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THE USE OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN AGRICULTURE: WORLD EXPERIENCE AND PROSPECTS FOR IMPLEMENTATION IN UKRAINE

ВИКОРИСТАННЯ ТЕХНОЛОГІЙ ШТУЧНОГО ІНТЕЛЕКТУ В СІЛЬСЬКОМУ ГОСПОДАРСТВІ: СВІТОВИЙ ДОСВІД ТА ПЕРСПЕКТИВИ ВПРОВАДЖЕННЯ В УКРАЇНІ

Modern agriculture is undergoing a profound transformation under the influence of digital technologies. Artificial Intelligence (AI) has become not only a tool for automating production processes but also a key instrument for managerial decision-making based on big data analytics. In the context of climate change, military risks, and energy challenges, AI opens up new opportunities to increase productivity, save resources, and ensure environmental sustainability in the agricultural sector.

According to the European Commission, around 30% of EU agricultural enterprises already use AI for yield analytics and risk management [1]. Table 1 presents the main areas of AI application in agriculture.

Table 1

Main areas of artificial intelligence application in agriculture

Direction	Application Example
Photo and statistical monitoring	Diagnosis of plant and animal diseases; soil nutrient monitoring; forecasting climate conditions.
Video and audio analysis	Monitoring animal behavior to minimize stress; automation of agricultural systems reacting to changes.
Robotics	Automation of agricultural operations to optimize repetitive tasks, speed up sowing and harvesting, and reduce manual labor.

Source: compiled by the author based on data from [2]

According to AgriTech Market Analysis, the global agrotechnology market, valued at USD 24.19 billion in 2023, is expected to reach USD 54.17 billion by

2029. The AI market in agriculture alone is projected to grow from USD 1.7 billion in 2023 to USD 4.7 billion by 2028, highlighting its enormous economic potential.

The World Economic Forum (WEF) reports that digital technologies in the agricultural sector could increase agricultural GDP in low- and middle-income countries by up to USD 450 billion annually [3].

As emphasized in the McKinsey & Company study *"From Bytes to Bushels: How Gen AI Can Shape the Future of Agriculture"* (2024), the integration of analytical platforms with generative AI could add approximately USD 100 billion of on-field value – through more efficient resource use and higher yields – and an additional USD 150 billion at the enterprise level by enabling innovative marketing strategies.

AI algorithms enable deep customer segmentation, automatic generation of personalized content, optimization of pricing decisions, and rapid reconfiguration of distribution channels, making artificial intelligence a key instrument of modern agri-marketing [4].

Syngenta has identified five key artificial intelligence trends shaping the development of agriculture in 2025:

1. AI in research. All research projects at Syngenta already employ machine-learning models to discover new active ingredients – both for synthetic and biological products.
2. AI in field operations. Implementing AI-based solutions for soil monitoring and forecasting will allow farmers to obtain detailed maps of nutrient composition, structure, and carbon content.
3. AI in the hands of farmers. Generative AI tools will act as digital agronomic advisors, helping farmers identify optimal crop management strategies.
4. AI in pest control. Precision agriculture technologies and data analytics help direct crop protection products only to affected areas, reducing pesticide use.
5. AI in supply chains. Artificial intelligence supports demand forecasting, market analysis, and the reduction of overproduction and waste, optimizing logistics and improving the efficiency of the agri-food sector [3].

Ukraine undoubtedly demonstrates significant potential in applying artificial intelligence in crop production. However, compared with leading countries – such as the United States, Canada, and Israel – which have already widely adopted AI to enhance the economic efficiency of crop production, Ukrainian agricultural enterprises still lag considerably in this field (Table 2).

Considering the successful examples of artificial intelligence implementation in the agricultural systems of the EU countries, the United States, Canada, and Israel, Ukraine possesses significant potential for integrating similar technologies into its own agricultural practices. First and foremost, it is essential to establish the necessary conditions for developing a national digital agricultural infrastructure that would include systems for

collecting, storing, processing, and analyzing large datasets (Big Data). Such databases would serve as the foundation for training machine learning algorithms used in yield forecasting, agricultural resource management, and minimizing environmental impact.

Table 2

International experience in AI implementation in the agricultural sector

Country	Successful cases of AI application in the agricultural sector
USA	• Blue River Technology uses crop care robots that use AI to identify and remove weeds, reducing pesticide use and increasing yields. • John Deere is implementing AI to automate agricultural machinery. Technologies include precision seeding and resource optimization, which increases field efficiency.
Canada	• Precision AI develops solutions to optimize pesticide spraying using AI-guided drones and uses machine learning for precision application.
Israel	• The Taranis project uses AI to monitor crops through satellite and drone imagery, allowing for early detection of plant diseases and soil problems. • Prospera has created a platform that uses AI to analyze field data, predict yields, and manage agricultural processes, helping farmers make informed decisions.
Netherlands	• At the best university of 2023, Wageningen University & Research, the agropark uses AI systems to automate greenhouses, including computer vision systems to optimize the cultivation of vegetables and flowers. The system provides climate control, irrigation, and lighting.
India	• CropIn's artificial intelligence system uses machine learning to predict crop yields and also to improve supply chain management for farmers in rural India. • Solinftec uses AI to monitor field conditions and precisely manage agricultural operations in real time, particularly for sugarcane.

Source: compiled by the author based on [5]

One of the key priorities should be the integration of research institutions, agricultural universities, and business enterprises to develop AI models adapted to Ukrainian conditions. Partnerships with international organizations – such as Horizon Europe, the FAO Innovation Lab, and EIT Food – should be strengthened to attract funding, exchange data, and share expertise.

Among the primary steps for implementing AI in Ukraine's agricultural sector, the following should be emphasized:

– developing a national roadmap for the digitalization of agriculture, with a focus on artificial intelligence;

– launching pilot "Smart Farming" projects in regions with diverse natural and climatic conditions;

– creating a unified agricultural data portal to ensure open access to analytical data from public and private sources;

– promoting educational initiatives aimed at training specialists who combine knowledge in agronomy, IT, and data analytics;

– providing state support for agri-innovation startups and establishing incubators for digital solutions.

Thus, artificial intelligence serves as a driving force in the transformation of agriculture, ensuring a new level of precision, predictability, and resource efficiency. The successful experience of leading countries demonstrates that the introduction of AI technologies contributes to increased productivity, reduced production costs, and improved environmental performance.

For Ukraine, the key tasks involve developing digital infrastructure, integrating scientific research into the practical operations of agricultural enterprises, and creating conditions for the large-scale expansion of innovations. The implementation of artificial intelligence should become an integral part of state policy in ensuring food security and environmental sustainability.

The synergy between intelligent technologies, big data analytics, and green energy has the potential to transform the Ukrainian agricultural sector into a competitive, environmentally responsible, and high-tech component of the European digital ecosystem.

Furthermore, to accelerate the adoption of artificial intelligence in the agricultural sector, it is crucial to enhance the digital literacy of rural communities. Many small and medium-sized farms still lack access to high-speed Internet, cloud platforms, and data processing tools, which limits their ability to benefit from AI-based systems. Addressing this digital divide requires coordinated efforts from the government, telecommunications companies, and local authorities to ensure the inclusiveness of technological transformation. Establishing regional agro-digital competence centers could support farmers in mastering new digital tools and integrating AI applications into everyday agricultural operations.

In the long term, Ukraine’s participation in European digital alliances and innovation clusters could become a powerful driver for scaling AI technologies in agriculture. Through cross-border research projects, exchange of open datasets, and collaborative pilot programs, Ukrainian agrotechnologies could achieve global recognition. The combination of AI-driven precision agriculture, sustainable resource management, and renewable energy integration will enable Ukraine not only to modernize its agricultural system but also to position itself as a regional leader in smart, climate-resilient, and environmentally sustainable farming.

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