



Artificial intelligence in agriculture: Clarification using artificial intelligence applications in precision agriculture, monitoring crops and predicting yields

Student full name :bashayer Osman Shaheen



Table of Contents

Abstract.	2
Introduction.....	3
Background	3
Problem Statement	4
Research Objectives.....	4
Research scope	5
Literature review.....	6
Research Methodology	10
Expected Outcomes.....	11
Gantt chart.....	11
References.....	12

Abstract

The importance of precision agriculture has become a demand and a necessity to ensure sustainable food production and optimize resource use. Traditional methods for crop monitoring and yield prediction are often labor-intensive, time-consuming, and prone to inaccuracy. This study aims to explore the application of AI in precision agriculture to improve crop monitoring and yield prediction. Specifically, the study will examine AI techniques such as machine learning algorithms, computer vision, and remote sensing data to analyze crop health, detect anomalies, and predict production outcomes. Data will be collected from satellite imagery, Internet of Things sensors, and historical agricultural records. Expected outcomes include the development of an AI-based framework capable of providing accurate and real-time insights to farmers, reducing crop losses, and supporting data-driven decision-making. By integrating AI into precision agriculture practices, this research seeks to contribute to more efficient, sustainable, and productive agricultural systems.

•Introduction :

Agriculture is one of the most important sectors for ensuring global food security. However, numerous challenges exist, including climate change, resource scarcity, and growing food demand. Traditional farming practices and monitoring methods are often insufficient to address these complex issues, relying heavily on manual observation and historical data. Precision agriculture, supported by technological innovations such as sensors, drones, and artificial intelligence, has emerged as a promising approach to improving agricultural operations. In particular, AI has demonstrated its potential to improve crop monitoring and yield prediction with greater accuracy, enabling farmers to make informed decisions that enhance productivity and sustainability.

Background :

Precision agriculture combines advanced technologies to improve agricultural practices by providing site-specific insights into crop conditions, soil health, and resource utilization. This approach not only reduces waste but also increases efficiency and productivity. AI, a key enabler, contributes to precision agriculture through machine learning, computer vision, and predictive analytics. For example, AI-powered models can analyze multispectral imagery from drones and satellites to detect crop stress early, while machine learning algorithms can predict yields based on environmental and historical data. Despite these advantages, the successful integration of AI into agriculture depends on overcoming challenges related to data availability, local adaptation, and scalability.

Problem statement :

Traditional agricultural practices, including conventional monitoring and evaluation (M&E), result in inefficient resource use and limited adaptability to changing environmental conditions. With increasing global food demand and increasing disruptions caused by climate variability, farmers face significant challenges in accurately monitoring crop health and predicting yields. Artificial intelligence (AI) offers advanced solutions through real-time data analysis, automated decision-making, and predictive modeling, but its practical application in agriculture remains limited. Key challenges include the lack of high-quality datasets, variability across different agricultural contexts, and the gap between research-level AI models and their real-world deployment. Furthermore, current AI systems are often not sufficiently optimized for local crop species, soil conditions, and regional weather patterns. Addressing these limitations is essential to ensure that AI-based solutions in precision agriculture are scalable, context-aware, and effective in enhancing decision-making and optimizing resources.

Research objective :

To investigate the current limitations of traditional agricultural methods, as well as crop quality monitoring and yield prediction.

To analyze To analyze how artificial intelligence and its technologies can be used to advance precision agriculture practices.

To develop traditional work on artificial intelligence in crop monitoring and real-time productivity prediction.

To test the accuracy and scalability of AI in different agricultural environments.

To provide viable plans for implementing AI in various agricultural systems, especially in resource-limited environments.

•Research scope:

This research aims to explore the role of artificial intelligence in precision agriculture, specifically focusing on crop monitoring and yield prediction. The study presents current AI applications, highlights their benefits and limitations, and identifies gaps in current approaches. The scope of the research is limited to exploring AI-based methods and models to support decision-making in agriculture, rather than covering the full spectrum of agricultural technologies such as robotics or biotechnology. The research also demonstrates the scalability and adaptability of AI solutions in diverse agricultural contexts, particularly in resource-limited areas.

Literature review:

Paper1: **Data-Driven Artificial Intelligence Applications for Sustainable Precision Agriculture**

Authors/year: Linaza et al,2021

Objective :learn and study AI applications to improve precision agriculture sustainably by comparing different field results in Europe, with the ultimate goal of improving farm management decisions and reducing resource consumption and environmental impacts.

Methodology:All data from various European field projects with different climatic conditions and agricultural technologies are collected. The results from these projects are also systematically analyzed to evaluate the performance of AI solutions on the ground to support agricultural decision-making.

Key Results:Implementing AI leads to increased productivity, better management of water and fertilizer resources, and reduced greenhouse gas emissions.

Some projects are in their early stages, but they have demonstrated significant improvements in improving farmers' decisions.

The researchers propose a broad scope and expanded research to include smart robots for collecting soil and plant samples and managing livestock more intelligently

Limitations:Lack of detailed models and algorithms.

Paper2: Computer vision and artificial intelligence in precision agriculture for grain crops: A systematic review

Authors/year: Patrício & Rieder, 2018

Objective : To monitor and determine the effectiveness of improved technologies in disease detection, seed quality, and plant phenotypes. Therefore, the usefulness of computer vision and artificial intelligence techniques in precision agriculture for cereal crops (such as corn, rice, wheat, soybeans, and barley) is evident.

Methodology: Analyzes the results of studies related to crops (such as SVM, DBN, CNN, and image processing), and the study objectives (such as disease detection and phenotyping).

Key Results: There has been increased interest in using GPUs and advanced technologies such as Deep Belief Networks to build robust computer vision systems for precision agriculture.

Limitations: Outdated technologies, limited sample size, lacking state-of-the-art learning methods.

Paper3: **Enabling Precision Agriculture Through Embedded Sensing
With Artificial Intelligence**

Authors/year: Shadrin et al,2020

Objective : To improve the low-power embedded sensor system with artificial intelligence (AI) processing, enabling continuous live monitoring of tomato plant growth over a long period (up to 180 days) without the need for constant farmer intervention.

Methodology: Relies on a long-term memory network (LSTM) RNN technology to perform in-situ prediction and integrates low-power field sensors with an on-board graphics processing unit (GPU). Field trials are underway on tomato crops, with a battery life of 180 days to ensure the system's autonomy.

Key Results: • The system successfully predicted plant growth over a 6-month period without human intervention, using only field sensor data.

- Demonstrated that NLP intelligence within devices can be efficiently implemented at low power, representing an important step toward autonomous intelligent systems in agriculture.

Limitations: Limited to a single plant; experiment limited and not generalizable

2024

Paper4: **Artificial Intelligence in Precision Agriculture: A Review**

Authors/year: Comprehensive Review,2023

Objective : This paper proposes a strategy that encompasses AI applications, including machine learning and deep learning, in precision agriculture from 2000 to 2023. The aim is to determine how these technologies have impacted improved crop management and reduced agricultural losses.

Methodology: • The methodology analyzes up to 100 research papers using the SALSA (Search, Appraisal, Synthesis, Analysis) method.

• The practical application of AI is classified into six areas: disease management, soil and irrigation, pests, weeds, yield forecasting, and general crop management.

Key Results: AI contributes to the optimal use of resources (water, pesticides, fertilizers), reducing costs and environmental impacts. Deep neural network technologies (such as CNN, Transformers, and Meta Learning) have improved the accuracy of yield forecasting and provided solutions for disease, irrigation, and soil management.

Limitations: Review without practical application, some repetition, weak statistical analysis.

Research methodology :

- **Study Type: Analytical-Empirical Research**

- **Data Collection:**

- **Secondary: Research papers (2018-2025) from Scopus, IEEE, MDPI, and ScienceDirect.**

- **Primary (if available): Drone imagery, IoT sensor data, and satellite data (MODIS, Sentinel-2).**

- **Analysis Techniques:**

- 1. Comparative Evaluation of AI Algorithms (CNN, LSTM, Random Forest, and Hybrid Models).**

- 2. Assessment of Accuracy, Scalability, and Resource Efficiency.**

- 3. Identification of Practical Challenges for Application.**

- **Alignment of Objectives: Ensures that the research objectives are met through the systematic evaluation of AI applications and provides practical recommendations.**

•Expected outcomes.

1. Identifies the most effective AI solutions for crop monitoring and yield prediction.
2. Assists in evaluating AI for rationalizing water, fertilizer, and energy consumption.
3. Recommendations for the sustainable deployment of AI-based precision agriculture solutions.
4. A framework for integrating AI with IoT and drone technologies to improve farm management.

•Gantt chart:

Task	Week1	Week2	Week3	Week4	Week5	Week6
Literature review						
Data collection						

References:

1. (Linazza et al., 2021) Data-Driven AI Applications in Sustainable Precision Agriculture((<https://www.mdpi.com/2073-4395/11/6/1227>))
 2. (Patricio and Rieder, 2018) Computer Vision and AI in Precision Agriculture of Cereal Crops: A Systematic Review((<https://www.sciencedirect.com/science/article/abs/pii/S0168169918305829>))
 3. (Comprehensive Review, 2023) Artificial Intelligence in Precision Agriculture: A Review((https://www.researchgate.net/profile/Mohd-Hairi-Mohd-Zaman/publication/390315661_Artificial_Intelligence_in_Precision_Agriculture_A_Review/links/6805b8b3df0e3f544f4333e7/Artificial-Intelligence-in-Precision-Agriculture-A-Review.pdf))
 4. (Shadrin et al., 2020) Enabling Precision Agriculture through AI-Integrated Sensing((<https://ieeexplore.ieee.org/abstract/document/8867862>))
-

1. Data-Driven AI Applications in Sustainable Precision Agriculture

(Linazza et al., 2021)

This study explores several European agricultural projects that integrate AI and data-driven technologies.

((<https://www.mdpi.com/2073-4395/11/6/1227>))

2. Computer Vision and AI in Precision Agriculture of Cereal Crops: A Systematic Review

(Patricio and Rieder, 2018)

This systematic review focuses on the use of computer vision and AI in cereal crop monitoring. It emphasizes early disease detection and quality assessment using image-based systems.

((<https://www.sciencedirect.com/science/article/abs/pii/S0168169918305829>))

3. Artificial Intelligence in Precision Agriculture: A Review

(Comprehensive Review, 2023)

A comprehensive review covers over 100 studies on AI applications in agriculture, including machine learning, computer vision, and IoT-based systems.

((https://www.researchgate.net/profile/Mohd-Hairi-Mohd-Zaman/publication/390315661_Artificial_Intelligence_in_Precision_Agriculture_A_Review/links/6805b8b3df0e3f544f4333e7/Artificial-Intelligence-in-Precision-Agriculture-A-Review.pdf))

4. Enabling Precision Agriculture through AI-Integrated Sensing

(Shadrin et al., 2020)

A practical research paper presenting a low-power, integrated AI system for tomato plant growth monitoring using sensor-integrated LSTM models.

((<https://ieeexplore.ieee.org/abstract/document/8867862>))