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ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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Annotation. The article describes the ways, methods and prospects of using artificial intelligence in agriculture. The main advantages of artificial intelligence and examples of using innovative technologies are considered.

Keywords: artificial intelligence, agriculture.

Introduction. Artificial intelligence has huge potential to transform agriculture, making it more efficient, sustainable and productive. It helps farmers make better informed decisions, automate processes, and improve product quality. Even though implementing AI requires investment, the long-term benefits can be significant.

The main advantages of using AI in agriculture [4, 9]:

– increasing the speed of data collection and processing;
– improving the accuracy of all processes;
– increase of production efficiency;
– reduction of production costs;
– reducing the need for manual labor;
– increase in yield;
– promoting sustainable development.

Unmanned technologies are revolutionizing agriculture by offering efficient and cost-effective solutions for crop monitoring, plant health assessment, field mapping, targeted spraying, and livestock management. These technologies allow farmers to gather precise data, detect problems early, automate tasks, and reduce environmental impact, leading to improved productivity, better decision-making, and increased sustainability in their operations. Ultimately, drones and other unmanned technologies are becoming indispensable tools for modern agriculture, enabling farmers to optimize their resources and manage their farms more effectively.

Main part. The BELARUS A3523i tractor is designed to perform tasks generated by the operator. The task is transmitted via the GSM remote communication channel, and you can also transmit it on a flash drive. The tractor will work equally efficiently both during the day and at night.

BELARUS A3523i is already able to see and move in offline mode. The tractor is equipped with sensors, two stereo video cameras that produce a high-resolution image and can subsequently recognize objects: a person, a tree, an animal, a stone, etc. The tractor has two radars in front and rear and an additional all-round LIDAR (a laser device that «knows» everything that is happening around it within 20 meters) [1]. The KFU-MTZ-112 mini-tractor has a hybrid drive (internal combustion engine + electric motor) and can operate both in normal mode with the operator behind the wheel, and in autonomous mode on electric traction (the electric motor is connected to the transmission via a PTO). The model is designed for performing specialized work in open areas – fields, farms, factories (production facilities with harmful conditions). There are several control modes: manual, remote, strategic, and tactical. Battery life – up to 8 hours. Driving speed on autopilot – up to 15 km/h. Object detection range – 30 m. The object recognition range is 15 m. The response time to dynamic objects is 0.2 seconds. [7].

The concept of precision farming emerged in the United States in the 1980s, but has only become widespread in the last five years due to the development of mobile technologies, high-speed Internet and satellite communications. Today, precision farming uses satellite data, sensors,

drones, and GPS technology. These technologies provide farmers with data on the state of their fields and take food production to a new level. The more information you have, the more accurate your analytics and forecasts are, so collecting and analyzing big data is very important for precision farming [2]. The example of the use of such technologies is the OneSoil's application. OneSoil's applications are built on big data analysis and machine learning. The data is collected from real fields and magnified thousands of times using mathematical operations. Then, the neural network learns to find patterns by processing the data and improving the result with each attempt. Initially, data from several farms in Belarus and the Baltic States were used. Machine learning algorithms learned to predict field boundaries by comparing them with real boundaries. If the algorithm circled the extra sections, it received a fine for this. This metric is called intersection over union, and it can take values from 0 to 1, where 1 is a perfect match. The intersection over union indicator varies from region to region, averaging 0.85–0.88. OneSoil customers have added 30 million hectares of land to the platform (as of February 2020). According to the latest FAO estimates, there are now 1 billion 567 thousand hectares of arable land in the world [10]. It turns out that 1.9% of all arable land on the planet is listed in OneSoil. Interactive map OneSoil Map provides information about fields and crops in Europe and the United States, helps you track trends at the regional level and monitor changes in a particular field. The map works thanks to machine learning algorithms and satellite images [12].

Analysis of satellite images allows you to monitor the state of fields remotely through changes in the vegetation index NDVI. NDVI (Normalized difference vegetation index) is a numerical indicator of the quality and quantity of vegetation on a field site. It is calculated from satellite images and depends on how plants reflect and absorb light waves of different lengths. A healthy plant actively absorbs red light and reflects near—infrared, while a sick plant does exactly the opposite. Sunlight falls on plants, light waves of one length are absorbed, waves of another length are reflected – and the satellite captures all this data using its sensors. By combining data from satellites and sensors, the farmer can calculate and apply the correct dose of fertilizers and chemicals to each part of the field – this is called differential fertilization. This, in turn, helps to reduce ground water pollution.

Machine learning helps farmers analyze weather and crop data over several years and look for patterns that will allow them to predict future yields. In addition, satellite images can be used to monitor the state of water and air in order to predict possible agricultural problems in specific regions. By understanding the scale of global disasters such as forest fires, earthquakes, or hurricanes, you can better manage your existing resources [11].

Today, the market offers many different agricultural technology solutions, and it is very important that these technologies and applications are affordable and easy to use.

According to statistics, less than 10 % of arable land in our country is processed using digital technologies. According to experts' estimates, only 13-15 % of agricultural producers are able to be engaged in digital transformation of their own business processes and commercialization of scientific and technical developments [7].

Today, the efficiency of the agricultural sector of the Republic of Belarus in a number of indicators is noticeably inferior to the largest economies in the world. Intelligent (precision) farming programs are available in many countries. The pace of implementation of artificial intelligence technologies in the agro-industrial complex is growing annually by more than by 20% [5].

Currently, the coverage of AI in agriculture is relatively small – about 12%. It will grow both for rational reasons and because it is planned to encourage the introduction of AI technologies at the government level. Based on the component, the market is divided into solutions and services. The solutions segment is projected to exceed US$11 billion by 2032, driven by the urgent need to improve efficiency, sustainability, and productivity in food production. Farmers face challenges such as climate change, labor shortages, and limited resources. AI technologies offer innovative solutions by providing real-time data analytics, predictive modeling, and

autonomous hardware. These tools make it possible to apply precise farming methods, optimize resource management, and make proactive decisions, ultimately increasing crop yields, reducing environmental impacts, and ensuring food security against the backdrop of changing agricultural landscapes (shown in Figure 1) [3].

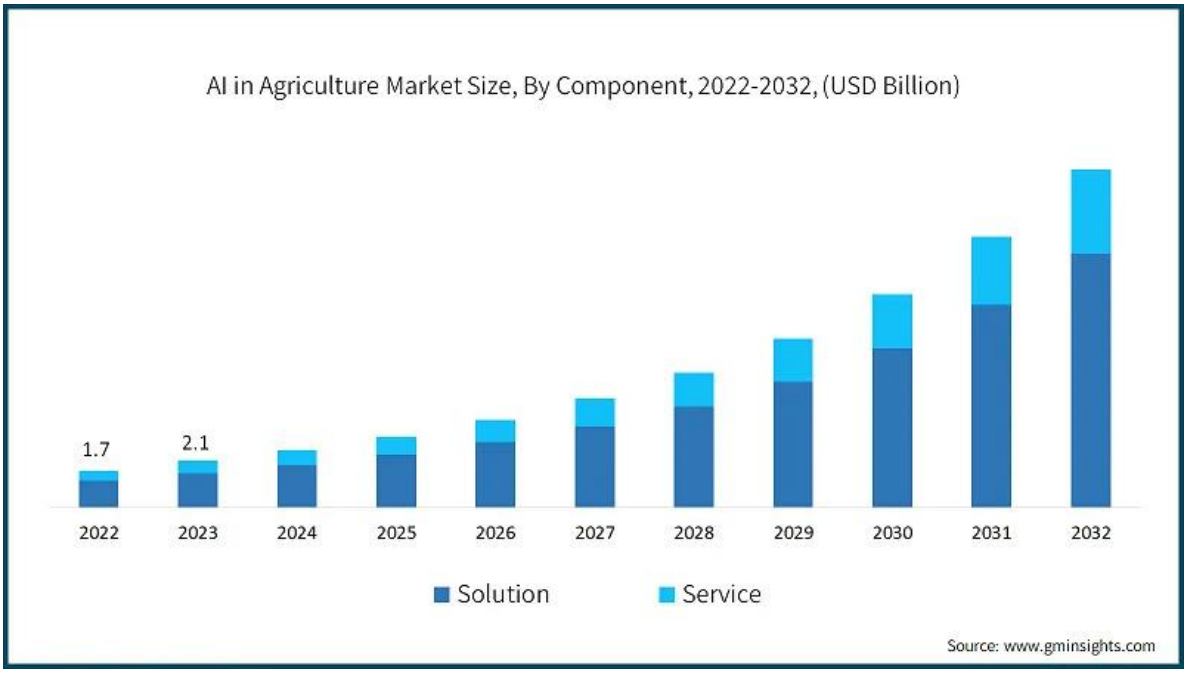

Figure 1 – AI in Agriculture Market Size, By Component, 2022-2032, (USD Billion)

The use of AI, according to statistics, contributes to an increase in the production of livestock products and crop yields by at least 3-5% [4].

Conclusion. AI implementation is becoming vital for agriculture due to its potential to revolutionize efficiency, sustainability, and productivity. It optimizes resource use, enables early disease detection, automates tasks, and provides data-driven insights for improved decision-making. Ultimately, AI promotes sustainable practices and contributes to global food security by addressing labor shortages and maximizing resources in an ever-growing world. In the Republic of Belarus, the digital transformation of the agricultural sector is an object of increased attention, but the introduction of technologies is taking place at a slow pace. One of the reasons for this is the lack of qualified specialists with IT competencies [2, 6]. For the intellectualization of domestic agriculture, the industry project «Digital Agriculture» is being implemented [8]. Its goals include increasing exports of agricultural products, increasing the industry's contribution to GDP, increasing labor productivity and quality, reducing production costs, producing new high-tech and high-tech products, etc. The development of the Internet of Things, big data analysis technologies, cloud computing and artificial intelligence creates prerequisites for a fundamental transformation of agricultural production and public administration in this area. The reform process should be gradual in order to ensure improved efficiency in agriculture and the successful implementation of artificial intelligence in this area.

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