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Application of artificial intelligence to improve the economic efficiency of land use management in the agricultural sector

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▶ **Abstract.** The purpose of the study was to assess the cost-effectiveness of using artificial intelligence (AI) to predict environmental changes in land use and optimise agricultural production. It was determined that the introduction of machine learning and big data analysis algorithms can significantly improve the accuracy of forecasts of agricultural land conditions, optimise the use of resources, including fertilisers and water, and reduce costs. The study analysed how AI can contribute to a more rational choice of crops and planning of sowing and harvesting, which has a positive impact on yields. In addition, the study addressed the environmental aspect: the use of AI can reduce the negative impact on the environment through precise resource management and reduced soil and water pollution. The work included modelling yields for different climate scenarios, which allows forecasting possible outcomes and developing adaptive strategies for the sustainable development of Ukraine's agricultural sector. The study demonstrated that the introduction of AI in the Ukrainian agricultural sector contributes to the improvement of land use efficiency, allowing farmers to respond more quickly to changing climate conditions. Machine learning algorithms, including those based on the analysis of

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data collected from satellite images and sensors, can help determine the timely need for fertiliser and water, which ensures the rational use of resources and reduces production costs. The forecasting models used in the article reflect possible yield scenarios for the period 2025-2028 for different climatic conditions, which allows enterprises to better plan agrotechnical measures and minimise risks. Thus, the study results emphasised the importance of AI as a tool for long-term strategic planning in the agricultural sector

▸ **Keywords:** yield forecasting; agriculture; data analysis; innovation; machine learning

▸ Introduction

The relevance of studying the use of artificial intelligence (AI) to improve the economic efficiency of land use management in the agricultural sector is driven by the growing challenges associated with landscape change, urbanisation, land degradation and the need for rational water management. Modern environmental problems, exacerbated by global climate change and population growth, require the search for innovative approaches to preserve natural resources and optimise the use of agricultural land. AI opens up new opportunities for analysing large amounts of data and predicting the effectiveness of various land use decisions, which allows for a balance between economic benefits and preserving environmental balance.

The study by R. Espinel *et al.* (2024) demonstrated how AI helps to optimise the management of agricultural land by accurately calculating fertilizer doses. This allows not only to reduce the use of chemicals but also to increase the efficiency of their application, which has a positive impact on economic results and the ecological state of the land. Y. Peng *et al.* (2019) focused on the use of predictive models to optimise irrigation. Thanks to AI technologies, farmers can use water resources more rationally, which, in turn, reduces irrigation costs and ensures stable yields even under changing climatic conditions.

The study by R. Ben Ayed & M. Hanana (2021) indicates a significant economic benefit from the introduction of AI in agricultural cost planning. Accurate allocation of resources based on AI forecasts helps to reduce costs and increase profitability, making the agricultural business more sustainable. R. Singh *et al.* (2020) explore the possibilities of automated soil monitoring systems that use AI to track the level of land degradation. This allows for timely detection of problems and the necessary measures to preserve soil quality, ensuring their long-term fertility.

M.Y. Shams *et al.* (2024) highlighted the benefits of crop rotation forecasting using AI algorithms. This allows agricultural enterprises to optimise the use of land for certain crops, improving their productivity and reducing the risk of soil depletion, which contributes to the economic stability of the farm. K. Jha *et al.* (2019) noted the importance of automating crop quality control through AI systems. AI's ability to identify problems at the stage of growing and harvesting helps to improve product quality, which is important for market-oriented agricultural enterprises.

L. Chen *et al.* (2023) investigated the effectiveness of AI technologies in reducing the risks associated with changes in weather conditions. AI helps to quickly adapt to unfavourable weather factors, which helps to avoid significant crop losses and maintain production stability. İ. Yağ & A. Altan (2022) analyse the benefits of AI in the selection of plant protection products. This allows reducing the use of chemicals and, at the same time, ensures high efficiency of crop protection, which has a positive impact on the environmental and economic performance of the enterprise.

S.A. Bhat & N.-F. Huang (2021) show how the use of big data and AI technologies allows agricultural enterprises to plan yields under different climatic conditions. This provides more accurate forecasts and stable financial performance, which helps minimise risks in the agricultural sector. M.J. Usigbe *et al.* (2024) noted that AI technologies make the agricultural sector more resilient to environmental and economic challenges. It helps to reduce losses, improves resource management, and increases the economic efficiency of agricultural enterprises, which is especially important for the long-term development of the industry.

Thus, researches demonstrate the effectiveness of using AI to predict land use changes, particularly in the agricultural sector. An important aspect is the forecasting of land degradation, changes in water resources, and the impact of anthropogenic activities on protected areas. Therefore, researching effective AI-based solutions for monitoring and managing these processes is key to ensuring sustainable development of the agricultural sector and conservation of natural resources. However, the use of AI to increase economic efficiency in the agricultural sector remains insufficiently studied. Also, the impact of integrated AI algorithms on land use management, taking into account climate conditions, has not yet been fully investigated.

The purpose of the study was to analyse the application of AI to improve the economic efficiency of land use management in the agricultural sector. The main tasks include: analysing AI capabilities for yield forecasting; researching AI algorithms, including machine learning, adapted to the needs of the agricultural sector; developing recommendations for optimising land use processes.

▸ Materials and methods

The study on the application of AI to improve the economic efficiency of land use management in the Ukrainian agro-industrial complex used various methodological approaches and materials to analyse the impact of innovative technologies on agricultural productivity and its resilience to environmental challenges. Firstly, secondary data from the State Statistics Service of Ukraine (n.d.) was used to collect data on the state of the agricultural sector, which provided information on the yields of major crops in Ukraine for the period 2017-2023. This data allowed to analyse the yield dynamics, identify the main trends, and identify the need to optimise agronomic practices, in particular in the context of AI implementation. Google Colab was used to forecast the yields of major crops for the period 2024-2028, which allowed the company to consider historical data and model various development scenarios. For this purpose, a model was considered that included optimistic, moderate and pessimistic scenarios that provided for different rates of growth or decline in yields depending on expected conditions and possible changes in the industry.

The study also examined big data analytics, which allows for the analysis of data on the condition of agricultural land, in particular using satellite images and sensor data. In addition, to assess the impact of the introduction of the latest technologies on the economic efficiency of agricultural enterprises, comparative analyses were conducted on the example of specific companies that have implemented AI-based solutions. Projects and platforms that demonstrate practical experience in implementing innovative technologies to improve the efficiency of land use and agriculture were also reviewed. In particular, considerable attention was paid to IBM's Watson solution, which uses AI to analyse large amounts of agricultural and climate data. Precision Agriculture, a platform that implements the concept of precision farming by using sensor data, satellite images, and GPS navigation, was also discussed. Smart Farming project, which provides comprehensive real-time monitoring of agricultural land. Agreena, which focuses on the implementation of carbon farming principles, in particular on approaches that help reduce the carbon footprint of the agricultural sector. Agrilab, which provides opportunities for detailed soil analysis to increase yields.

Another important aspect of the study was the environmental factors associated with changes in land use. The analysis of changes in natural landscapes, land degradation, and water pollution made it possible to identify the main environmental risks arising from intensive land exploitation. AI technologies were assessed in terms of their potential to reduce the negative impact on the environment, in particular by increasing the efficiency of natural resources use. As a result, the key recommendations for the implementation of AI in land management were considered, including the need to create an infrastructure for data collection and processing, development and implementation of machine learning algorithms, and training of agricultural enterprises' personnel.

▸ Results

The introduction of AI in the agricultural sector opens up new horizons for improving economic efficiency, which is manifested in a number of key aspects. AI enables accurate assessment and monitoring of agricultural land. The use of algorithms to analyse data from satellites and sensors allows farmers to determine the need for fertilizers, irrigation and other resources, which leads to lower input costs and higher yields. Machine learning technologies allow to analyse which crops are best suited to specific growing conditions, which optimises crop rotations and improves overall productivity. By predicting the best time for sowing and harvesting, farmers can increase their output.

In addition, AI helps to optimise water and fertilizer use through precise irrigation and nutrient application. Systems using AI algorithms can automatically adjust the supply of water and fertilizers depending on soil conditions and plant needs, which not only reduces costs but also reduces the negative impact on the environment (Talaviya *et al.*, 2020). Big data analytics and predictive models can also optimize the processing and storage of products, allowing farmers to better plan production and avoid surpluses, which reduces storage costs and prevents losses.

Another important aspect is increasing resilience to climate change. AI allows farmers to respond more quickly to extreme weather conditions, which helps ensure crop safety and reduce economic risks associated with unstable weather conditions. Studies show that businesses that implement AI technologies have higher profitability. By increasing the efficiency of resource use and improving product quality, farmers can earn more income, which has a positive impact on their competitiveness (Leal Filho *et al.*, 2022).

The introduction of the latest technologies, such as drones for field monitoring, robotic harvesting systems, and automated enterprise management solutions, creates new opportunities for optimising business processes, which not only reduces costs but also increases overall productivity. Thus, the use of AI in agriculture not only increases economic efficiency but also ensures sustainable development of agriculture, reducing its negative impact on the environment (Vrochidou *et al.*, 2022). Innovative technologies are becoming an important tool in addressing the challenges faced by the agricultural sector in the modern world. The environmental aspects of land use play a critical role in ensuring sustainable development, as proper management of natural resources can maintain ecological balance and prevent negative consequences associated with anthropogenic activities. The main environmental issues related to land use include landscape change, land degradation, water management and the impact of urbanisation (Vyshnevska *et al.*, 2022; Fedorchuk *et al.*, 2024).

Changing natural landscapes is one of the most obvious problems. Intensive agricultural production, urbanisation, and industrial activities lead to the destruction of natural ecosystems such as forests, marshes, and prairies, which in turn leads to biodiversity loss as many plant and animal species lose their natural habitats (Wang *et al.*, 2021). The use of land for agriculture is often accompanied by the drainage of marshes and deforestation, which has serious consequences for ecosystems. Land degradation is another important problem that arises from the mismanagement of agricultural land. It can manifest itself in the form of erosion, reduced soil fertility, salinity, and pollution. The intensive use of fertilizers and pesticides leads to soil and water pollution, which negatively affects ecosystems and human health (Hossain *et al.*, 2020). Without proper control and remediation, such processes can lead to a significant reduction in land productivity and threaten food security.

Proper water management is critical to ensuring sustainable land use. Improper irrigation and pollution of water sources can lead to water shortages, which can negatively affect agricultural production. Water consumption without consideration of natural resources leads to groundwater depletion, degradation of reservoirs and deterioration of water quality. Due to global climate change affecting precipitation patterns, it is important to develop adaptive strategies for the efficient use of water in agriculture (Srivastav *et al.*, 2021).

Anthropogenic activities, including urbanisation, industry and agriculture, have a significant impact on ecosystems and the environment. Population growth and urban expansion lead to increased demand for land for housing, infrastructure, and agriculture, which leads to competition for resources, degrading environmental quality (Prakash & Verma, 2022). In particular, urbanisation is often accompanied by air and water pollution, which has serious consequences for human health and ecosystems. Biodiversity conservation is an important aspect of environmental management.

Shrinking areas of natural habitats and the use of one-sided agricultural technologies lead to the loss of species diversity. Declining biodiversity reduces the resilience of ecosystems to climate change and other environmental stresses, which threatens the ecological balance and sustainability of agricultural production. Thus, environmental aspects of land use are critical to achieving sustainable development (Li *et al.*, 2020). Effective management of natural resources, biodiversity conservation, and development of adaptive strategies to climate change are key tasks to ensure balanced land use, reduce negative environmental impact, and increase the efficiency of the agricultural sector.

AI is being actively implemented in agriculture to reduce the negative impact on ecosystems, preserve soil and biodiversity, and reduce greenhouse gas emissions. For example, companies such as IBM with its Watson project use AI to analyse data on soil conditions, weather, and water resources. This allows farmers to optimise the use of water and fertilizers, which reduces the likelihood of soil weathering and water pollution. Another example is platforms such as Precision Agriculture, which use machine learning algorithms to predict yields based on historical data and growing conditions. This helps farmers make informed decisions about sowing and harvesting, reducing waste and resource use, which reduces pressure on ecosystems.

The Smart Farming project has developed solutions that use drones and computer vision to identify threatened plant and animal species. This helps agronomists plan crop rotations and use ecological management practices to preserve biodiversity on farms. Using AI to analyse crop rotation data allows farmers to develop more sustainable practices that reduce the need for chemical fertilizers. For example, farmers can receive recommendations on how to change crops in their fields, which helps preserve soil structure and increase fertility. Companies such as Agreena are also using AI to assess the environmental impact of agricultural practices. This allows farmers to better understand how their actions affect CO_2 emissions and other factors contributing to climate change, and to adapt their practices according to the data obtained. Thus, the introduction of AI in agriculture not only increases production efficiency, but also helps to reduce negative environmental impact, conserve biodiversity, and improve soil health (Busse *et al.*, 2021).

In Ukraine, the use of AI in the agricultural sector is growing rapidly, as farmers are actively looking for new solutions to improve production efficiency, optimise costs, and conserve natural resources. Agricultural enterprises are increasingly implementing precision farming technologies based on the analysis of large amounts of data obtained from satellite images, drones, and soil sensors. These technologies allow for detailed monitoring of the condition of fields and plants, determination of moisture levels, soil micronutrient content, forecasting yield potential, and more precise resource management.

One example of how AI is being used is the AgriLab platform, which implements analytics to optimise the use of water, fertilizers and plant protection products, helping to reduce farmers' costs and minimise negative environmental impact. Based on the analysis of long-term data, the platform recommends the most effective irrigation and fertilization schemes, which helps to achieve stable yields even in the face of climate change. In addition, the Ukrainian market actively supports start-ups specialising in the development of machine learning solutions. These start-ups offer innovative tools for yield forecasting, risk analysis, and real-time monitoring of crops. By using AI algorithms, agricultural companies can more accurately predict plant nutrient requirements and detect stressors such as diseases or pests in a timely manner, which helps reduce crop protection costs while ensuring a high level of environmental safety.

Overall, the introduction of AI in Ukraine's agricultural sector not only increases efficiency and productivity, but also contributes to more sustainable development. This is especially important in the context of current challenges, such as soil depletion, climate change, and the effects of war, which make it difficult to maintain high yields without harming ecosystems. AI technologies enable Ukrainian farmers to create more environmentally responsible and cost-effective farming practices that are focused on long-term sustainability and food security. Table 1 shows Ukraine's yields over the past 7 years.

Table 1. Crop yield in Ukraine for 2017-2023, c/ha

Year	2017	2018	2019	2020	2021	2022	2023
Grain and legume crops	42.5	47.4	49.1	42.5	53.9	45.8	55.2
Potato	168	171	155	157	166	174	177
Vegetable crops	208	214	214	207	215	200	209
Sunflower	20.2	23	25.6	20.2	24.6	21.6	24.5

Source: developed by the authors based on State Statistics Service of Ukraine (n.d.)

Different crops show different dynamics, which indicates the need to optimise agronomic practices. In particular, the decline in soybean and rapeseed yields observed in studied years may be the result of environmental factors or insufficient implementation of innovative technologies, including AI, to manage these crops. This suggests that AI should be more actively used to monitor plant health and adapt agronomic measures to environmental conditions.

At the same time, the high yields of potatoes and fodder sunflower demonstrate the potential for using precision farming technologies, which can lead to increased productivity. For example, the introduction of AI-based systems to predict yields and optimise inputs could significantly improve outcomes for less productive crops. As climate change and environmental conditions directly affect yields, the use of AI-powered analytical tools will help farmers respond to challenges and adapt their strategies more quickly, which will generally contribute to the economic efficiency of the agricultural sector (Shebanina *et al.*, 2024). To create a forecast table of yields of major crops in Ukraine for the period of 2025-2028, Google Colab AI methods were used to take into account historical data and model various development scenarios. Machine learning was used to analyse past trends and generate forecasts for three main scenarios: optimistic, moderate, and pessimistic. Each scenario considers different levels of annual yield growth or decline depending on expected conditions and possible changes in the industry. Table 2 shows the yield forecasts for different climate scenarios for 2025-2028, c/year.

Table 2. Yield forecasts for different climate scenarios for 2025-2028, c/ha

Year	2025	2026	2027	2028
Optimistic scenario				
Grain and legume crops	58.68	61.45	63.17	66.09
Potato	185.75	192.39	200.46	208.00
Vegetable crops	220.58	228.06	235.06	243.00
Sunflower	26.18	27.29	29.31	30.23
Moderate scenario				
Grain and legume crops	56.19	58.51	59.86	61.25
Potato	180.00	185.06	190.08	195.09
Vegetable crops	215.19	220.06	225.01	230.60
Sunflower	25.19	26.98	26.52	27.29
Pessimistic scenario				
Grain and legume crops	53.77	52.15	51.00	50.86
Potato	170.30	165.29	160.22	155.17
Vegetable crops	210.01	205.67	200.04	195.68
Sunflower	24.03	23.73	23.33	22.00

Source: developed by the authors using Google Colab

The optimistic scenario envisages a significant increase in yields for the major crops, with grain and legume crops reaching 66.09 c/ha by 2028, an increase of 21% compared to the 2023 yield of 55.2 c/ha. Similarly, potato yields are expected to rise to 208.00 c/ha, a 17% increase from 177 c/ha in 2023. Vegetable crop yields are projected to grow by 16% to 243.00 c/ha, and sunflower yields are forecast to reach 30.23 c/ha, a 25% increase from 24.5 c/ha in 2023. The moderate scenario takes a more conservative approach with moderate growth across all crop types. Grain and legume crops are expected to reach 61.25 c/ha by 2028, marking a 10% increase from the 2023 yield. Potato yields are projected to grow by 10% to 195.09 c/ha, while vegetable crops are anticipated to increase by 10% to 230.60 c/ha. Sunflower yields are expected to grow by 10% to 27.29 c/ha by 2028. The pessimistic scenario envisages a decline or slower growth in yields, with grain and legume crops decreasing by 9% to 50.86 c/ha by 2028. Potato yields are expected to fall by 12% to 155.17 c/ha, while vegetable crop yields are anticipated to decrease by 7% to 195.68 c/ha. Sunflower yields are also projected to decrease by 8% to 22.00 c/ha by 2028.

These forecasts provide essential insights for long-term strategic planning, helping the agricultural sector prepare for different scenarios and optimise land use management, ultimately improving the economic efficiency and sustainability of Ukraine's agro-industrial complex. For the effective implementation of AI in land use management in Ukraine's agricultural sector, several key recommendations should be considered. It is important to ensure proper infrastructure for data collection and processing, which involves investing in modern technologies such as drones, satellite monitoring systems, and Internet of Things sensors for measuring soil and climate parameters. This will allow to collect the necessary data for analysis and decision-making. It is worth focusing on the development and implementation of machine learning algorithms that can process large amounts of data and offer insights into optimising resource use, crop selection, yield forecasting and risk management (Shebanin *et al.*, 2024; Mema *et al.*, 2024).

Agribusinesses should provide training and upskilling of their employees in data and AI, as this will allow them to make the most of new technologies and adapt to the changing environment. The fourth recommendation is to develop partnerships between agribusinesses, research institutions, and technology start-ups, which will allow for joint projects, experience sharing, and innovation (Hafiyya *et al.*, 2024). It is also important to take into account the environmental aspects of AI implementation, ensuring sustainable development of the agricultural sector and reducing the negative impact on ecosystems. As part of this, agricultural companies should actively implement environmental regulations and standards that would encourage the conservation of natural resources and biodiversity. Finally, state support, in particular in the form of subsidies for the introduction of AI technologies, can significantly contribute to the development of innovations in the agricultural sector, ensuring the competitiveness of Ukrainian producers in the international market. Implementation of these recommendations can be the key to successful integration of AI into land use management, which in turn will have a positive impact on the productivity and sustainability of Ukraine's agricultural sector.

▸ Discussion

This section discusses the results of a study on the introduction of AI in the agricultural sector to improve economic efficiency and ensure sustainable development. The findings show that the use of AI allows for accurate monitoring and assessment of land conditions, which enables farmers to use resources more efficiently and optimise fertilizer and irrigation costs. Modern algorithms for processing big data collected by satellites and sensors help farmers better understand the needs of crops and increase their yields.

In particular, predicting the optimal timing of sowing and harvesting makes a significant contribution to economic efficiency, allowing farmers to increase production. Optimising water and fertilizer use through precise irrigation and nutrient application methods also helps to reduce costs and minimise negative environmental impact. These results correlate with the findings of other authors, who emphasise the benefits of precision agriculture technologies in production planning and avoiding surpluses. V. Vidric *et al.* (2023) focused on analysing the economic benefits of precision agriculture. They found that the use of AI in irrigation management could reduce costs and improve crop quality. These results are in line with current research on the efficient use of water and fertilizer, but it was noted that the economic impact could be lower in conditions of poor resource management.

In the study by I. Laktionov *et al.* (2023), the authors analysed in detail the impact of AI on grain yields. The authors focused on the use of drones to monitor crops, which allowed not only to increase productivity but also to reduce losses at the stages of growing and harvesting. The findings are consistent with current research findings, confirming that optimisation technologies contribute to the rational use of resources, increasing the overall productivity of agricultural enterprises. The environmental aspects of land use management are an integral part of the discussion, as biodiversity conservation and proper use of natural resources ensure the sustainability of agriculture. Based on the analysis of Ukrainian agricultural enterprises, it was found that precision farming technologies are already being actively used, which allows for a reduction in the use of chemical fertilizers and minimises the impact on ecosystems. For example, yield prediction platforms allow farmers to make informed decisions about planting crops, reducing costs and ecosystem impact.

To better understand environmental performance, this study applies a yield forecasting model based on climate change scenarios. This approach allows to assess potential threats to production and develop measures to neutralise them. In his work, O.B. Akintuyi (2024) emphasised the importance of environmental aspects of land management. He argued that without proper management of natural resources, even the most advanced technologies can be ineffective. This is in line with current findings that have pointed out that AI can compensate for governance shortcomings if applied correctly. J.A. Aznar-Sánchez *et al.* (2019) also investigated sustainable land use practices in the context of climate change. They found that farmers who used AI to analyse soil data earned more income by reducing the risk of losses due to extreme weather events. These findings are in line with current findings on increasing climate resilience.

H. Dadashpoor *et al.* (2019) studied the impact of AI on key microeconomic indicators of agricultural enterprises, including profitability and market position. The study showed that enterprises that actively integrated AI into management and forecasting processes significantly improved their competitiveness, especially in international markets. This is in line with current findings, as it confirms the significant contribution of technology to improving the economic stability and competitive advantage of agricultural companies.

For a deeper understanding of the impact of AI on the economic efficiency of the agricultural sector, it is also important to take into account specific aspects such as access to information technology and the level of education of farmers. The adoption of AI technologies can be hampered by insufficient infrastructure in rural areas or limited access to the Internet, which hinders the potential for innovation. C. Feijóo *et al.* (2020) drew attention to the role of government support in the adaptation of AI in the agricultural sector. They believed that without financial support and infrastructure development, the effectiveness of AI adoption would be limited. This differed from the results of the previous survey, which focused more on the need for farmers to organise themselves and to adopt innovative approaches.

An important aspect of the introduction of new technologies in the agricultural sector is the willingness of farmers to adapt to modern management methods, which often requires a change in traditional approaches to farming. The use of AI provides for more accurate planning and forecasting, which can significantly increase the efficiency of crop cultivation and processing costs. However, the success of implementing the latest technologies depends not only on the availability of AI, but also on the ability of farmers to use these tools, interpret data, and adapt management decisions based on the forecasts. W. Leal Filho *et al.* (2022) examined how the impact of AI can affect farmers' total costs in the context of production. They concluded that farmers who use AI to predict product prices can significantly reduce the risks associated with unpredictable market fluctuations. The current research findings show that AI does indeed help reduce costs, but it is important to take into account the limited technical capabilities of small and medium-sized farms, lack of awareness of technology, and the lack of proper infrastructure that would allow for the integration of AI into all stages of production.

Investments in AI in the agricultural sector can have a significant impact on productivity, efficiency, and food safety. M. Ryan (2023) emphasised that, despite the significant initial costs, investments in AI technologies pay off within three years on average, especially if resources are properly managed, which can accelerate this process even in conditions of market volatility. At the same time, J. Azizi (2024) pointed out that the use of AI in the agricultural sector contributes to increased production, which has a positive impact on food security, especially in regions where there are risks of food shortages. Thus, the introduction of AI not only increases the competitiveness of agricultural enterprises, but also ensures stability and security in the face of climate change, which underscores the importance of farmers' readiness to adapt new approaches to efficient resource management and improve the economic sustainability of the agricultural sector.

In general, it is important to introduce AI in the field of agricultural production, which not only increases economic efficiency but also contributes to the sustainable development of the industry. Research shows that the use of AI technologies enables farmers to use resources rationally, optimise fertilizer and irrigation costs, and increase productivity by accurately monitoring land conditions and predicting the optimal time for sowing and harvesting. In particular, the use of AI-based systems, such as yield forecasting platforms, allows for more efficient production planning, reducing costs and environmental impact.

▸Conclusions

The study results confirm that the introduction of AI in the Ukrainian agro-industrial complex can significantly increase the economic efficiency of agricultural production and ensure the sustainable development of the industry. In particular, the use of AI technologies helps to optimise the use of resources, such as fertilizers, water, and pesticides, thanks to the ability to accurately monitor and forecast. The use of predictive models to determine the optimal timing of sowing and harvesting allows farmers to achieve stable production volumes even in the face of climate instability. Projects such as Watson, Precision Agriculture, Smart Farming, Agreena and Agrilab have become important elements of the analysis. They have demonstrated how innovative solutions based on AI data and algorithms can optimise crop cultivation processes, reduce input costs, and improve crop quality and yield. In particular, the Precision Agriculture and Smart Farming projects use technologies that allow farmers to obtain accurate data on field conditions, predict yields, and control resource consumption, which significantly increases the economic efficiency of production.

The study of crop yields in Ukraine for 2017-2023 analysed their dynamics and considered yield forecasts for different climate scenarios for 2025-2028. The importance of this study is driven by the rapid development of technologies and their ability to significantly increase agricultural productivity, which, in turn, contributes to the country's food security. Based on the results obtained, it can be argued that the introduction of AI in the agricultural sector of Ukraine is not only appropriate, but also necessary to ensure sustainable agricultural development. Given the predictions of climate change and the growing need for food, it is important to continue research in this area to identify new opportunities for increasing productivity. A limitation of the study is the use of historical data, which may not take into account possible abrupt changes in climate and economic factors that affect yields. Further research could focus on integrating more accurate climate models and considering regional specifics to improve the accuracy of forecasts.

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▸Conflict of interest

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Застосування штучного інтелекту для підвищення економічної ефективності управління землекористуванням в агропромисловому комплексі

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▸ **Анотація.** Метою дослідження була оцінка економічної ефективності використання штучного інтелекту (ШІ) для прогнозування екологічних змін у землекористуванні та оптимізації аграрного виробництва. Визначено, що впровадження алгоритмів машинного навчання та аналізу великих даних може значно покращити точність прогнозів щодо стану сільськогосподарських земель, оптимізувати використання ресурсів, зокрема добрив і води, та знизити витрати. Проаналізовано, як застосування ШІ може сприяти більш раціональному вибору культур і плануванню посівів та збирання врожаю, що позитивно впливає на врожайність. Додатково, у дослідженні розглянуто екологічний аспект: використання ШІ дозволяє зменшити негативний вплив на довкілля завдяки точному управлінню ресурсами та зниженню забруднення ґрунтів і водних ресурсів. Робота включала моделювання врожайності для різних кліматичних сценаріїв, що дозволяє прогнозувати можливі результати та розробляти адаптивні стратегії для стабільного розвитку агропромислового комплексу України. Дослідження продемонструвало, що впровадження ШІ в агропромисловий сектор України сприяє підвищенню ефективності землекористування, дозволяючи фермерам оперативніше реагувати на змінні кліматичні умови. За допомогою алгоритмів машинного навчання, зокрема на основі аналізу даних, зібраних із супутникових знімків і сенсорів, можна своєчасно визначати потребу рослин у добривах та воді, що забезпечує раціональне використання ресурсів і знижує виробничі витрати. Моделі прогнозування, застосовані у статті, відображають можливі сценарії врожайності на період 2025-2028 років для різних кліматичних умов, що дозволяє підприємствам краще планувати агротехнічні заходи та мінімізувати ризики. Таким чином, результати дослідження підкреслюють важливість ШІ як інструмента для довгострокового стратегічного планування в аграрному секторі

▸ **Ключові слова:** прогнозування врожайності; сільське господарство; аналіз даних; інновації; машинне навчання