UDC: 631.3:004.8

T.S. Shabatura
Doctor of Economics
A.O. Yakovenko
PhD in Economics
Institute of Climate-Smart Agriculture
National Academy of Agrarian Sciences of Ukraine,
c. Odesa, Ukraine

THE ROLE OF ARTIFICIAL INTELLIGENCE IN PRECISION AGRICULTURE: APPLICATIONS AND IMPACT

The world's population is projected to reach nearly 10 billion by 2050, leading to an unprecedented increase in demand for food. Traditional farming methods face difficulties in meeting such demand while minimizing environmental impact. One promising approach to solving this problem is precision agriculture, which is based on the use of digital technologies and makes decisions based on data. An important component of this transformation is the integration of artificial intelligence (AI) into precision agriculture, which increases the efficiency and sustainability of agricultural operations.

Precision farming involves the use of advanced technologies to optimize agricultural processes. Key benefits of this approach include:

1. *Increase in yield.* One of the identified areas for the development of precision agriculture is to increase yields through the use of modern data analysis technologies and predictive modeling. Agriculture has traditionally depended on a number of natural factors, such as weather, state of reasonableness, water availability, and pests. However, thanks to artificial intelligence (AI), farmers provide the ability to predict changes in these factors, adapt production strategies, and improve productivity based on analysis enormous amounts of data [1].

AI uses large amounts of historical data on climate conditions, crops, state of justifications, and crop development to develop prediction models. Through machine learning, these models are constantly improving usage and providing farmers with recommendations on the optimal timing for planting, fertilizer use, watering, and harvesting. Predictive modeling can reduce the risk of loss due to adverse weather conditions or pests, which ensures a stable increase in yield [2].

In addition, data analytics will help identify weaknesses in agricultural processes, such as uneven use of resources or declining plant conditions in certain areas of the field. The use of drones and satellite imagery in combination with AI allows farmers to preserve detailed images of fields and quickly respond to any deviations, which also contributes to higher yields [3].

2. *Resource efficiency.* Optimizing the use of resources is one of the key areas of application of AI in agriculture. In the context of global climate change and increasing competition for water and land resources, effective management is becoming critical. Artificial intelligence can reduce the loss of water, fertilizers and pesticides, which not

only reduces costs but also minimizes the negative impact on agriculture. AI also analyzes the needs of plants for living substances and the state of justifications, recommending precise doses of fertilizer for individual plots. This not only saves on fertilizer costs, but also prevents excessive application of chemicals, which can have a negative impact on the environment. Optimizing pesticide use is also important to reduce the risk of developing resistant pests and improve product quality.

3. Environmental development. Environmental challenges such as climate change, base degradation, water pollution, and biodiversity reduction require agriculture to shift to more sustainable practices. Precision agriculture based on artificial intelligence contributes to the achievement of global sustainable development goals, in particular in terms of protecting ecosystems, rational use of resources and minimizing chemical pollution [4].

Changing the use of pesticides and fertilizers through more precise technologies can reduce the level of pollution of land and water resources, which is in favor of maintaining ecological balance. In addition, optimizing the use of water resources will help prevent the depletion of natural water sources, which is a critical point in arid regions.

The introduction of precision agriculture also contributes to the conservation of land resources by preventing the degradation of justifications and reducing the need for agricultural land expansion. This, in turn, contributes to the conservation of natural landscapes and biodiversity and the reduction of greenhouse gas emissions as a result of reducing the use of fertilizers and fuels for machinery. This contributes to the fight against climate change. Thus, sustainable development is an important component of a precision farming strategy that integrates AI technologies to achieve sustainable and environmentally friendly practices.

One of the key areas of future development of precision agriculture is the further improvement of artificial intelligence technologies to enable more accurate and proactive management of agricultural processes. This includes the development of more sophisticated models to predict yields and disease spread, an integrated network to monitor the status of grounded and water resources, and the development of autonomous robotic systems to perform labor-intensive activities.

Technologies such as computer star, machine learning, and the Internet of Things (IoT) also play an important role in providing greater accuracy and reducing operational costs. For example, the use of computer vision can detect plant health problems at an early stage, allowing the farmer to react quickly and reduce crop losses. It is also accepted that the combination of machine learning with Big Data opens up new opportunities for agricultural risk analysis and forecasting [5].

The role of AI in supply chain management will also become more important. With its help, it is possible to optimize logistics processes, reduce product losses at the stages of transportation and storage, as well as ensure rapid adaptation to changes in market demand. With the help of AI, farmers are quickly adapting their strategies to new environmental conditions and making agricultural practices more sustainable and environmentally friendly.

The integration of AI into precision farming leads to more sustainable farming practices by minimizing resource wastage, reducing the use of chemicals, and

promoting better land management. This has a positive impact on achieving environmental conservation goals while increasing agricultural productivity.

Despite the significant benefits of AI in precision agriculture, challenges such as high implementation costs, barriers to technology adoption, and the need to train farmers need to be addressed. Future advances in AI are likely to further expand its capabilities in agriculture.

Artificial intelligence is revolutionizing precision agriculture by providing tools that improve decision-making processes, optimize resource use, and promote sustainable practices. As these technologies continue to advance, they have the potential to significantly increase agricultural productivity while addressing global food security challenges. The continued integration of AI into farming practices will be critical to the future success of the agricultural sector.

So, the future of precision agriculture is inextricably linked with the further development and implementation of artificial intelligence. This allows not only to increase the productivity and efficiency of agriculture, but also to contribute to its transformation into an environmentally sustainable and technologically advanced industry. The integration of innovative solutions will be a key factor in overcoming global challenges to food security and preserving the planet's ecosystems.

References:

1. How artificial intelligence is changing the agricultural sector in Ukraine. URL: https://ugic.com.ua/yak-shtuchnyj-intelekt-zminyuye-galuz-silskogo-gospodarstva-v-ukrayini/

2. Sam Fox (2024). Artificial Intelligence in Agriculture – Automation and Precision Farming. URL: https://mediacom.com.ua/shtuchnij-intelekt-vagropromislovomu-kompleksi-avtomatizatsiya-ta-tochne-zemlerobstvo/

3. Maxim Filippov (2024). How Artificial Intelligence and Robots Are Changing the Aero Sector. URL: https://www.epravda.com.ua/columns/ 2024/05/ 13/713533/

4. Tetiana Shabatura, Alisa Shevchenko, Olga Petrenko and Oleksandr Halytskyi, (2024). The by-products of grain production are an ecological and economic solution to the energy crisis. BIO Web of Conferences 114, 01019 (2024). DOI: https://doi.org/10.1051/bioconf/202411401019

5. Zamlynskyi V, Shabatura T, Zamlynska O, et al. (2023) Perspective Chapter: Exploring the Possibilities and Technologies of the Digital Agricultural Platform. Sustainable Development. IntechOpen. DOI: 10.5772/intechopen.112358. URL: https://www.intechopen.com/online-first/87828