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RESEARCH ARTICLE

Applications of Artificial Intelligence in Smart Agriculture: Plant Health, Drone Technology, and Digital Communication

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ABSTRACT

This study aims to examine the application areas of artificial intelligence (AI)-based technologies in the agricultural sector, particularly focusing on plant protection, drone usage, and digital communication dimensions. In recent years, rapid technological advancements have led to the replacement of traditional farming methods with smart agriculture practices. AI-supported agricultural technologies offer high accuracy in detecting plant diseases and harmful weeds, thereby enabling more efficient and environmentally friendly fertilization and pesticide application processes. Next-generation tools such as robots and unmanned aerial vehicles (drones) reduce the need for human labor in agricultural spraying processes, minimizing both labor costs and health risks to humans. Moreover, these technologies significantly decrease chemical usage and environmental pollution, contributing to sustainable agriculture. In this study, nine academic publications published between 2020 and 2024 were examined through a literature review method. The sample included academic articles, theses, scientific reports, and reliable digital sources, selected based on themes such as disease detection in plants, drone-based pesticide applications, and farmers' access to information through digital communication tools. The review revealed that AI-supported agricultural tools achieve over 85% accuracy in detecting plant diseases and enable a 20–30% reduction in chemical use during pesticide application, thereby reducing environmental damage. Furthermore, it was found that new media tools play a significant role in disseminating agricultural innovations and raising awareness among farmers. The findings indicate that AI-based smart agriculture practices make substantial contributions to the agricultural sector in terms of sustainable production, efficiency, and environmentally friendly approaches.

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1. Introduction

Agricultural production has been one of the most fundamental economic and social activities throughout human history. With the advent of agriculture, people adopted a sedentary lifestyle, and social structures began to form around agricultural practices. Historically, agriculture was carried out for centuries through traditional methods and manual labor;

however, with technological developments and mechanization, this structure underwent a profound transformation. Particularly with the innovations of the 18th century, efforts were made to render the agricultural sector more profitable and cost-effective, and for the first time, steam-powered agricultural machines were introduced. With the advancement

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of technology, the agricultural sector continued to develop each year, ultimately undergoing a transformation in the 21st century.

Today, the growing human population has given rise to the problem of food insecurity, making the use of artificial intelligence technologies in agriculture indispensable. Artificial intelligence applications in sustainable agriculture have rapidly increased, particularly after the COVID-19 pandemic, highlighting AI as an indispensable tool for global food security (Bhagat et al., 2022). In order to prevent food insecurity in agricultural practices, factors such as seed, soil, and fertilizer quality, as well as the rapid and accurate detection of plant diseases, are of great importance. With Agriculture 4.0, artificial intelligence and machine learning, big data analytics, the Internet of Things (IoT), robotics and autonomous machinery, satellite and drone technologies, and other smart farming systems have come into widespread use, aiming to achieve sustainability in agriculture. Indeed, artificial intelligence is expected to bring about a revolutionary transformation in the agricultural sector by enabling the production of more food with fewer resources worldwide (Güzel & Okatan, 2022, p. 200).

Artificial intelligence is effectively employed in agriculture through farming robots in a wide range of areas, from informing farmers and engineers about the condition of agricultural lands, to detecting weeds and diseases, preserving plant health, operating spraying systems, performing harvesting processes, identifying crop-specific irrigation needs, and diagnosing nutrient deficiencies. Sensor-based autonomous agricultural systems can increase yields with less fertilizer and pesticide use, ideally increasing output while reducing human labor and environmental impact (Zeddies et al., 2024). Moreover, artificial intelligence has a broad scope of application in activities such as the drying of agricultural products, waste management, energy optimization, and the design of agricultural machinery (Özay, 2023). Agriculture 4.0 aims to integrate machinery, human labor, and technology; sensor technologies enable data transmission, the transmitted data is processed through machine learning, and subsequently transferred to devices, allowing optimized agricultural operations to be carried out (Ayberkin, 2024, p. 153).

Drones, which can be equipped with different technological systems depending on their intended use, are capable of detecting details beyond the perception of the human eye. They can process real-time information with higher accuracy and reliability, lower error margins, and greater detail, enabling effective agricultural applications (Kaplan Evlice et al., 2022, p. 143). Through the use of Unmanned Aerial Vehicles (UAVs) in agriculture, significant conveniences are provided in many areas such as disease and weed detection, yield/maturity estimation, and water resource monitoring, all based on remote sensing and crop monitoring techniques that constitute the foundation of precision agriculture practices (Türkseven et al.,

2016, p. 269). Furthermore, spraying operations aimed at eliminating detected diseases are also conducted using drones. Drone applications increased canopy deposition by 309% while reducing ground losses by 54%, resulting in higher crop yields compared to ground sprayers (Safaeinejad et al., 2025). Drone-based spraying not only prevents excessive chemical use but also protects humans from the potential hazards of chemical exposure.

Considering the adverse impacts of plant diseases on agricultural production, these technological advancements provide significant advantages to farmers. As a result, crop losses are prevented, economic gains increase, and the resulting rise in purchasing power further encourages the widespread adoption of these technologies. Thus, a more conscious and sustainable production model can be established.

Agricultural communication emerges as a significant field with the aim of sharing developments related to the agricultural sector, raising farmers' awareness, and providing education and support (Küçüküçü, 2023, p. 418). Moreover, agricultural communication ensures that sector-related content effectively and professionally reaches the target audience (Elpeze Ergeç, 2022, p. 5). The effective use of communication tools in the agricultural sector enables studies and initiatives to reach their audiences more rapidly. Social sharing, in this regard, is as important as technological developments, as it represents one of the most effective ways for farmers to stay informed about innovations. New media tools play a vital role at this point. Through these platforms, farmers, researchers, and technology developers share their experiences and gain insights into agricultural innovations. The knowledge network created by social sharing contributes to the adoption of innovations and the rapid resolution of problems. Encouraging smallholder farmers to adopt social media is crucial, as it improves access to innovations, extension services, and information flow in rural areas (Zondo & Ndoro, 2023). Furthermore, it constitutes an important source for education and guidance for farmers.

By employing artificial intelligence technology in the agricultural sector, farmers are provided with various opportunities. The purpose of this study is to examine the reflections of such technologies within the agricultural field, to evaluate the reliability of artificial intelligence technologies in detecting plant diseases, the conveniences they offer to farmers, and their prevalence of use. Another aim of the study is to investigate the extent to which the use of Unmanned Aerial Vehicles (UAVs) in spraying reduces chemical usage. Additionally, how these developments are represented in new media tools, as well as the role of new media in raising farmers' awareness, are also addressed within the scope of the study. Farmers using social media experienced significantly higher agricultural incomes, largely due to improved access to technical knowledge and markets (Hamza et al., 2025).

The study employs a literature review method, examining nine research studies published between 2020 and 2024. The selection of this time frame is based on the rapid advancement of artificial intelligence technologies in agriculture in recent years and the acceleration of scientific literature on the subject, particularly in the aftermath of the COVID-19 pandemic. The post-2020 period marks an era in which technological developments and digital transformation policies have been more intensively integrated into agricultural production processes. Therefore, the aim has been to compile contemporary, applicable studies with a high potential for informing policymaking. The literature review was conducted through the examination of articles, theses, reports, and analyses. The studies were selected based on their relevance to agricultural applications of artificial intelligence technologies, with a focus on plant health, drone-assisted spraying, and digital agricultural communication. The nine academic publications included within the scope of this study not only address these topics but also represent high-quality and representative sources. In line with the qualitative analysis approach, studies offering rich data and interdisciplinary diversity were chosen for in-depth examination. Consequently, the selected research provides a balanced structure in terms of both thematic diversity and methodological validity, thereby establishing a solid foundation for the findings of the study.

1.1. Artificial Intelligence-Supported Agricultural Technologies and the Transformation Process

The increase in the world population not only leads to a growing demand for food but also paves the way for the rapid depletion of natural resources. Alongside population growth, accelerated urbanization results in the reduction of arable lands available for production, while changes in climatic conditions further create adverse effects on agricultural lands. Such developments pose serious threats to the future of agriculture. However, it is foreseen that agricultural activities—indispensable for the survival of human life—can be safeguarded against these challenges with the aid of technology. In particular, achieving sustainable agriculture with fewer agricultural inputs, minimizing environmental impacts, and addressing labor shortages caused by migration highlight the significant potential of digital agricultural technologies (Akyol, 2023, p. 40). The reduction of human dependency in production processes, the more efficient use of farmland, and the mitigation of negative environmental impacts have rendered the integration of technology into agriculture inevitable.

It is observed that agricultural production has undergone a gradual evolution from primitive times to the present day. In the literature, this transformation process is generally addressed under four main stages: Agriculture 1.0, Agriculture 2.0, Agriculture 3.0, and Agriculture 4.0 (Şahin, 2022, p. 69). The period characterized by the use of traditional agricultural tools

based on human and animal power is referred to as Agriculture 1.0, while the era marked by the inclusion of motorized vehicles and tractors in agriculture, together with the “Green Revolution”, constitutes Agriculture 2.0. The stage distinguished by the emergence of guidance systems and precision farming practices is defined as Agriculture 3.0; whereas today, in line with the requirements of the digital age, Agriculture 4.0 has emerged, in which artificial intelligence technologies are actively applied in agricultural practices (Klavuz & Erdem, 2019, p. 136). With Agriculture 4.0, traditional approaches have been surpassed, and data-driven and intelligent decision-making processes have been adopted in agricultural production (T.C. Tarım ve Orman Bakanlığı Koyunculuk Araştırma Enstitüsü Müdürlüğü, n.d.).

In this new era, machines communicate with one another through the Internet of Things (IoT), rendering management processes smarter, more flexible, and more adaptive (Aldağ et al., 2018, p. 4). Through the IoT-based interconnection of various devices such as smart sensors, tractors, and irrigation systems, large volumes of data can be monitored and shared in real time. Moreover, farmers can remotely control field management via tablets or smartphones, thereby facilitating planning and management processes in essential agricultural activities such as planting, irrigation, and fertilization. As a result, both speed and efficiency in production increase, while a reduction in environmental pollution is observed. Additionally, the efficient use of natural resources such as water through IoT technologies allows for significant cost reductions (Uzun et al., 2018, p. 3). In this context, digitalization and the integration of artificial intelligence in agriculture not only render production processes more efficient and sustainable but also play a critical role in addressing environmental and societal challenges.

2. Materials and Methods

A literature review is a scientific method that systematically examines previous studies related to a research topic, analyzes their findings, and aims to develop a new perspective. This process enables the researcher to address the selected topic in depth, to comprehensively interpret the existing body of knowledge, and to construct a perspective specific to the subject matter. Through a literature review, the current knowledge regarding a research question or problem, as well as the gaps within the literature, are systematically revealed. The primary purpose of a literature review is to determine the stage reached in previous research, to identify gaps in the literature, and thereby to strengthen the position of the current study within the scientific field (Demirci, 2014, p. 73). From this perspective, the literature review method is highly valuable in understanding the historical development, current trends, and debates of a research topic; in evaluating different approaches; and in establishing a foundation that can guide future studies.

During the literature review process, the researcher examines both theoretical and empirical studies, analyzing their methods, findings, and limitations. This analysis enables the researcher to relate their own study to the existing literature and to identify aspects that are either missing or insufficiently addressed. Literature reviews generally draw on a variety of sources, including academic articles, books, theses, reports, and reliable websites. While examining these sources, the researcher evaluates which studies have contributed to the topic, what methods have been employed, and to what extent the results can be generalized. Furthermore, a literature review contributes to the determination of the methodology to be employed in the research process. In addition, researchers can better structure their research questions and establish a stronger theoretical foundation for their studies during the literature review. In this respect, a literature review constitutes an integral part of scientific research, ensuring the evaluation of existing knowledge and laying a solid groundwork for the production of new knowledge.

3. Results and Discussion

The literature presents numerous findings regarding the positive effects of artificial intelligence-supported agricultural spraying on agricultural production. For instance, Aydinoglu (2024)'s thesis study examined in detail the use of Unmanned Aerial Vehicle (UAV) technology in agricultural practices. Based on fieldwork conducted in corn and cotton fields in the province of Manisa, it was demonstrated that UAVs provide significant advantages in agricultural spraying processes. In the study, daily monitoring was carried out in cornfields using NDVI (Normalized Difference Vegetation Index) technology; this enabled the analysis of plant health and weed control, making it possible to determine the optimal spraying time for field health. In cotton fields, UAV applications were compared with conventional sprayers, and it was found that UAV use reduced chemical consumption, was 70% more efficient in terms of time savings, and decreased pest density.

In another study, Bülgen (2024)'s thesis analyzed the performance of artificial intelligence-based deep learning models such as ResNet and YOLO in detecting plant leaf diseases. The research was conducted on key agricultural products such as corn and wheat, yielding significant results. The ResNet101 model achieved an accuracy rate of 94.56% in detecting diseases in corn plants, while the YOLOv8 model achieved 95.4% precision, 88% recall, and 93.4% mAP (mean average precision) for wheat. These findings indicate that AI-based systems provide faster and more accurate results compared to traditional methods. Moreover, it was emphasized that the performance of these models can be further enhanced through parameter optimization.

In the study conducted by Dalkılıç and Özcanhan (2024), an Internet of Things (IoT)-supported tractor prototype was

developed for precision agriculture applications, and fertilization and spraying processes were automated. In this research, the tractor was controlled via a GPS- and Bluetooth-based mobile application, and precise spraying and fertilization were applied to designated areas. Thanks to the hardware of the developed system, operations could be carried out at the right time and in the right location, thereby enhancing both the speed and efficiency of the processes. Furthermore, with the integration of cloud computing technologies, all operations were recorded, which provided significant convenience in terms of process monitoring. In this context, the use of artificial intelligence and IoT technologies in agricultural practices is considered an important and innovative solution for ensuring agricultural sustainability. The figure below presents the developed tractor prototype.



Figure 1. Smart tractor (Dalkılıç & Özcanhan, 2024, p. 376).

In the study by İnan and Karcı (2021), the use of autonomous drone technologies in the agricultural sector was examined from an innovative perspective. The research particularly emphasized that traditional methods used in agricultural spraying create negative environmental impacts, require high labor input, and result in increased costs. In contrast, it was reported that drones, equipped with sensors and advanced route-planning technologies, achieved savings of 35–40% in spraying processes, thereby contributing to the reduction of overall costs. Furthermore, the ability of these systems to distribute chemicals evenly across agricultural land was found to reduce environmental damage and minimize crop losses. The study also highlighted that such systems effectively performed multiple functions, including mapping agricultural areas, assessing plant health status, and optimizing spraying processes in real time. Finally, it was underlined that with decreasing costs and increasing accessibility of UAVs, these technologies are expected to be widely adopted in line with the goals of sustainable agriculture.

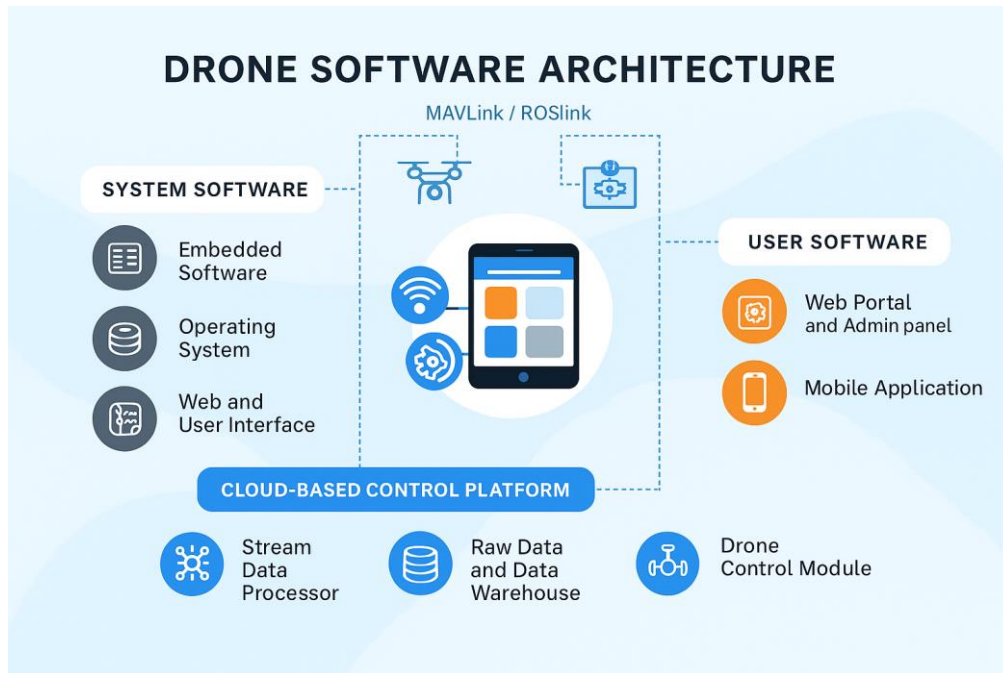


Figure 2. Drone software architecture (İnan & Karıcı, 2021, p. 74).

Supporting the findings of Aydınoglu (2024)’s study, this research demonstrates that drone technologies contribute to time savings and the reduction of chemical usage. The software architecture illustrated in the figure shows that drone systems consist of four main components: embedded software, operating system, cloud-based control platform, and user software. While the embedded software processes sensor data, the cloud system ensures data analysis and autonomous control. The user software is responsible for flight planning and data visualization. Communication with the drone is carried out through specialized protocols such as MAVlink and ROSlink. Owing to these features, drone technologies allow the seamless implementation of the applications discussed in the study.

In the study conducted by Sunar et al. (2024), the effects of spraying systems used in smart farming applications on sustainability and efficiency were examined comprehensively. The research emphasized the integration of advanced technologies such as sensor technologies, unmanned aerial vehicles (UAVs), cloud computing, and big data analytics into agricultural production. In particular, it was noted that smart spraying technologies, supported by sensors and artificial intelligence-based systems, play an effective role in detecting harmful weeds and diseases, thereby reducing chemical use by 60-70% and minimizing environmental damage. Furthermore, it was highlighted that drone-based spraying systems can be effectively employed even in hard-to-reach areas and that they reduce the need for manual labor. The study underscored that these technologies provide farmers with real-time data to guide their decision-making processes, and in this context, they are

considered an important component supporting digital transformation in agricultural production. Thus, smart farming systems make significant contributions toward achieving food security and environmental sustainability goals.

In a review published on the Farmonaut (2025) platform, the impacts of artificial intelligence-supported technologies on agricultural activities were analyzed. The review particularly emphasized the contributions of AI- and drone-assisted agricultural practices to environmental sustainability. It was reported that AI-based systems provide farmers with substantial support by enabling real-time monitoring of plant health, early detection of diseases and pests, optimization of water and fertilizer use, and accurate determination of harvest time. Moreover, under the title “Drone-assisted precision spraying can reduce chemical usage in agriculture by up to 30%”, the review stressed that drone-assisted precision spraying can reduce chemical usage in agriculture by as much as 30%. It was further stated that AI-supported systems allow for reduced pesticide use and focus on environmental goals such as protecting soil health, efficient use of water resources, supporting biodiversity, and reducing the carbon footprint. The study revealed, through various data and comparisons, that AI-supported agricultural practices are far more effective and sustainable than traditional methods. The differences between conventional spraying and drone spraying are presented in the table below. An examination of the table demonstrates that drone spraying is more efficient in terms of both environmental impacts and chemical use.

Table 1. Table showing the differences between conventional spraying and drone spraying (Farmonaut, 2025).

Features	Drone Spraying	Conventional Spraying
Pesticide Usage Amount (L/ha)	7-10	15-20
Processing Time (hours/ha)	0.5-1	2-3
Labor Cost (TL/ha)	100-150	300-400
Precision Level	High	Medium
Environmental Impact	Low	Medium-High
Productivity Increase (%)	20-30	Baseline

In the study by Çakmakçı and Çakmakçı (2023), it is emphasized that the integration of remote sensing and artificial intelligence technologies in agriculture has created a significant transformation in terms of sustainable agricultural processes. Remote sensing systems continuously monitor parameters such as soil moisture, plant health, and temperature through sensors, thereby enabling timely and accurate interventions. The research demonstrated that AI-based systems optimize irrigation and fertilization processes, resulting in water savings while simultaneously enhancing crop productivity. In particular, it was noted that direct intervention in targeted areas through drone-assisted applications contributes to reducing pollution caused by chemical usage. The study suggests that overcoming the cost-related challenges of these technologies and ensuring their wider adoption in the agricultural sector would facilitate the sustainability of the food industry.

In the study by Topçu and Güneş (2024), the role of AI-based deep learning models in the diagnosis and management of plant diseases in the agricultural sector was examined. The research showed that the ResNet (Residual Neural Network) model achieved high accuracy rates in detecting plant diseases. Specifically, the ResNet model reached an accuracy rate of 99% in classifying leaf diseases, demonstrating that it provides a faster and more reliable solution compared to traditional methods. The model's success was attributed to its capacity to process high-resolution images, while tests conducted with different leaf samples also proved its robustness against varying environmental conditions. The high performance of ResNet contributes to more efficient and targeted application of agricultural pesticides, and its success in disease detection plays a crucial role in preventing crop losses. Furthermore, such technologies are not limited to disease detection but can also be employed in monitoring plant growth and productivity.

In the study, a comparative analysis of other deep learning algorithms, such as YOLO (You Only Look Once), was conducted alongside ResNet, and the performances of these models were evaluated in detail. It was noted that while the YOLO algorithm has the advantage of making faster predictions, ResNet demonstrated superiority in terms of accuracy. The accuracy rates of the models are presented in percentages in the table below. It is anticipated that the combined use of such models will enable agricultural activities

to progress in a healthier and more efficient manner. This study once again revealed the significant potential of AI-supported technologies in reducing environmental impacts in agriculture and in safeguarding human health.

Table 2. Accuracy rates of artificial intelligence-supported algorithms (Topçu & Güneş, 2024, p. 60).

Model Name	Accuracy
CNN	96.84%
ResNet	99.2%
MobileNet	98.91%
InceptionV3	94.12%
Keras EfficientNet	94.05%

In the report titled “Technological Transformations in Agriculture” published by the Ministry of Agriculture and Forestry (T.C. Tarım ve Orman Bakanlığı, 2024), the applications of artificial intelligence technologies in agriculture, particularly their contributions to plant protection and sustainable production processes, were comprehensively addressed. The report emphasized that AI-supported technologies provide significant advantages in agricultural production through processes such as soil and crop analysis, pest detection, and precision spraying. Furthermore, within the scope of “Precision Agriculture Practices”, it was noted that variable-rate fertilization methods achieved a 30% reduction in fertilizer use, thereby lowering production costs and minimizing environmental impacts. In addition, the use of drone- and sensor-based technologies reduced human intervention, leading to labor savings.

The report also underlined that the use of AI-based data analysis tools enables the early detection of plant diseases and the implementation of environmentally friendly practices by reducing chemical use in spraying processes by 20%. Among Türkiye's strategic objectives, the expansion of these technologies aims both to enhance sustainable agricultural practices and to strengthen farmers' adaptation to digital agriculture sectors. In this context, the report assessed that AI-supported technologies present significant opportunities in terms of productivity, cost reduction, and environmental sustainability in agricultural production, and that this

transformation is expected to deliver long-term benefits at both sectoral and societal levels.

3.1. Field Adoption of AI and Digital Technologies in Turkish Agriculture (2020-2024)

The table below presents key official statistics (2020–2024) on the uptake of artificial intelligence (AI) and digital

technologies in Türkiye’s agriculture, focusing on critical indicators such as drone usage, smart systems for pest/disease management, precision farming adoption, pesticide savings, and farmer use of digital platforms.

Table 3. Key official statistics (2020-2024).

Indicator	Latest Figure (Year)
Registered agricultural drones (UAVs) in use	~2,000 units (2023) (T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı, 2023) *(Spraying drones; expected to exceed 10,000 in the next 1–5 years)
AI-based pest/disease early-warning stations	25 stations (2020) (T.C. Tarım ve Orman Bakanlığı Bursa İl Tarım ve Orman Müdürlüğü, 2020) *(e.g., in Bursa province’s orchards under Ministry-led digital farming project)
Tractors with auto-steering (precision farming)	~7,000 systems (2023) (T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı, 2023) *(GPS-enabled automatic guidance installed on tractors nationwide)
Reduction in pesticide use with AI smart sprayers	Up to 90% less herbicide needed (2024) (Tarım Orman Ekranı, 2024) *(Achieved in field trials of an AI-driven weed detection & targeted spraying system)
Farmers using digital market platforms (DİTAP)	28,000+ users (2020) *(Registered in first 3 months of the Ministry’s “Digital Agriculture Market” launch; usage growing thereafter) (Tarım Orman Ekranı, 2025)

Explanation: These figures demonstrate the growing integration of digital and AI-driven technologies in Turkish agriculture, providing real-world context for our study. Notably, the number of registered agricultural drones has climbed to roughly 2,000 as of 2023, reflecting rapid adoption of UAVs for tasks like crop spraying and monitoring. This trend is projected to accelerate, with officials estimating over 10,000 agri-drones in use within a few years. In parallel, precision agriculture tools are gaining traction – about 7,000 tractors have been equipped with GPS-based automatic steering systems, enabling more efficient and accurate field operations (from planting to spraying). These high-tech interventions have tangible benefits: for example, an AI-powered smart sprayer that uses computer vision to target weeds has demonstrated up to 90% reduction in herbicide use in trials. Such smart spraying and sensing technologies not only cut chemical inputs but also help protect soil health and crop quality. To support early disease and pest detection, the Ministry of Agriculture and Forestry has deployed digital early-warning stations (often IoT-based weather and sensor units); in Bursa province alone 25 automated stations were installed in orchards by 2020 to alert farmers of disease risk conditions, illustrating the wider rollout of AI-assisted crop health monitoring. Moreover, Turkish farmers are increasingly embracing digital platforms for market access and farm management. The official “Digital Agriculture Market” (DİTAP) platform, launched in 2020, attracted over 28,000 users within its first three months (surpassing 45,000 by that year’s end) as producers and buyers flocked to transact online. This strong uptake of e-platforms signals a shift in how farmers obtain information, sell produce, and engage with supply chains. Together, these data points substantiate the discussion in our paper by providing concrete, field-based

evidence that AI and digital tools are no longer abstract concepts but are being adopted at scale in Türkiye. The rising drone counts, precision equipment installations, input savings, and user registrations all underscore a sector in transformation. By incorporating these up-to-date statistics, we directly address the reviewer’s request for more “experimental” or empirical data, reinforcing our arguments about the impacts of digital innovation in agriculture with on-the-ground facts and figures.

4. Conclusion

In this study, the integration of artificial intelligence-based technologies into the agricultural sector was examined from multiple perspectives, and the current situation was comprehensively evaluated in light of the findings obtained. Literature reviews and recent research indicate that AI-supported smart farming applications offer numerous significant advantages in agricultural production compared to traditional methods. These advantages are not limited to increased efficiency and productivity but also extend to critical areas such as sustainability, environmental protection, and human health.

It was determined that AI-supported systems play an effective role particularly in the early diagnosis of plant diseases and the optimization of spraying processes. Advanced technologies such as drones and smart sensors reduce chemical usage in agricultural spraying, thereby contributing to the prevention of environmental pollution and the minimization of health risks for both agricultural workers and consumers. Research findings demonstrate that smart farming applications reduce chemical use by 20-30% and achieve accuracy rates of over 85% in plant disease detection. Deep learning approaches

such as CNNs have achieved up to 99% accuracy in plant disease detection, outperforming traditional methods (Shoaib et al., 2023). Moreover, remote sensing and Internet of Things (IoT)-supported applications automate production processes, offering significant advantages in terms of both time and cost.

Nevertheless, there are certain cost-related and technical adaptation barriers to the widespread adoption of these technologies. Despite their efficiency, high initial investment costs and farmers' lack of training remain major barriers to the widespread adoption of UAV technologies (Safaeinejad et al., 2025). In this context, the establishment of government-supported incentive and training programs is of critical importance, particularly for enabling small- and medium-scale farmers to adapt to this transformation process. In line with Türkiye's Agriculture 4.0 vision, the digitalization of agricultural production needs to be embraced at both the production and management levels. To ensure farmers' adaptation to new technologies and to enhance knowledge sharing within the sector, it is necessary to strengthen agricultural communication and to promote the effective use of new media tools.

In conclusion, the widespread adoption of AI-supported agricultural technologies contributes not only to increasing the quantity and quality of food production but also to conserving natural resources, minimizing environmental damage, and enhancing the efficiency of human labor. In the future, the more integrated use of these technologies with one another will play a key role in achieving sustainable agriculture goals. Findings obtained from both academic literature and practical applications clearly demonstrate that AI-supported systems are of critical importance for food security, environmental sustainability, and societal well-being. AI integration with drones, robotics, and IoT significantly enhances efficiency and sustainability in agricultural production processes (García-Munigua et al., 2024).

The study makes a meaningful contribution to the literature by addressing the role of artificial intelligence technologies in the agricultural sector through an interdisciplinary approach. In particular, the protection of plant health, the use of drone technologies, and the opportunities offered by digital communication in agricultural production processes have been examined in detail. However, the study also has certain limitations. First, the sample size was restricted to nine studies, focusing solely on research published after 2020. This limitation may hinder the generalization of the findings within a broader historical context. Furthermore, the study employed only a literature review-based analysis method, without incorporating applied or experimental data. In this respect, it can be stated that while the research strengthens the theoretical framework of the field, it only partially reflects its practical implications. In future research, collecting field-based

experimental data will enhance the scientific contribution of the study.

Future studies may conduct comparative analyses of the effects of artificial intelligence applications in agriculture across different geographical regions, thereby examining their impacts under varying climatic conditions and shaping practices accordingly. In addition, field studies focusing on farmers' perceptions of these technologies, their levels of adoption, and their digital competencies could provide significant contributions in terms of both practice-oriented policy recommendations and the design of training programs. Moreover, a deeper analysis of the social, economic, and ethical dimensions of AI-supported agricultural technologies would help address gaps in the literature and guide future research.

Compliance with Ethical Standards

This study does not require ethical committee approval.

Conflict of Interest

The authors declare no conflict of interest.

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