th>Satellite communication technologies</th>
<th>Telemetry systems and technologies</th>
<th>Big data technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>Smart sensor sensors, agricultural drones from Unmanned Technologies, Geoscan, Autonomous Aerospace Systems - GeoService and ZALA AERO, automated systems (tractor with C-Pilot computer vision system). Azimut-1 navigation console from Rateos LLC for parallel driving of agricultural machines across the field.</td>
<td>Satellite tracking, weather reports, agro-cycle control, remote monitoring and telemetry system (Agrotronic).</td>
<td></td>
<td>Forecasting and strategy development, analysing big data from sensors.</td>
</tr>
<tr>
<td>USA</td>
<td>Parallel Driving System from Trimble, Inc.: Determine the current position of agricultural equipment.</td>
<td>Precision farming in the satellite navigation sector: AGCO Corporation, CropX, John Deere, Trimble, Inc. and Monsanto</td>
<td></td>
<td>Internet of Things (IoT) system to remotely monitor the health of livestock and other animals.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Leica mojoMINI from Leica Geosystems: parallel driving and car navigator with detailed map.</td>
<td>Precision farming in the satellite navigation sector: Leica Geosystems</td>
<td></td>
<td>No data available</td>
</tr>
<tr>
<td>Germany</td>
<td>CAM PILOT parallel guidance system from CLAAS: automatic guidance of agricultural machinery in strictly defined paths.</td>
<td>Use of satellite communications for locating agricultural machinery.</td>
<td></td>
<td>CLAAS Telematics system</td>
</tr>
</tbody>
</table>
5.2 Problems and Prospects of Digitalisation of Agriculture in Russia

The Digital Agriculture project includes the following stages:

1) creation of a federal digital platform of the agro-industrial complex for agricultural management;
2) creation and implementation of mechanisms for forecasting and planning of agricultural production;
3) training specialists in the competences of the digital economy.

We will consider each aspect separately.

5.2.1 Creation of a federal digital platform of the agro-industrial complex for agricultural management

Currently, 11 information systems have been created to provide the agricultural industry with production and financial indicators for accurate management decision-making. A unified digital platform in the future will allow planning balances of production, consumption of agricultural products, providing government services in digital form and much more. Currently, it is planned to start creating a neural network that will make it possible to recognise the contours of fields and the crops growing on them [10].

5.2.2 Creation and introduction of mechanisms for forecasting and planning of agricultural production

The mechanism of agricultural production forecasting is based on mathematical modelling. Close interaction of the created digital platforms with the databases of Roshydromet and Agrohimcentres will make it possible to forecast the harvest and harvesting dates of agricultural crops.

5.2.3 Training of specialists in digital economy competences

The survey method (testing) was chosen to study this issue. The study involved 100 representatives of the agrarian industry from different regions of Russia, both employees of the agrarian industry and representatives of agrarian universities (teachers and students). Age category of respondents: from 20 to 70 years old. Both male and female representatives took part in the survey. The survey was conducted anonymously and exclusively on a voluntary basis. The questionnaire contained the following questions:

1) How do you assess the availability of qualified personnel in the Russian agricultural industry (from 1 to 10 on a ten-point scale)?
2) How do you assess the attractiveness of work in the agricultural sector for young people (from 1 to 10 on a ten-point scale)?
3) How do you assess the level of agrarian education (from 1 to 10 on a ten-point scale)?
4) Do you consider it necessary to make changes in the educational system of the agricultural sector in the conditions of transition to digital transformation?

5) What do you see as the causes of staff shortage in the agricultural industry?

The answers received from the respondents were formed into diagrams (Fig. 1-4).

As can be seen from Fig. 1, the majority of respondents (39%) assessed the level of provision of the Russian agricultural industry with qualified personnel at 3 points on a 10-point scale. The attractiveness of work in the agrarian sphere for young people was predominantly assessed as 2 points on a 10-point scale (43%). The level of agrarian education was predominantly rated 6 points on a 10-point scale (51%). Also 94% of respondents answered that they consider changes in the educational system of the agrarian sector in the conditions of transition to digital transformation necessary. Among the reasons for staff shortages in the agricultural sector, the respondents named:

- Low labour remuneration of agricultural workers;
- Low level of prestige of the profession;
- Low quality of life in agricultural areas;
- Insufficient level of social support for agricultural workers.

Fig. 1. Availability of qualified personnel in the Russian agricultural industry

Fig. 2. Attractiveness of work in the agricultural sector for young people
According to the results of the conducted survey, as well as the analysis of literary sources, the following conclusions can be drawn:

1) training of future personnel for the agricultural industry does not meet the current level of technology development and provokes "lagging behind" at the stage of entering the digital transformation;

2) the professional level of existing employees in the agricultural industry lags behind the current level of technological development;

The following ways can be proposed to solve the above problems:

1) introduction of "advanced" training in the higher education programmes of agrarian universities, based on the best world practices with consideration of the Russian specifics;

2) systematic professional retraining and advanced training of agricultural workers.

Today, continuous professional development is a necessity for every employee in any sphere of industry. The development of the digital economy leads to the emergence of new and renewal (change) of existing professions. The pace of scientific and technological progress is so high that the system of higher education does not have time to prepare graduates for the constantly changing requirements of the labour market due to the mismatch between the speed of updating educational programmes and the pace of technology development, and employers do not have time to respond to the transformation of employee qualifications and carry out rapid retraining / advanced training. In this regard, when we talk about training new personnel for the agricultural industry, who should participate in the digital transformation of the industry, i.e., today's students of agricultural universities, it is necessary to predict what competences will be in demand in the agricultural industry by the time they graduate. Advanced training in this case means the formation of necessary professional competences in the field of introduced, emerging or planned to be introduced means of production, techniques and technologies [11-32].

In the process of organising advanced training there are such priority tasks as:

1) renewal of material and technical base of agrarian universities;

2) professional development of teaching staff;

3) updating the content of educational programmes.
For the personnel professional retraining organisation in the agrarian industry, it is proposed to use a modular approach. The methodological basis of professional retraining programmes is the basic modules that complement the variable modules focused on specific specialization. Such a modular approach is considered in [33, 34] and has proved itself in practical application [35-37].

6 Conclusions

Based on the analysis of global experience of the application of digital technology in the agricultural industry, it was revealed that Russia is developing in all areas of digitalisation of agriculture along with other countries and is capable of developing its own digital solutions in this industry. As for the digitalisation of agriculture in Russia, it can be noted that certain successes have been achieved within the framework of the Digital Agriculture project. However, in order to maintain a proper level of labour productivity in the agricultural industry, it is necessary, first of all, to solve the issue of qualified personnel supply. In addressing this issue, it is important to combine the formation of a new social policy to attract young personnel (improvement of socio-economic conditions of the rural population), the introduction of "advanced" training in the educational programmes of higher education of agrarian universities and improving the professional level of existing employees (through additional professional education - advanced training programmes, professional retraining, internships).

References