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## THE USE OF ROBOTIC TOOLS AS A NEW STAGE OF TRANSFORMATION IN THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE

Ukraine's agricultural sector is one of the country's leading industries, accounting for a significant share of exports and the domestic market. In the context of global competition and climate change, there is a need to modernise production. Robotic tools, such as drones, autonomous tractors, and robotic harvesting systems, are becoming the basis for the transition to smart agriculture. These technologies help to optimise production processes, increase efficiency and reduce costs. The purpose of this article is to analyse the current state and prospects of using robotic tools in the Ukrainian agro-industrial complex.

Automation and robotics help minimise the impact of the human factor, reduce labour costs and make agribusiness more efficient. «Before analysing the introduction of robotic systems, it is important to understand the main challenges faced by the Ukrainian agro-industrial complex, namely: 1) shortage of skilled labour - a decrease in the number of workers in agriculture due to military operations, migration and urbanisation; 2) rising production costs - prices for fuel, fertilisers, crop protection products and labour are constantly rising; 3) climate change - unstable weather conditions and droughts require flexible and efficient technologies; 4) the need to increase yields - to remain competitive in the global market, farmers must look for new ways to increase productivity» [2].

Ukraine's modern agricultural sector is actively implementing robotic technologies that are transforming traditional approaches to agriculture. Agrodrones monitor fields, analyse soil conditions, and apply fertilisers and plant protection products accurately, processing up to 100 hectares per day with an accuracy of 1 cm. Autonomous tractors and combines equipped with GPS navigation and artificial intelligence operate without operator intervention, which significantly reduces labour costs. In developed countries, robots are already being used to pick berries, fruits and vegetables, while in Ukraine, these technologies are at the initial stage of implementation. «The integration of robotics with modern technologies helps to optimise sowing, watering and fertilisation using sensor data, which is the basis of precision farming systems» [1].

The use of robotic tools brings a number of benefits. Precision application of inputs can reduce fuel, fertiliser and pesticide consumption by 20-30%, which helps to save money. Automation speeds up agricultural operations and increases yields by 10-15%. In addition, precision farming reduces $CO_2$ emissions and chemical soil pollution, contributing to environmental sustainability. Robots also minimise the impact of human error by eliminating mistakes caused by fatigue or lack of skills.

However, the introduction of robotics in Ukraine faces a number of challenges. The high cost of equipment, such as agrodrones or autonomous tractors, makes it unaffordable for small and medium-sized farms. Limited access to high-speed internet in rural areas makes it difficult for IT systems to work. «There is also a shortage of robotics and programming specialists capable of maintaining modern technology. In addition, the lack of an adapted regulatory framework hinders the use of autonomous vehicles and drones» [3].

Prospects for the development of robotic technologies in the Ukrainian agro-industrial complex are associated with active state

support, in particular through subsidy programmes for the purchase of equipment. It is important to introduce educational programmes in robotics in agricultural educational institutions to train qualified personnel. The creation of cooperatives will allow small farms to share expensive equipment, reducing their financial burden. Adaptation of technologies to European standards will help increase the competitiveness of the Ukrainian agro-industrial complex in the international market, opening up new opportunities for the development of the industry.

The use of robotics in the Ukrainian agro-industrial complex is a necessary step to ensure the sustainable development and competitiveness of the industry. Despite challenges such as high cost and insufficient infrastructure, the potential of these technologies to increase productivity and reduce environmental impact is significant. Successful implementation requires government support, education and adaptation of legislation.

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