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ARTIFICIAL INTELLIGENCE IN AGRICULTURE: STUDY OF MODERN TRENDS

АУЫЛ ШАРУАШЫЛЫҒЫНДАҒЫ ЖАСАНДЫ ИНТЕЛЛЕКТ: ЗАМАНАУИ ТРЕНДТЕРДІ ЗЕРТТЕУ

ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ В СЕЛЬСКОМ ХОЗЯЙСТВЕ: ИССЛЕДОВАНИЕ СОВРЕМЕННЫХ ТРЕНДОВ

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Abstract. The increase in population and increasing burden on food production characterize the formulation of issues of increasing efficiency of agriculture and ensuring food security as particularly in demand and requiring urgent solutions. Artificial intelligence (AI) technologies are capable of making significant contribution to optimization of agricultural processes. *The goal* - is to determine priority areas of research into scientific interests in cybernetic devices in agro-industrial complex. *The methods* are based on systematic literature review of the works of domestic and foreign scientists using the Biblioshiny software package for the use of intelligent systems, computer modeling of various intelligence capabilities in agricultural sector. *The results* showed noticeable increase in the level of knowledge in the field of computer skills to imitate human actions. Thanks to machine methods, farmers can get the opportunity to modernize their farms and improve quality of their products. Taking into account the factors affecting crop yields, neural networks build accurate forecasts, helping to make the right decisions in planning and management process in agro-industrial complex. With the help of technologies, such operations as sowing, weeding, weed control, and harvesting are automated. Works controlled by "smart machines" maximize labor productivity and reduce labor costs. It has become popular to practice AI in growing grain crops, in vegetable growing, precision farming to reduce water consumption for irrigation, forecasting gross harvest, as well as animal husbandry, for example, in cattle breeding and feeding. *Conclusions* - the number of publications on the topic under study has increased significantly

over the past eight years. It is noted that in the near future, the synergy effect of artificial intelligence with genetic engineering, biotechnology and nanotechnology will become widespread. The popularity of digital intelligence is due to high results, rationalization of human labor. To ensure competitiveness and obtain the necessary profit in agricultural formations, the use of AI technologies is inevitable. This publication will be useful for agricultural specialists, as well as scientists and researchers involved in computer programming and artificial intelligence modeling.

Аңдатпа. Халық санының артуы және азық-түлік өндірісіне жүктеменің артуы ауыл шаруашылығының тиімділігін арттыру және азық-түлік қауіпсіздігін қамтамасыз ету мәселелерін ерекше сұранысқа ие және тез арада шешуді талап етеді. Ауылшаруашылық процестерін оңтайландыруға айтарлықтай үлес қоса алатын жасанды интеллект (AI) технологиялары. *Мақсаты* - агроөнеркәсіптік кешендегі кибернетикалық құрылғыларға ғылыми қызығушылықтарды зерттеудің басым бағыттарын анықтау. *Әдістері* - интеллектуалды жүйелерді пайдалану, аграрлық сектордағы интеллекттің әртүрлі қабілеттерін компьютерлік модельдеу үшін Biblioshiny бағдарламасының пакетін қолдана отырып, отандық және шетелдік ғалымдардың еңбектеріне жүйелі әдеби шолуға негізделген. *Нәтижелері* - адамның іс-әрекетіне еліктеу үшін компьютерлік дағдылар саласындағы білім деңгейінің айтарлықтай өскенін көрсетті. Машиналық әдістердің арқасында фермерлер шаруашылықты модернизациялауға және өнім сапасын жақсартуға мүмкіндік алады. Өнімділікке әсер ететін факторларды ескере отырып, нейрондық желілер АӨК жоспарлау және басқару процесінде дұрыс шешім қабылдауға көмектесетін нақты болжамдар жасайды. Технологияның көмегімен егу, арамшөптерді жою, арамшөптермен күресу, егін жинау сияқты операциялар автоматтандырылады. «Ақылды машиналар» басқаратын жұмыстар еңбек өнімділігін арттырады және еңбек шығындарын азайтады. Суару кезінде суды тұтынуды азайту, жалпы жинауды болжау, сондай-ақ мал шаруашылығы, мысалы, мал өсіру және азықтандыру үшін астық өсіруде, көкөніс өсіруде, дәл егіншілікте IT тәжірибесімен айналысу танымал болды. *Қорытынды* - соңғы сегіз жыл ішінде зерттелетін тақырып бойынша жарияланымдар саны едәуір өсті. Жақын арада гендік инженериямен, биотехнологиялармен және нанотехнологиялармен жасанды интеллект синергиясының әсері кең таралатыны атап өтілді. Сандық ақыл-ойдың танымалдығы жоғары нәтижелерге, адам еңбегін ұтымды етуге байланысты. Бәсекеге қабілеттілікті қамтамасыз ету және агроқұрылымдарда қажетті пайда алу үшін IT технологияларын қолдану сөзсіз. Бұл басылым ауылшаруашылық саласының мамандарына, сондай-ақ компьютерлік бағдарламалау және жасанды интеллектті модельдеу мәселелерімен айналысатын ғалымдар мен зерттеушілерге пайдалы болады.

Аннотация. Увеличение численности населения и возрастающая нагрузка на производство продуктов питания характеризуют постановку вопросов повышения эффективности сельского хозяйства и обеспечения продовольственной безопасности как особо востребованных и требующих скорейшего решения. Технологии искусственного интеллекта (ИИ) способных внести значительный вклад в оптимизацию сельскохозяйственных процессов. *Цель* – определение приоритетных направлений исследования научных интересов к кибернетическим устройствам в агропромышленном комплексе. *Методы* основываются на системном литературном обзоре трудов отечественных и зарубежных ученых с применением пакета программы Biblioshiny для использования интеллектуальных систем, компьютерного моделирования различных способностей интеллекта в аграрном секторе. *Результаты* показали заметный рост уровня знаний в сфере компьютерных навыков имитировать человеческие действия. Благодаря машинным методам фермеры могут получить возможность модернизировать хозяйство и улучшить качество продукции. Учитывая факторы, влияющие на урожайность, нейронные сети строят точные прогнозы, помогая принимать правильные решения в процессе планирования и управления в АПК. С помощью технологий автоматизируются такие операции, как посев, прополка, борьба с сорняками, уборка урожая. Работы, управляемые «умными машинами» максимизируют производительность труда и сокращают затраты на рабочую силу. Стало популярным практиковать ИИ на выращивании зерновых культур, в овощеводстве, точном земледелии для снижения потребления воды при орошении, прогнозировании валового сбора, а также животноводстве, например, в разведении и кормлении скота. *Выводы* – последние восемь лет значительно возросло количество публикаций по изучаемой теме. Отмечается, что в ближайшей перспективе получит распространение эффект синергии искусственного интеллекта с генной инженерией, биотехнологиями и нанотехнологиями. Популярность цифрового разума обусловлена высокими результатами, рационализацией человеческого труда. Для обеспечения конкурентоспособности и получения необходимой прибыли в агроформированиях применение технологий ИИ неизбежно. Данная публикация будет полезна специалистам сельскохозяйственной отрасли, а также ученым и

исследователям, занимающимся проблемами компьютерного программирования и моделирования искусственного интеллекта.

Keywords: agro-industrial complex, artificial intelligence, growth of scientific interests, crop production, livestock farming, productivity, competitiveness, profitability, ensuring food security.

Түйінді сөздер: агроөнеркәсіптік кешен, жасанды интеллект, ғылыми қызығушылықтардың өсуі, өсімдік шаруашылығы, мал шаруашылығы, өнімділік, бәсекеге қабілеттілік, табыстылық, азық-түлік қауіпсіздігін қамтамасыз ету.

Ключевые слова: агропромышленный комплекс, искусственный интеллект, рост научных интересов, растениеводство, животноводство, производительность, продуктивность, конкурентоспособность, доходность, обеспечение продовольственной безопасности.

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Introduction

The modern world is witnessing a new technological revolution related to the use of artificial intelligence in all sectors of the economy and, in general, in society. Experts attribute the rapid spread of artificial intelligence not only to the direct economic effect that it is already demonstrating at this stage, but also to the fact that artificial intelligence technologies themselves are subject to continuous improvement. Today, experts note that technologies such as deep machine learning and neural network training, generative artificial intelligence and natural language processing are able to demonstrate high efficiency in production processes, management, and partially replace the creative component of human thinking. It can clearly be argued that artificial intelligence is capable of making fundamental qualitative changes in the agricultural sector, as evidenced by numerous publications in leading foreign journals.

The agricultural sector is traditionally a key priority sector of the economy of Kazakhstan, which is associated with its geographical and historical features, therefore, the use of the advantages of artificial intelligence in the agricultural production of our country seems logical and economically feasible. First of all, slightly less than half of the population of Kazakhstan continues to live in rural areas, while their activities are directly related to and depend on the seasonality of production processes.

As noted by the country's authorities, “almost 40% of the country's population lives in 6 256 rural settlements. That's 7.6 million people. The share of the rural population with incomes below the subsistence level is 7.2%, while the unemployment rate is 4.7%, and the self–employed is 33% or 1.2 million people” (Improving the quality of life…) [1]. It is also important that Kazakhstan is one of the largest producers of wheat, a significant part of which is exported.

Thus, the important role of agriculture in the economy of Kazakhstan and the growing role of AI in this industry have determined the relevance of this study. The purpose of the article is to identify relevant areas of research, as well as the current state of scientific interests in the field of artificial intelligence in agriculture. The research question posed is "What are the possible main applications of AI technologies in agriculture?"

The structure of this article is as follows: the methodology of data collection and sampling is reflected in section Materials and methods, the results of the study and their discussion are presented in sections Results and Discussion. Last section presents the conclusion.

Literature review

Existing literature reviews on the topic of AI in agriculture contain either only descriptive analysis or only narrowly focused content analysis. For example, Oliveira R.C., Silva R.D. [2], based on a bibliometric analysis of 176 articles on the use of AI in agriculture, identified the most commonly used technologies such as machine learning, convolutional neural networks, the Internet of Things, big data, robotics, computer vision, as well as key agricultural sectors using AI. However, the review covers limited number of articles and does not contain co-occurrence network, trend topics.

Ruiz Real J., Uribe-Toril J., Torres J. et al. [3] use a bibliometric methodology to analyze the research trends of artificial intelligence in agriculture and define the most relevant and prolific authors, supporting research organizations and countries. Sarkar U., Banerjee G., Ghosh I. [4] conducted a trend analysis of the most popular AI technologies used in agriculture. The areas of application of AI technologies are such branches of agriculture as pest control, diseases, weeds, irrigation control, and yield forecasting. For instance, the machine

vision systems were mostly applied in a significant number of weed control cases.

Zhai Z., Martínez J.F., Beltran V. et al. [5] in his review provides insight into decision support systems in agriculture using AI technologies. Such systems are used to plan agricultural tasks, manage water resources, adapt to climate change, and control food waste. Talaviya T., Shah D., Patel N. et al. [6] has carried out a review of technologies that can reduce excessive consumption of water, pesticides and herbicides, maintain soil fertility, increase labor efficiency, productivity and quality of agricultural processes. The use of unmanned aerial vehicles for spraying and crop monitoring is discussed.

Ben Ayed R., Hanana M. [7] explored key areas of application of artificial intelligence and machine learning algorithms in the agricultural supply chain. In this case, machine learning technologies are used to predict crop yields, soil properties, and irrigation requirements, as well as for disease detection and weather forecasting. Particularly, AI allows to check defective crops and improve the potential for healthy crop production. Smagulova Sh.A.[8] analyzes the implementation of digitalization of land use in farms in the northern regions of Kazakhstan, in particular, the use of satellite navigation for rapid monitoring of crop maturation, irrigation levels, plant diseases, and online monitoring of sowing and harvesting operations.

Kulisz M., Duisenbekova A. [9] applied artificial neural networks (ANN) to predict agricultural yields in Kazakhstan, focusing on the effects of economic management and policy development. Accurate yield forecasts can facilitate agricultural planning and make a positive contribution to food security.

Materials and methods

The overall methodology is influenced by the need for a comprehensive and systematic approach to analyze literature on artificial intelligence in agriculture.

The method of systematic literature review, which contains a descriptive part and content analysis, was applied. The Aria M., Cuccurullo C. [10] was used for the descriptive part of the review. Such an approach is aimed at ensuring that the findings are robust, reproducible, and provide a clear picture of the current state of research in the field.

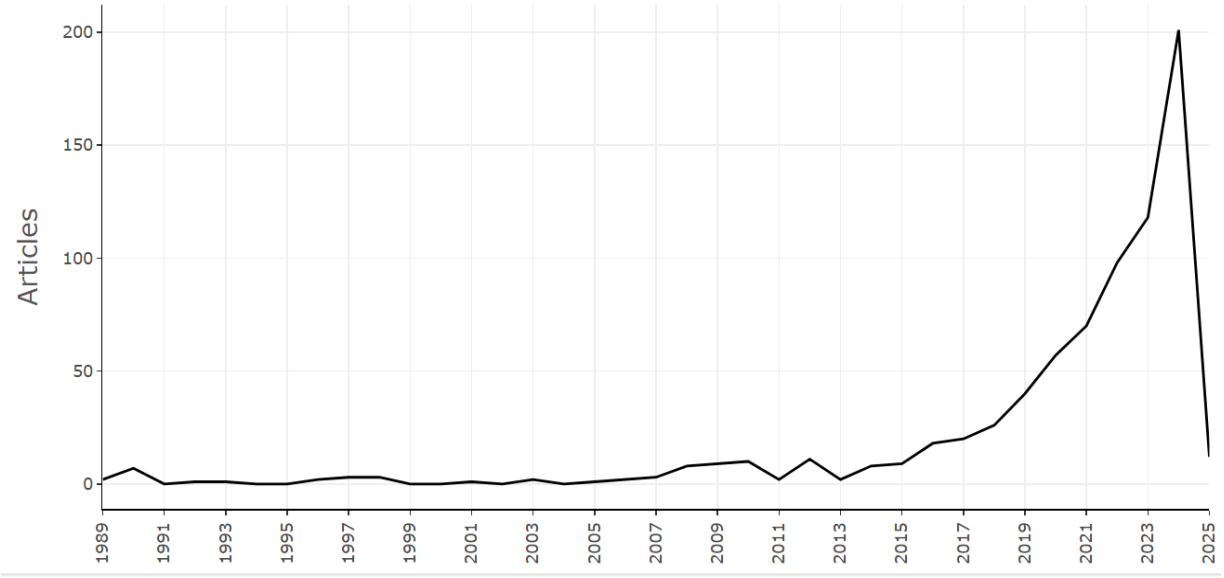
The initial search results in the context of the current study included articles published up to and including January 2025. Keywords such as “artificial intelligence" and "agriculture" were used as the main search query. The results obtained were limited to the thematic categories of business, management and accounting, the type of document "Article" or "Review" and the English language. As a result, 747 articles were selected, which were the focus of the descriptive analysis. This analysis includes several fundamental components, including the co-occurrence network and trend topics. A search query in the Scopus database was conducted based on the article title, abstract, and keywords. The Biblioshiny software was used for descriptive analysis. Subsequently, the second section of the review focuses on content analysis, which focuses on the 10 most relevant articles. This methodical approach ensures a comprehensive study of the existing literature.

Results

Annual publication productivity. An analysis of the annual publication productivity shows that up to and including 2007, there were almost no publications on the topic of AI in the agricultural sector, only in some years no more than 3 studies per year on this topic were published. In the period from 2008 to 2015, publication activity increased slightly, averaging about 8 studies per year. Since 2016, there has been a noticeable increase in scientific interest in the topic of AI in the agricultural sector: in 2016, twice as many articles were published as in 2015. And in 2024, publication activity exceeded that in 2023 by almost 2 times, amounting to 201 articles – as many as had not been published on this topic in all previous years (figure 1).

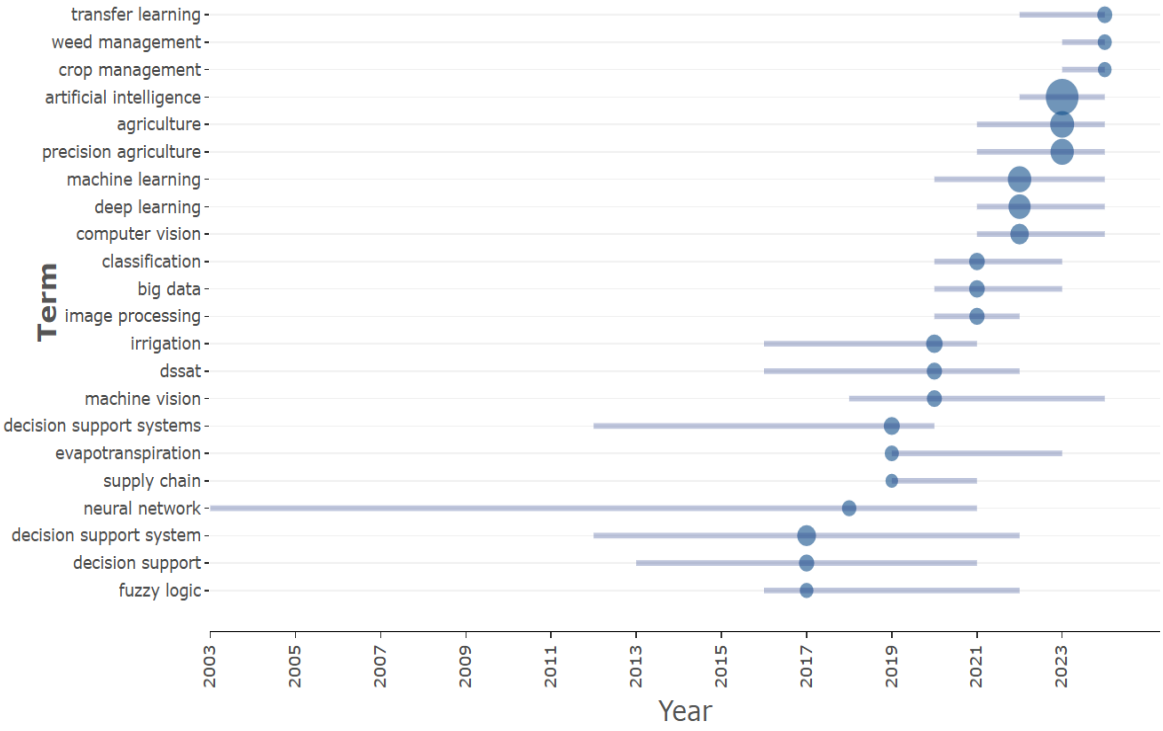
Trend topics. Figure 2 shows the trend topics in the field of artificial intelligence in the agricultural sector for the period from 2003 to 2024. Along with AI and agriculture, which are the core of the topic under study, precision farming has been a trend topic since 2021. Starting from 2019, machine learning and deep learning topics are gaining popularity. The fundamental topic that remained popular for 15 years, from 2003 to 2018, was the topic of neural networks. The topic of irrigation is important, since the frequency of occurrence of the corresponding keyword was 18. Decision support systems in agriculture, including through dynamic simulation, are also of scientific interest, reaching a peak in popularity in 2017-2020. Since 2024, the topics of crop management and weed control have become popular.

Co-occurrence Network. The Bibliometrix R package with the Biblioshiny tool was used to build a co-occurrence network. The author's keywords with the Walktrap clustering algorithm were used.



Note: received in the biblioshiny program

Figure 1 - Annual publication productivity



Note: received in the biblioshiny program

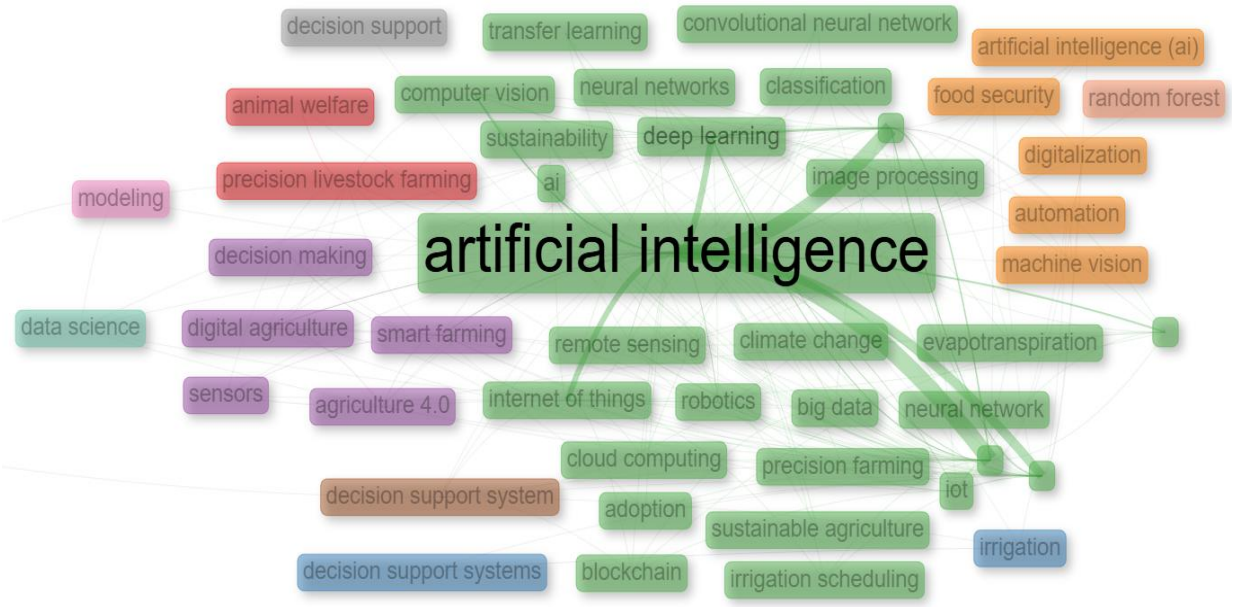
Figure 2 - Trending topics in the field of AI in the agricultural sector

The basic central and largest cluster is the artificial intelligence cluster. Within this cluster, such nodes as "agriculture", "precision farming" and "machine learning" are located close to the central node. The proximity of these nodes indicates a close relationship between these concepts. Technologies such as neural networks, blockchain, the Internet of Things, remote sensing, big data, robotics, computer vision, smart agriculture, and cloud computing are located in the same cluster. The location of these technologies within the AI cluster indicates the active use of these technologies in agriculture. The AI cluster also includes the keywords "evapotranspiration" and "irrigation planning".

These concepts are closely related and play an important role in managing water

resources and improving agricultural efficiency. The location of these concepts in the AI cluster indicates the significant role of AI technologies in water resource management and irrigation planning. The nodes of "sustainable agriculture", "sustainability" and "climate change" are also located within the central cluster of AI, which indicates the important role of AI in achieving the goals of sustainable development through the application of more effective practices of sustainable agriculture.

The next largest cluster is the Food Security cluster, which includes keywords such as automation, digitalization, machine vision, and AI. The "Smart Agriculture" cluster has been allocated to a separate cluster, containing such nodes as "Agriculture 4.0", "Digital Agriculture", "Sensors" and "Decision-making". A small but distinct cluster is the Precision Animal Husbandry cluster, which includes the keyword "Animal welfare." According to the co-occurrence network, the cluster "Precision animal husbandry" is closely related to keywords such as modeling, sensors, and smart agriculture (figure 3).



Note: received in the biblioshiny program

Figure 3 - Co-occurrence Network

Content analysis results. In addition to the descriptive bibliographic analysis, a content analysis was conducted. The period from 2016 to 2025 was used for content analysis, as a noticeable and steady increase in scientific interest in the topic of AI applications in agriculture began in 2016. This involved identifying the 10 most influential and relevant articles on the topic of artificial intelligence in agriculture, namely those with the highest overall citation rate. The list of 10 articles selected for content analysis is presented in table.

Zhai Z., Martínez J.F., Beltran V. et al. [5] examined the challenges associated with the application of agricultural decision support systems in Agriculture 4.0. In this article, a systematic literature review method is used to examine thirteen representative decision support systems, including their application to agricultural task planning, water resources management, climate change adaptation, and food waste control. A comprehensive assessment was conducted in terms of interoperability, scalability, availability, and usability.

Talaviya T., Shah D., Patel N. et al. [6] reviewed various applications of artificial intelligence in agriculture, such as irrigation, weeding, crop spraying and monitoring, yield mapping and monitoring using sensors and other means embedded in robots and unmanned aerial vehicles. These technologies help to avoid excessive use of water, pesticides, herbicides, maintain soil fertility, and also help to use labor efficiently, increase productivity, and improve product quality. The article also discusses various methods used by unmanned aerial vehicles for spraying and crop monitoring

Kakani V., Nguyen V.H., Kumar B.P. et al. [11] provides insight into modern artificial intelligence and computer vision technologies that can help farmers in agriculture and the food industry. In particular, the review examines computer vision and intelligent analysis methodologies that are used in several fields of agriculture, such as the food industry, agricultural-

based applications, plant data analysis, and intelligent irrigation. The authors also consider in detail startups based on artificial intelligence and computer vision used in the agricultural food industry.

Paymode A.S., Malode V.B. [12] proposed a neural network model for classifying sick and healthy leaves using the example of grapes and tomatoes. As part of the study, the effectiveness parameters of the proposed model, such as accuracy, sensitivity, and specificity, were calculated and monitored. To identify and analyze leaf diseases, a deep learning convolutional neural network (CNN) model was used to classify images of healthy and diseased leaves. The methods of data augmentation, dataset preprocessing, training, and testing were applied to the neural network model. Thus, the model proposed by the authors increased the accuracy of classification of diseased and healthy leaves for grapes by 98.40%, and for tomatoes by 95.71%.

Zhang P., Guo Z., Ullah S. [13] provide examples of how the integration of artificial intelligence and nanotechnology into precision farming can optimize agricultural processes. For example, controlled machine learning algorithms can be used to predict acquired biomolecular crowns (secretions from the rhizosphere, leaf sections, and bionts) and their evolution during the entry of nanomaterials into plants, as well as to predict the transformation of nanomaterials and their effects on soil or leaf bionts. Machine learning with reinforcement can also have a positive impact on agricultural processes: an intelligent Internet of Things system for agriculture based on deep reinforcement learning has been developed to increase food production using deep reinforcement learning to make operational decisions such as determining the amount of water needed for irrigation.

Hafeez A., Husain M.A., Singh S.P. et al. [14] conducted an analysis of technologies of unmanned aerial vehicles and their modifications in the agricultural sector over the past decade. The use of unmanned aerial vehicles in the field of crop monitoring and pesticide spraying in precision agriculture was considered. In addition, the use of artificial intelligence and deep learning for remote monitoring of crops was discussed.

The main purpose of the Virnodkar S.S., Pachghare V.K., Patil V.C. [15] study was to review approaches to detecting crop water scarcity around the world based on remote sensing methods and machine learning algorithms.

Important research objective by Subeesh A., Mehta C.R. [16] and his co-authors was to identify the most significant areas of application of artificial intelligence and the Internet of Things in the field of agricultural engineering based on a review of relevant articles. Based on the results of the review, the authors identified the most important areas of AI application in the field of agriculture:

Application of fertilizers. Along with the presence of weeds, insufficient or excessive fertilization is another important reason for the low yield of agricultural land. The Internet of Things technology can help to apply fertilizers more efficiently. Applying the principles of fuzzy logic helps to analyze and make a conclusion about the amount of fertilizers that need to be applied.

Pest and weed control. The targeted use of herbicides to control weeds remains a difficult task, as it leads to harmful effects on health and the environment. The introduction of AI in agriculture will reduce the rate of herbicides application, as well as the number of sprays of field and horticultural crops, thereby reducing the need for pesticides, the risk of overuse and reducing soil and groundwater pollution.

Automated livestock management. The precision poultry farming system consists of three components that require monitoring, namely the environment, the precision feeding system, and the well-being of the bird. Environmental monitoring systems consist of several sensors that are capable of measuring temperature, humidity, and gases such as carbon dioxide and ammonia, which can affect poultry health. In addition, forecasting models based on deep learning can predict the weight of broilers 72 hours in advance. Precision feeding systems allow to control feed intake.

In the Ben Ayed R., Hanana M. [7] study, the authors explore the main areas of application of artificial intelligence and machine learning algorithms in various parts of the agricultural supply chain. At the pre-production stage, machine learning technologies are used to predict crop yields, soil properties, and irrigation requirements. At the manufacturing stage, machine learning can be applied to detect diseases and predict the weather.

Javaid M., Haleem A., Khan I.H. et al. [17] briefly describe the process of applying artificial intelligence in agriculture and some agricultural parameters monitored using artificial intelligence. The authors also identified and discussed important areas of application of artificial intelligence in agriculture. Examples include tractors with automatic control, intelligent irrigation, spraying, fertilization systems, and harvesting robots based on artificial intelligence. Artificial intelligence is used in

agriculture to harvest crops in fields, monitor livestock health, control pests, and identify shortages. Data on temperature, soil, water use, weather and other factors are collected and processed by artificial intelligence models in real time to select the optimal seed planting time, to select the optimal type and variety of seeds to increase yields (table).

Table - Content analysis of the 10 most relevant and cited studies in the field of AI applications in agriculture

Article (author and reference)	Article type	Research question	Conclusion
Zhai	review	What challenges should decision support systems in the field of Agriculture 4.0 meet?	Seven key challenges have been identified that need to be addressed for more effective functioning of decision support systems
Talaviya	review	How can artificial intelligence be introduced into agriculture to optimize irrigation, application of pesticides/herbicides and other agricultural processes?	Artificial intelligence has improved crop production, monitoring, harvesting, processing, and marketing
Kakani	review	How can computer vision and AI be applied in agriculture?	An overview of the use of AI and computer vision in agriculture is presented
Paymode	empirical	What is the purpose of predicting the type of disease that can affect grapes and tomato leaves at an early stage?	The proposed neural network model achieved 98.40% accuracy for grapes and 95.71% for tomatoes when classifying healthy and diseased leaves
Zhang	review	How can the convergence of nanotechnology and AI enable sustainable and precision agriculture?	The convergence of AI and nanotechnology in precision agriculture can accelerate development and help overcome current barriers
Hafeez	review	What are the advances in unmanned technologies for precision farming, crop monitoring, and pesticide spraying?	Multicopters and fixed-wing devices are used to monitor crops and detect livestock. Unmanned helicopters are used to spray pesticides or fertilizers
Virnodkar	review	What methods of monitoring the water stress of crops using remote sensing and machine learning are used?	Remote sensing and machine learning techniques can improve the detection and management of crop water scarcity
Subeesh	review	What are the applications of AI and the Internet of Things in the field of agricultural engineering?	Applications include intelligent agricultural machinery, irrigation systems, weed and pest control, and fertilization
Ben Ayed	review	What are the main applications of AI and machine learning in the agri-food sector?	AI is used to predict crop yields, detect diseases, and forecast the weather
Javaid	review	The goal is to identify and discuss the main areas of AI application in agriculture	AI is used in intelligent irrigation, spraying, fertilization, pest control, selection of the optimal seed planting time, the optimal type and variety of seeds
Note:compiled by authors			

Discussion

The review revealed that since 2021, the topics of precision farming, irrigation, crop and weed management, and decision support have become popular research in the agricultural sector related to artificial intelligence. This is confirmed by the content analysis of the most cited papers in this field.

In turn, the use of "co-occurence networks" to identify key topics and trends has also demonstrated the close relationship between artificial intelligence research and areas such as agriculture, precision farming, and

machine learning. At the same time, there is an active interdisciplinary intersection of research in the agricultural sector with such areas as neural networks, blockchain, the Internet of Things, remote sensing, big data, robotics, computer vision, smart agriculture, and cloud computing. Interdisciplinary research in the field of water resources management, sustainable agriculture and food security represents a significant share. So far, a relatively small share is occupied by research on precision animal husbandry, which is closely related to keywords such as modeling, sensors and smart agriculture, which, however, does not exclude their further growth.

Despite the rapid development, such significant research areas as the use of machine learning technologies, precision farming, the Internet of Things, computer vision, and remote sensing remain insufficiently researched in terms of improving agricultural efficiency. Decision support systems, genetic algorithms, modeling and simulation, as well as neural networks, including data mining and quality control, need to be actively studied. Technologies such as artificial neural network (ANN) and adaptive neuro-fuzzy inference system (ANFIS) combined with drought seem promising.

In general, it is obvious that in the near future there will be significant effects from the synergy of artificial intelligence with specific industry technologies such as genetic engineering, biotechnology and nanotechnology.

Conclusion

1. Since 2016, there has been a noticeable increase in scientific interest in the topic of AI in the agricultural sector, which is associated with the growing relevance of issues related to improving agricultural efficiency and food security. These issues can be solved using AI technologies.

2. Current research areas in the field of AI applications in agriculture are precision farming, machine learning and deep learning technologies. Decision support systems in agriculture using AI are a trend topic. In addition, since 2024, the issues of precise irrigation, crop management and weed control become relevant.

3. According to the results of the co-occurrence network, remote sensing, big data, robotics, computer vision, smart agriculture, and cloud computing collectively form the core of AI technologies which can be used in agriculture.

4. A content analysis of the ten most relevant and cited publications has shown that key AI technologies such as cloud technologies, remote sensing, computer vision algorithms, machine learning, unmanned AI technologies, neural networks and deep learning can be used in precision agriculture to reduce water consumption during irrigation, crop yield forecasting, and monitoring of crops and spraying of pesticides and fertilizers.

5. The conducted systematic literature review has shown the growing relevance of the use of artificial intelligence in agriculture, which is confirmed by the growth of scientific productivity, the analysis of trend topics, as well as the results of the co-occurrence network and content analysis.

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