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REVIEW ARTICLE

Application of artificial intelligence in agriculture and allied sectors: A comprehensive review towards sustainable solutions

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Abstract

Sustainability is a holistic goal that can be effectively achieved through the combined efforts of agriculture and its allied sectors. Artificial intelligence (AI) plays a transformative role in this endeavour by bridging sector-specific solutions and integrating them to promote environmental protection and food security. AI is revolutionizing sustainable agriculture, ensuring both food security and environmental protection. The main objective of this article is to comprehensively review the various applications of AI in agriculture and its interlinked sectors like fishery, animal husbandry, forestry, agricultural engineering, horticulture and food science by compiling several previous studies to highlight their role in achieving sustainability and identify research gaps. The literature review was done through databases like Scopus and Google Scholar. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) framework was used to identify, screen and select articles. This article explores the various applications of AI in pest and disease management, weed management, weather forecasting, soil management, greenhouse farming, precision agriculture and yield management. AI has numerous advantages, such as data-driven decision-making, resource management and reduced environmental impacts. This review highlights the implementation of inclusive strategies to achieve sustainability by pointing out the gaps in research, policy and implementation of technologies. The review concludes that integrating AI into agriculture and its allied sectors offer significant benefits that outweigh potential drawbacks, thereby fostering sustainable practices and environmentally friendly innovations.

Keywords: agriculture; allied sectors; artificial intelligence; sustainable agriculture

Introduction

The world population is about to reach 9.9 billion by 2050 (1). The food demand is rising (2) as a result of the increasing population (3). Addressing this demand sustainably is a critical challenge (4), as the existing traditional agricultural practices faced numerous challenges and have resulted in resource depletion and environmental deterioration (5). Therefore, modern agricultural practices are required to address these challenges to attain sustainability.

Artificial intelligence (AI) offers transformative potential in modern agriculture (6). AI is the emulation of human intelligence in computers that have been trained to think and behave like humans (7). AI has emerged as a vital technology in various sectors (8), including agriculture (9). In agricultural contexts, AI is applied in crop health monitoring, pest and disease detection, soil health assessment and crop yield prediction. Technologies such as machine learning (ML), the Internet of Things (IoT) and computer vision are increasingly integrated into agricultural systems to enhance productivity and improve decision-making processes. As a result, agriculture can certainly be reshaped to become more resilient, sustainable and effective with the help of AI (10). AI-driven advisory services serve farmers with customized suggestions and assistance based on real-time information analysis (11).

Given the interconnected nature of agriculture and its allied sectors, such as animal husbandry, food science, fisheries, horticulture, forestry, agricultural marketing and engineering-sustainability cannot be achieved by focusing on farming alone (12). Agricultural practices both affects and are influenced by these interrelated allied disciplines, resulting in an intricate web, where changes in one discipline can have a major impact on others. Several papers have reviewed the use of AI in the agriculture sector, emphasizing its capacity to enhance sustainability. However, there is a lack of comprehensive review that covers the AI application in agriculture along with its interrelated disciplines for achieving sustainability. This paper aims to review several existing literatures on AI services for sustainable agriculture. This review fills the gap by offering an integrative synthesis of AI application in agriculture and its allied sectors. Its novelty lies in cross sectoral analysis of common challenges and opportunities and providing an integrated overview of attaining sustainability using AI.

The primary objective of this review is to explore and consolidate the diverse applications of AI in delivering advisory

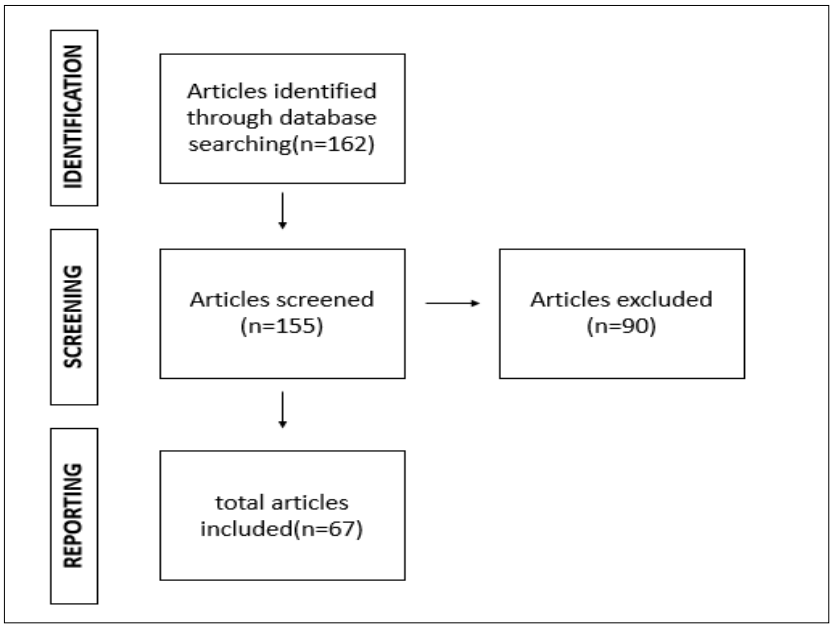

Fig. 2. Description of PRISMA method.

weed management, crop protection, greenhouse farming, precision agriculture, irrigation and yield management. The applications of AI in agriculture sector have been depicted through visual illustrations (Fig. 3).

Pest management

AI-based technologies provide timely pest identification and offer control recommendations (13). The earliest possible action is taken by the precise identification of pests from the images by AI-driven image recognition systems that use deep learning (13). It enables forecasting future pest outbreaks by analyzing historical pest occurrence patterns using ML algorithms (14). Drones and IoT sensors powered with AI track insect activity and apply pesticides more efficiently, using fewer chemicals and thus resulting in a lesser environmental impact. When pests are detected, farmers receive mobile alerts with tailored recommendations, enabling timely action and minimizing crop losses (15).

Disease management

AI-driven solutions enhance plant disease management by facilitating early identification, diagnosis and prevention (16). Disease lesions and leaf discolorations are examined by deep learning algorithms to identify diseases with the help of images captured by the smartphones and AI driven drones and IoT sensors (17). AI powered chat bots and advisory systems give real time and personalized disease management advice to the farmers, which results in less dependence on chemical treatments (18). The process of disease recognition generally involves five stages: image acquisition, image pre-processing, image segmentation, feature extraction and finally image classification (19). This step by step process is illustrated in the form of flowchart (Fig. 4).

Weather forecasting

Weather prediction and forecasting, impact assessment of climate change are some of the applications of AI that helps the farmers to take immediate action regarding the weather related issues that affect agriculture (10). Incorporating

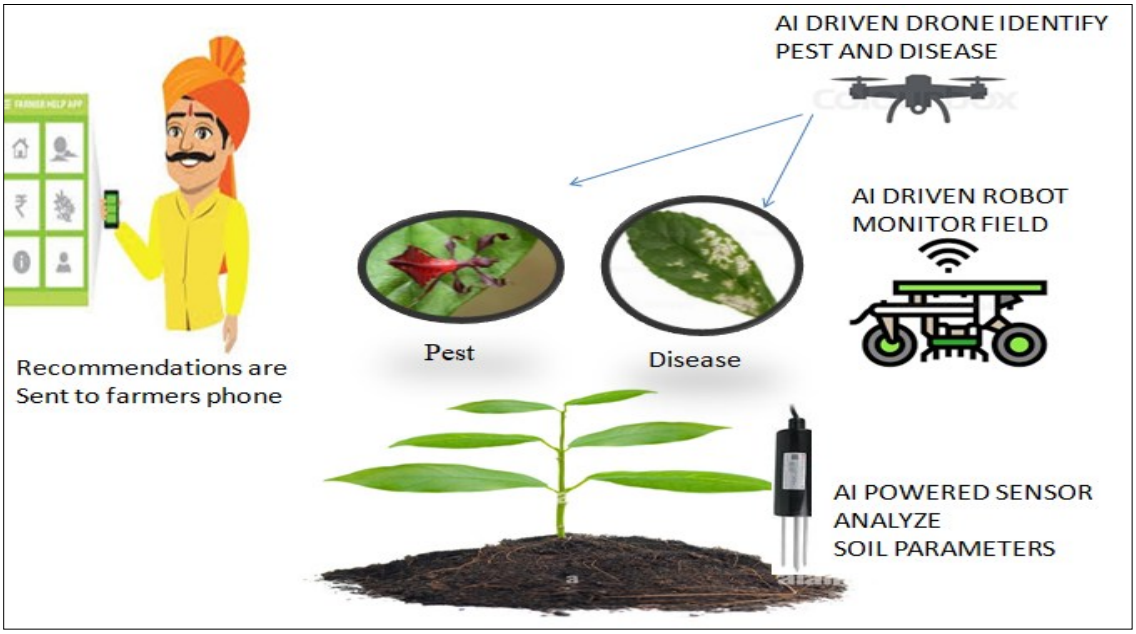

Fig. 3. AI application in core agricultural fields.

and operational services across agriculture and its allied sectors, with an emphasis on promoting sustainability (Fig. 1). This review pinpoints the benefits and challenges that help to identify the gaps that need to be addressed for achieving sustainability. To achieve this, the study addresses the research questions such as "what are the key application and emerging trends of AI in agriculture and its allied sectors?" and "what are the major challenges hindering AI adoption in Agri-allied sectors and what are its key advantages and disadvantages?".

Methodology

A comprehensive literature review was conducted in this paper. This literature review followed by PRISMA was completed in three phases: identification, screening and reporting.

Identification phase

The topics to be covered in the review are considered in the identification phase. In the present case, the various applications and of AI in agriculture and its allied sectors such as horticulture, animal husbandry, fishery, forestry, agricultural marketing, food science and agricultural engineering were considered. Several relevant literatures have been identified through the databases such as Google Scholar and Scopus. The primary keywords used for the search include "AI in agriculture" and "AI in agro-allied sectors". The review primarily targets studies published within the last five years, ensuring up-to-date insights. The articles are selected based on their relevance to the topic. A total of 162 articles have been identified through database searching in the identification phase.

Inclusion criteria

The document type selected included articles, book chapters, conference papers and reviews. Those articles which are written in English were selected.

Exclusion criteria

Articles not related to agri-allied sectors, lacking meaningful AI application context and non-English publications were excluded.

Screening phase

In the screening phase, the suitable and required information was collected and mined from the selected papers. In this comprehensive review, the screening is done manually for each paper to cull out the relevant information. In this phase the relevant information is obtained by examining and screening out the title of the selected paper, main concept of the paper, result and conclusion. The papers that are not directly related to the review topic and the papers that don't contain information related to our subject area were excluded. Totally 155 articles have been screened in this phase and 90 articles were excluded, since it doesn't meet the inclusion and exclusion criteria.

Reporting phase

In the final phase, the findings from the selected literature were synthesized and discussed. The analysis was organized into two main categories:

Application of AI in agriculture including topics such as pest and disease management, weather forecasting, greenhouse and precision agriculture, irrigation management and yield prediction.

Application of AI in allied sectors covering different fields such as animal husbandry, fisheries, forestry, horticulture, agricultural engineering, agricultural marketing and food science.

Additionally, the advantages and disadvantages of AI in these domains are examined. The review concludes with a discussion of results and key insights drawn from the reviewed studies. In the final reporting stage, a total of 67 articles were included in this review. The identification, screening and reporting phase of this review is summarized in the PRISMA flow diagram shown in Fig. 2.

Application of AI in agriculture sector

AI-driven solutions have significantly transformed the agricultural landscape by enhancing pest and disease management, weather forecasting, soil health assessment,

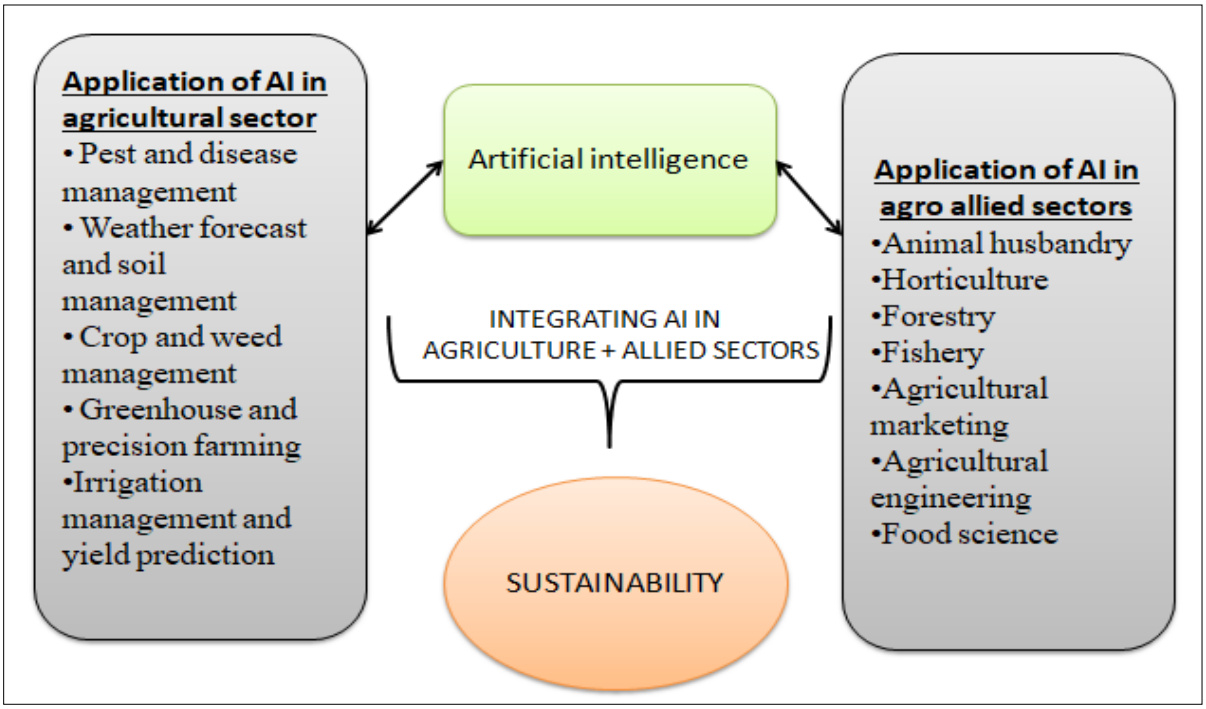

Fig. 1. Application of AI in agriculture and its allied sectors to attain sustainability.

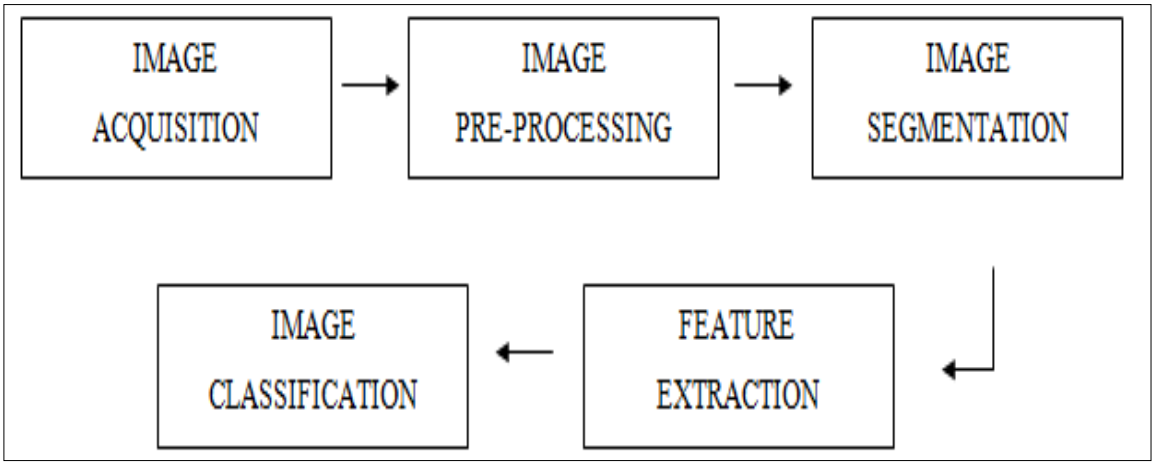

Fig. 4. Process of disease recognition.

weather data provided by AI technologies, by analyzing the historical weather patterns with farm operation enhances precision agriculture. AI powered weather advisory services provide real time localized weather information to the farmers (20). Early prediction of disasters such as flood and drought by the AI systems, aids the farmers in mitigating the risks by providing early warning to the farmers phone (21).

Soil management

The assessment of soil health, soil nutrient content and soil parameters such as pH, soil moisture content, soil texture and soil type by the AI driven technologies, such as sensors, drones and robots assist the farmers in taking management practices by giving the real time information (22). Using AI technologies for soil management reduces the fertilizer usages, which enhances the soil fertility and lessen the adverse environmental impacts (10).

Crop protection and management

AI driven devices such as drones, sensors and robots frequently monitor the crop health by predicting the early signs of pest and disease outbreaks and give alerts to the farmers so that they can take immediate management actions and thereby enhancing the productivity and reducing crop losses (10). Machine learning algorithms monitor the plant growth indicators that aids in easy crop management (23).

Weed management

Weed management has become easy with the help of AI technologies that precisely identifies the weed and gives control measures (24). Images taken from drones and smartphones identify weeds by differentiating them from other crops by using machine learning and image recognition systems and gives alerts to farmers (25). Reduced herbicide use and targeted weed control are the advantages of using AI driven robotic sprayers (24).

Greenhouse farming

In greenhouse farming, plants are grown under controlled conditions. AI technologies aids in attaining sustainability by monitoring parameters such as temperature, pH and humidity which helps in increasing the crop yields and enhancing efficient usage of water and fertilizer (26, 27). AI driven sensors predict the occurrence of pest and disease inside the greenhouse. Robots powered with AI automate the operation in greenhouses such as harvesting and weeding (28).

Irrigation management

AI driven smart irrigation systems precisely use water by predicting the irrigation needs of the crop (29). Irrigation systems such as sprinkler and drip are managed by automated AI systems efficiently use the water based on the water needs and thus reducing the water loss as well as assisting the farmers in handling the water issues (30). AI based digital application called AIDSII is used in irrigation management (31).

Precision agriculture

Integrating AI with precision agriculture enhances efficiency, effectiveness and sustainability of agricultural practices. AI optimizes input utilization, thereby enhancing crop yield and resource efficiency (32). Crop monitoring, efficient water use, assessing soil health, pest and disease detection and yield prediction are the advantages of using artificial intelligence in precision agriculture (33).

Yield prediction and management

By analyzing the weather, soil and crop conditions, the AI technologies predict and manage the yield of the crops (10). These predictions enable farmers to make data-driven decisions that maximize yield potential and reduce uncertainty in agricultural planning (10).

Application of AI in agricultural allied sectors

Artificial Intelligence (AI) is revolutionizing agri-allied sectors such as animal husbandry, agricultural marketing, forestry, fishery, food science, agricultural engineering and horticulture by improving operational efficiency, productivity and sustainability. Some of the applications of AI in agri-allied sectors have been depicted through visual illustrations in Fig. 5.

Animal husbandry

AI in animal husbandry improves animal welfare (34). AI systems assist in animal identification and analysing the animal behaviour (35), which results in the easy detection of diseases in animals (36). Incorporating AI with drone technology has enhanced the management of herding cows (37). AI has been used for automated milking in cattle (38). The oestrus cycle of the cattle has been detected with the application of AI-based monitoring systems (39). IoT devices fitted with AI driven sensors, monitors the drinking and feeding habits of the livestock (37). Robotics combined with AI also support vaccination processes in poultry (38). AI has been used to evaluate the vocalizations of livestock and aided in recognizing

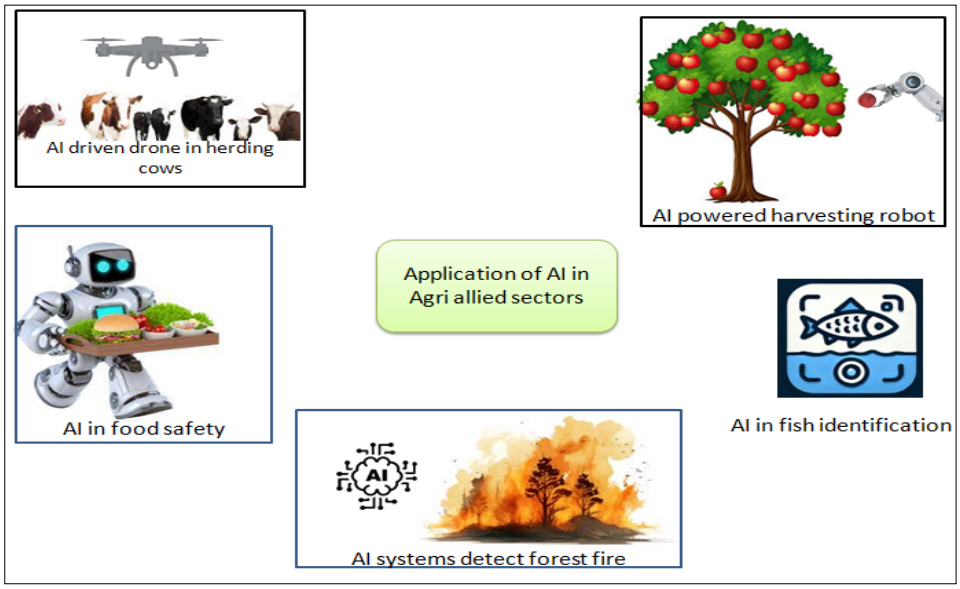

Fig. 5. Application of AI in agri-allied sectors.

distress and comfort calls (36). The diagnosis of optimum artificial insemination timing has also been done by the artificial intelligence (40).

Agricultural marketing

Most of the farmers are not aware of the market prices and they are exploited by the middleman who makes them to sell their produce at a lower rate. This can be avoided with the help of AI since it forecast the market prices to the farmers and assist in data driven decision making (10). The marketing industry can greatly benefit from artificial intelligence (41). AI-powered models facilitate in developing a market approach that is customer-driven and builds a cohesive market strategy (42). It enables marketers to find future trends and forecast them (41). Artificial intelligence has helped marketers to analyse customer behaviour. AI-driven supply chain optimization aids in supply optimization by identifying potential risks and opportunities and helps in resource optimization (43). AI also plays a vital role in agricultural product management (44).

Forestry

Artificial intelligence predicts the forest fire (45). It assists in forest classification and mapping, identifying the illegal felling and wood trafficking, tracking ecosystem health and conserving biodiversity (46). AI powered robots assist in tree trunk detection (47). AI technologies are also used for the classification of forests and mapping, as well as in the quantification of the resources of the forest, which results in the conservation of forests (46).

Fishery

Artificial intelligence ensures sustainable fisheries (48). DL, which is a subset of artificial intelligence assisted in live fish identification (49). It aids in fish stock monitoring and management (48). One of the AI techniques, SVM, assisted in disease detection in fish by identifying infected fish from fresh fish (50). AI-driven technologies keep in check the pollution that affects the fish (49).

Food Science

One of the applications of AI in Food science is that it reduces the food shortage crisis and food waste (10). AI plays a major role in the agri-food industry (51). There are many AI-based food processing strategies (52). AI-driven technologies assess the food quality (53). AI-driven technologies also play a major role in maintaining food safety and managing the agro-food waste (54). Artificial intelligence can be used to make eco-friendly food packaging for food and beverages. It also aids in maintaining the viability of the high-quality food production (10).

Agricultural engineering

Agricultural engineering has brought about various strategies for reducing risk in agricultural practices (55). AI powered Agricultural engineering technologies enhance crop production and pest resistance (10). AI driven robots assisted farmers in doing various agricultural operations (56). Various AI -driven smart machineries have been developed for doing operations such as seedbed preparation, harvesting, threshing and weeding (57). ANN was used to forecast the performance of the tractor engine (58).

Horticulture

Horticulture is the branch of agriculture dedicated to the cultivation of fruits and vegetables (59). Modern agricultural systems use artificial intelligence to identify and classify fruits and vegetables by analysing their physical attributes-such as size, shape and colour and comparing them to established standard criteria and biological characteristics (10). It is used for crop grading and quality assessment of fruits by checking their moisture levels (59). The maturity of fruits and vegetables can be determined by AI technologies (60). AI detects the pest and disease infestation as well as nutrient deficiency of fruits and vegetable crops and assists the farmers in taking management measures and thus optimising yield and reducing the crop loss (61). AI assists in the drying process of fruits and vegetables (59). Gardening can be made fully automatic with AI-driven robots. It also plays a major role in lawn management and landscaping (10). AI driven IoT system reduces the spoilage of the horticultural crops during transportation. It is used to find whether the fruit has been ripened naturally or artificially as well as in identifying plant stress. AI-powered robots have been used for harvesting, pruning and weeding and thus automate the labour-intensive works (61). Additionally, AI is used in postharvest stages to monitor temperature, extend shelf life and maintain product quality (62).

To offer a comparative perspective of how artificial intelligence is used in various agricultural and allied sectors. Table 1 provides an overview of important domains, the AI technologies utilized application areas, their principal benefits and limitation involved.

Advantages and disadvantages of AI

Although AI presents massive possibilities in revolutionizing agriculture and allied sectors, its adoption is not without benefits and disadvantages. Table 2 enlists the major advantages, including increased efficiency and access to real-time data and the disadvantages, including problems like data privacy, unequal access and infrastructure constraints.

Results and Discussion

This review has demonstrated the diverse applications of artificial intelligence (AI) in agriculture and its allied sectors. AI-driven solutions enable data-informed decision making, optimize resource utilization and enhance productivity across each area such as pest and disease management, precision and greenhouse farming, soil health monitoring, yield prediction, weather forecasting and irrigation management.

In agri-allied sectors, such as horticulture, fisheries, forestry, agricultural marketing, animal husbandry and food science-AI has facilitated disease detection in crops and livestock, streamlined supply chains and improved food safety practices. The key advantages of AI include efficient resource management, enhanced productivity and reduced environmental impact through precision practices.

However, challenges remain the widespread adoption of AI is hindered by high implementation costs, lack of infrastructure, low digital literacy, intermittent connectivity, data privacy, lack of trust in AI systems and resistance to adoption.

In India, for example, the studies shows that although AI -driven mobile advisory platforms have potential, farmers lack of trust in AI technologies, their low literacy level and those in rural areas tend not to use them (10, 63). These limitations must be addressed to fully realize the potential of AI in agriculture.

Conclusion

There is no doubt that AI has the potential to foster sustainability in agriculture and its allied sectors, particularly when viewed through the lens of environmental conservation, efficiency and resilience. Its integration represents a transformative shift to towards smart and sustainable agriculture. Farmers can take informed decisions that enhance production while reducing the cost of inputs through AI-based solutions such as automated irrigation, precision agriculture, pest and disease management and real-time weather

Table 1. Summary of AI applications by sectors

Domain	AI technologies	Application area	Benefits	Limitation	References
Agriculture	ML, IoT, DL	Pest and disease management, Weather forecast and soil management, Crop and weed management, Greenhouse and precision farming, Irrigation management and yield prediction	Real time monitoring, reduced losses, increased yield	Unequal access by AI technologies especially by small scale farmers	(10, 13, 16, 24, 26, 31, 32, 64, 65)
Horticulture	Image recognition, robotics	Quality grading, ripeness detection	Improved sorting, reduced post-harvest loss	Lack of awareness of AI technologies by farmers in rural areas	(10, 59, 62)
Animal husbandry	AI sensors, ML, AI drones	Disease detection, analysing animal behaviour, milking in cattle	Improved livestock welfare	Data privacy	(34-36, 38, 63)
Forestry	Remote sensing+ DL/ML models	Forest fire prediction, biodiversity tracking	Resource conservation, illegal activity detection	Connectivity issues	(45, 46, 65)
Fishery	DL models, smart sensors, SVM	Species detection, disease monitoring	Sustainable fishery, fish stock management	Lack of training to farmers about usage of AI technologies	(48-50, 64)
Food science	AI and IoT predictive analysis	Food quality assessment, packaging	Waste reduction, improved safety and shelf life	High cost of AI technologies	(10, 53, 54, 66)
Agricultural engineering	AI robots, ANN	Mechanization (sowing, harvesting)	Precision operation	AI technologies reduce need for manual labour	(56-58, 64)
Agricultural marketing	DL, ML	Market price forecasting, supply chain optimization	Reduced middleman dependency for farmers, easy market access	Low digital literacy of the farmers	(10, 41, 43)

Table 2. Advantages and disadvantages of AI

Advantages of AI	Disadvantages of AI
AI provides data-driven insights and thus enhances resource management (64)	There is a lack of well-developed infrastructure for using AI (66)
AI has the potential to reduce the adverse environmental impacts (67)	The application of AI is highly expensive for the farmers (66)
Artificial intelligence enhances crop yield by predictive analysis (10)	Most farmers lack training about the AI usage (64)
Artificial intelligence technology advancements have strengthened and increased the productivity of agricultural based business (65)	AI application in agriculture creates Data safety and privacy concerns(63)
AI technologies improve efficiency in agriculture (65)	Farmers in rural areas face connectivity issues (65)
AI systems offer real-time and accurate data, allowing farmers to take timely decisions (64)	Unequal access to AI technologies by farmers, particularly small-scale farmers (65)
AI-driven technologies facilitates climate change adaptation by predicting weather patterns (65)	AI technologies decreases the need for manual labour (64)

forecasting. Despite these benefits, several barriers impede large-scale adoption including high implementation costs, a shortage of skilled professionals, inadequate digital infrastructure and data privacy concerns. Stakeholder collaboration and enabling policies are central to making AI available and farmer-friendly, particularly for smallholders.

In the future, agricultural sustainability can be enhanced further by integrating AI with advanced technologies such as block chain, the Internet of Things (IoT) and remote sensing. Long-term success will depend on a balanced approach that integrates AI-driven technologies with traditional farming principles. New technologies like federated learning (to enable privacy-preserving AI models) and generative AI (to model crop situations or advisory assistance) show great promise. There are still questions around how to best localize AI, scale it among smallholder farmers and combine it with conventional approaches. It will be essential to achieve a harmonious, farmer-driven balance that connects technological innovation with accessibility if the full potential of AI in sustainable agriculture is to be achieved. Ultimately, the advantages of AI outweigh its limitations, making it a powerful tool in the pursuit of sustainable agricultural development.

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Authors' contributions

SV carried out the survey, analysed the data and formulated the manuscript. SN assisted in data collection and analysis as part of the research study. KC contributed by developing ideas, reviewing the manuscript and assisting with procuring research grants.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

References

1. Gustafson JP, Raven PH. World food supply: problems and prospects. In: Sivasankar S, Ellis N, Jankuloski L, Ingelbrecht I, editors. Mutation breeding, genetic diversity and crop adaptation to climate change. 1st ed. UK: CABI; 2021. p. 3-9. https://doi.org/10.1079/9781789249095.0001
2. Talaviya T, Shah D, Patel N, Yagnik H, Shah M. Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. Artif Intell Agric. 2020;4:58-73. https://doi.org/10.1016/j.aiia.2020.04.002
3. Merrill BF, Lu N, Yamaguchi T, Takagaki M, Maruo T, Kozai T, et al. Next evolution of agriculture: A review of innovations in plant factories. In: Pessarakli M, editor. Handbook of photosynthesis. CRC Press; 2018. https://doi.org/10.1201/9781315372136-40
4. Chandel N, Kumar A, Kumar R. Towards sustainable agriculture: Integrating agronomic practices, environmental physiology and plant nutrition. Int J Plant Soil Sci. 2024;36(6):492-503. https://doi.org/10.9734/ijpss/2024/v36i64651
5. Sonnino A. Towards Sustainable Food and Agriculture Systems. Rendiconti/Accademia Nazionale Del Xl XLII(Tomo I). 2018:103-14.
6. Naresh RK, Chandra MS, Vivek S, Charankumar GR, Chaitanya J, et al. The prospect of artificial intelligence (AI) in precision agriculture for farming systems productivity in sub-tropical India: A review. Curr J Appl Sci Technol. 2020;39(48):96-110. https://doi.org/10.9734/cjast/2020/v39i4831205
7. Nagendraswamy C, Salis A. A review article on artificial intelligence. Ann Biomed Sci Eng. 2021;5:013-4. https://doi.org/10.29328/journal.abse.1001012
8. Fadziso T. How artificial intelligence improves agricultural productivity and sustainability: A global thematic analysis. Asia Pac J Energy Environ. 2019;6:91-100. https://doi.org/10.18034/apjee.v6i2.542
9. Erh-Chun, Shan L, Chan P. How artificial intelligence is transforming agriculture. Rev Bus Res. 2023;23(1):59-70. https://doi.org/10.18374/RBR-23-1.6
10. Javaid M, Haleem A, Khan IH, Suman R. Understanding the potential applications of artificial intelligence in agriculture sector. Adv Agrochem. 2023;2(1):15-30. https://doi.org/10.1016/j.aac.2022.10.001
11. Kolikipogu R, Darak V, Yennapu R, Reddy S, Sureddi RMK, Kuchipudi R. Agriculture recommender system for precision farming using machine learning (ARS). In: 2023 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA). IEEE; 2023 Dec 21. p. 921-7. https://doi.org/10.1109/ICIMIA60377.2023.10426510
12. Begum M. Impact of climate change on agriculture and its allied sectors: An overview. Emerg Trends Clim Change. 2022;1(1):19-28. https://doi.org/10.18782/2583-4770.103
13. Jose Mekha, Parthasarathy V. An automated pest identification and classification in crops using artificial intelligence-A state-of-art-review. Autom Control Comput Sci. 2022;56(3):283-90. https://doi.org/10.3103/S0146411622030038
14. Prabha R, Kennedy JS, Vanitha G, Sathiah N, Priya MB. Artificial intelligence-powered expert system model for identifying fall armyworm infestation in maize (*Zea mays* L.). J Appl Nat Sci. 2021;13(4):1339-49. https://doi.org/10.31018/jans.v13i4.3040
15. Susheel KS, Rajkumar R. A comprehensive review on intelligent techniques in crop pests and diseases. Int J Recent Innov Trends Comput Commun. 2023;11(9):137-49. https://doi.org/10.17762/ijritcc.v11i9.8328
16. Patil R, Sinkar Y, Ruke A, Kulkarni H, Kadam O. Smart agri-advisor: Integrating chatbot technology with CNN-based crop disease classification for enhanced agricultural decision-making. Int J Eng Trends Technol. 2024;72(7):375-80. https://doi.org/10.14445/22315381/IJETT-V72I7P141
17. Shoaib M, Shah B, EI-Sappagh S, Ali A, Ullah A, Alenezi F, et al. An advanced deep learning models-based plant disease detection: A review of recent research. Front Plant Sci. 2023;14:1158933. https://doi.org/10.3389/fpls.2023.1282443
18. Storey G, Meng Q, Li B. Leaf disease segmentation and detection in apple orchards for precise smart spraying in sustainable agriculture. Sustain. 2022;14(3):1458. https://doi.org/10.3390/su14031458
19. Karar ME, Alsunaydi F, Albusaymi S, Alotaibi S. A new mobile application of agricultural pests recognition using deep learning

in cloud computing system. Alex Eng J. 2021;60(5):4423-32. https://doi.org/10.1016/j.aej.2021.03.009

20. Tannous M, Stefanini C, Romano D. A deep-learning-based detection approach for the identification of insect species of economic importance. Insects. 2023;14(2):148. https://doi.org/10.3390/insects14020148
21. Adikari KE, Shrestha S, Ratnayake DT, Budhathoki A, Mohanasundaram S, Dailey MN. Evaluation of artificial intelligence models for flood and drought forecasting in arid and tropical regions. Environ Model Softw. 2021;144:105136. https://doi.org/10.1016/j.envsoft.2021.105136
22. Awais M, Naqvi SMZA, Zhang H, Li L, Zhang W, Awwad FA, et al. AI and machine learning for soil analysis: an assessment of sustainable agricultural practices. Bioresour Bioprocess. 2023;10(1):90. https://doi.org/10.1186/s40643-023-00710-y
23. Bilal M, Rubab F, Hussain M, Shah SAR. Agriculture revolutionized by artificial intelligence: Harvesting the future. In: The 2nd International Online Conference on Agriculture. MDPI; 2023. p. 11. https://doi.org/10.1186/s40643-023-00710-y
24. Ghatrehsamani S, Jha G, Dutta W, Molaei F, Nazrul F, Fortin M, et al. Artificial intelligence tools and techniques to combat herbicide resistant weeds—A review. Sustain. 2023;15(3):1843. https://doi.org/10.3390/su15031843
25. Etienne A, Ahmad A, Aggarwal V, Saraswat D. Deep learning-based object detection system for identifying weeds Using UAS imagery. Remote Sens. 2021;13(24):5182. https://doi.org/10.3390/rs13245182
26. Maraveas C. Incorporating artificial intelligence technology in smart greenhouses: Current state of the art. Appl Sci. 2022;13(1):14. https://doi.org/10.3390/app13010014
27. Codeluppi G, Cilfone A, Davoli L, Ferrari G. AI at the edge: a smart gateway for greenhouse air temperature forecasting. In: 2020 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor). Trento, Italy: IEEE; 2020. p. 348-53. https://doi.org/10.1109/MetroAgriFor50201.2020.9277553
28. Fernando S, Nethmi R, Silva A, Perera A, Silva RD, Abeygunawardhana PWK. AI based greenhouse farming support system with robotic monitoring. In: 2020 IEEE Region 10 Conference (TENCON). Osaka, Japan: IEEE; 2020. p. 1368-73. https://doi.org/10.1109/TENCON50793.2020.9293745
29. Tace Y, Tabaa M, Elfilali S, Leghris C, Bensag H, Renault E. Smart irrigation system based on IoT and machine learning. Energy Rep. 2022;8:1025-36. https://doi.org/10.1016/j.egyr.2022.07.088
30. Wei H, Xu W, Kang B, Eisner R, Muleke A, Rodriguez D, et al. Irrigation with artificial intelligence: Problems, premises, promises. Hum-Centric Intell Syst. 2024;4(2):187-205. https://doi.org/10.1007/s44230-024-00072-4
31. Raouhi EM, Zouizza M, Lachgar M, Zouani Y, Hrimech H, Kartit A. AIDSII: An AI-based digital system for intelligent irrigation. Softw Impacts. 2023;17:100574. https://doi.org/10.1016/j.simpa.2023.100574
32. Padhiary M, Saha D, Kumar R, Sethi LN, Kumar A. Enhancing precision agriculture: A comprehensive review of machine learning and AI vision applications in all-terrain vehicle for farm automation. Smart Agric Technol. 2024;8:100483. https://doi.org/10.1016/j.atech.2024.100483
33. Alazzai WK, Abood BShZ, Al-Jawahry HM, Obaid MK. Precision farming: The power of AI and IoT technologies. In: Li G, Subramaniam U, Sekar M, editors. International Conference on Environmental Development Using Computer Science (ICECS'24). Vol. 491. E3S Web Conference; 2024. p. 04006. https://doi.org/10.1051/e3sconf/202449104006
34. Bao J, Xie Q. Artificial intelligence in animal farming: A systematic literature review. J Clean Prod. 2022;331:129956. https://doi.org/10.1016/j.jclepro.2021.129956
35. Kandarpa Boruah, Prabodh Kumar Hembram, Debapritam Deb, Shehnaaz Rahman, Nilotpal Ghosh. Internet of Things (IoT) and Artificial Intelligence (AI) in livestock farming. BioNE. 2025;28(32).
36. Neethirajan S. Artificial intelligence and sensor innovations: Enhancing livestock welfare with a human-centric approach. Hum-Centric Intell Syst. 2023;4(1):77-92. https://doi.org/10.1007/s44230-023-00050-2
37. Melak A, Aseged T, Shitaw T. The influence of artificial intelligence technology on the management of livestock farms. Int J Distrib Sens Netw. 2024;2024:1-12. https://doi.org/10.1155/2024/8929748
38. Patel H, Samad A, Hamza M, Muazzam A, Harahap MK. Role of artificial intelligence in livestock and poultry farming. Sinkron. 2022;7(4):2425-9. https://doi.org/10.33395/sinkron.v7i4.11837
39. Cho Y, Kim J. AI-based intelligent monitoring system for estrus prediction in the livestock industry. Appl Sci. 2023;13(4):2442. https://doi.org/10.3390/app13042442
40. Nagahara M, Tatemoto S, Ito T, Fujimoto O, Ono T, Taniguchi M, et al. Designing a diagnostic method to predict the optimal artificial insemination timing in cows using artificial intelligence. Front Anim Sci. 2024;5:1399434. https://doi.org/10.3389/fanim.2024.1399434
41. Haleem A, Javaid M, Asim Qadri M, Pratap Singh R, Suman R. Artificial intelligence (AI) applications for marketing: A literature-based study. Int J Intell Netw. 2022;3:119-32. https://doi.org/10.1016/j.ijin.2022.08.005
42. Ljepava N. AI-enabled marketing solutions in marketing decision making: AI application in different stages of marketing process. TEM J. 2022;1308-15. https://doi.org/10.18421/TEM113-40
43. Elufioye OA, Ike CU, Odeyemi O, Usman FO, Mhlongo NZ. Ai-Driven predictive analytics in agricultural supply chains: a review: assessing the benefits and challenges of ai in forecasting demand and optimizing supply in agriculture. Comput Sci IT Res J. 2024;5(2):473-97. https://doi.org/10.51594/csitrj.v5i2.817
44. Hongbing W, Jing G, Bohan K, Peng L, Yuxian S. Analysis and research on the marketing strategy of agricultural products based on artificial intelligence. Math Probl Eng. 2022;2022:1-7. https://doi.org/10.1155/2022/7798640
45. Sakr GE, Elhajj IH, Mitri G, Wejinya UC. Artificial intelligence for forest fire prediction. In: 2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics. Montreal, QC, Canada: IEEE; 2010. p. 1311-6. https://doi.org/10.1109/AIM.2010.5695809
46. Shivaprakash KN, Swami N, Mysorekar S, Arora R, Gangadharan A, Vohra K, et al. Potential for Artificial Intelligence (AI) and Machine Learning (ML) applications in biodiversity conservation, managing forests and related services in India. Sustain. 2022;14(12):7154. https://doi.org/10.3390/su14127154
47. Da Silva DQ, Dos Santos FN, Filipe V, Sousa AJ, Oliveira PM. Edge AI-based tree trunk detection for forestry monitoring robotics. Robotics. 2022;11(6):136. https://doi.org/10.3390/robotics11060136
48. Honarmand Ebrahimi S, Ossewaarde M, Need A. Smart fishery: A systematic review and research agenda for sustainable fisheries in the age of AI. Sustain. 2021;13(11):6037. https://doi.org/10.3390/su13116037
49. Hari Prasad Mohale1 PJ, Jawahar P, Jayakumar N, Arul Oli G, Ravikumar T. Application of deep learning (AI) in marine fisheries resource management. Trends Agri Sci. 2023;2(9):753-63.
50. Ahmed MS, Aurpa TT, Azad MdAK. Fish disease detection using image based machine learning technique in aquaculture. J King Saud Univ - Comput Inf Sci. 2022;34(8):5170-82. https://doi.org/10.1016/j.jksuci.2021.05.003
51. Rejeb A, Rejeb K, Zailani S, Keogh JG, Appolloni A. Examining the interplay between artificial intelligence and the agri-food

industry. Artif Intell Agric. 2022;6:111-28. https://doi.org/10.1016/j.aiia.2022.08.002

52. Kakani V, Nguyen VH, Kumar BP, Kim H, Pasupuleti VR. A critical review on computer vision and artificial intelligence in food industry. J Agric Food Res. 2020;2:100033. https://doi.org/10.1016/j.jafr.2020.100033

53. Misra NN, Dixit Y, Al-Mallahi A, Bhullar MS, Upadhyay R, Martynenko A. IoT, big data and artificial intelligence in agriculture and food industry. IEEE Internet Things J. 2022;9(9):6305-24. https://doi.org/10.1109/JIOT.2020.2998584

54. Kutyauripo I, Rushambwa M, Chiwazi L. Artificial intelligence applications in the agrifood sectors. J Agric Food Res. 2023;11:100502. https://doi.org/10.1016/j.jafr.2023.100502

55. Golshani T. The role of AI in managing risk in agricultural engineering. SSRN Electron J. 2024. https://doi.org/10.2139/ssrn.4842193

56. Wakchaure M, Patle BK, Mahindrakar AK. Application of AI techniques and robotics in agriculture: A review. Artif Intell Life Sci. 2023;3:100057. https://doi.org/10.1016/j.ailsci.2023.100057

57. Subeesh A, Mehta CR. Automation and digitization of agriculture using artificial intelligence and internet of things. Artif Intell Agric. 2021;5:278-91. https://doi.org/10.1016/j.aiia.2021.11.004

58. Nagar H, Machavaram R, Kulkarni P, Soni P. AI-based engine performance prediction cum advisory system to maximise fuel efficiency and field performance of the tractor for optimum tillage. Syst Sci Control Eng. 2024;12(1):2347936. https://doi.org/10.1080/21642583.2024.2347936

59. Singh R, Singh R, Gehlot A, Akram SV, Priyadarshi N, Twala B. Horticulture 4.0: Adoption of industry 4.0 technologies in horticulture for meeting sustainable farming. Appl Sci. 2022;12(24):12557. https://doi.org/10.3390/app122412557

60. Kumar V, Jakhwal R, Chaudhary N, Singh S. Artificial intelligence in horticulture crops. Ann Hortic. 2023;16(1):72-9. https://doi.org/10.5958/0976-4623.2023.00014.2

61. Gammanpila HW, Sashika MAN, Priyadarshani SVGN. Advancing horticultural crop loss reduction through robotic and AI technologies: Innovations, applications and practical implications. Xiao X, editor. Adv Agric. 2024;2024(1):2472111. https://doi.org/10.1155/2024/2472111

62. Opara IK, Opara UL, Okolie JA, Fawole OA. Machine learning application in horticulture and prospects for predicting fresh produce losses and waste: A Review. Plants. 2024;13(9):1200. https://doi.org/10.3390/plants13091200

63. Meghwanshi S. Artificial intelligence in agriculture: A Review. Int Res J Mod Eng Technol Sci. 2024;6:4358-63.

64. Hussein AHA, Jabbar KA, Mohammed A, Jasim L. Harvesting the future: AI and IoT in agriculture. In: Slimani K, Gerasymov O, Kerkeb ML, editors. International Conference on Smart Technologies and Applied Research (STAR'2023). Vol. 477. E3S Web Conference; 2024. p. 00090. https://doi.org/10.1051/e3sconf/202447700090

65. Verma A, Verma S. Role of artificial intelligence in agriculture. Agric Magazine. 2023;2:281-6. https://doi.org/10.58532/V2BS16CH8

66. Mathur R. Artificial intelligence in sustainable agriculture. Int J Res Appl Sci Eng Technol. 2023;11(6):4047-52. https://doi.org/10.22214/ijraset.2023.54360

67. Olabimpe Banke Akintuyi. Adaptive AI in precision agriculture: A review: Investigating the use of self-learning algorithms in optimizing farm operations based on real-time data. Open Access Res J Multidiscip Stud. 2024;7(2):016-30. https://doi.org/10.53022/oarjms.2024.7.2.0023

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