https://doi.org/10.46335/IJIES.2026.11.2.4 e-ISSN: 2456-3463
Vol. 11, No. 2, 2026, PP. 12-15

International Journal of Innovations in Engineering and Science, www.ijies.net

A Review On Smart Agriculture System Using Machine Learning and IOT

Dr. Snehal Golait[1], Anshika Palewar[2], Snehal Bhagat[3], Om Gupta[4], Sujal Kothale[5]

[1] Assistant Professor, Computer Science and Engineering, Priydarshni College of Engineering, Nagpur
[2,3,4,5,6] UG student, Computer Science and Engineering, Priydarshni College of Engineering, Nagpur

anshikapalewar@gmail.com

***Received on**: 05 March, 2026* ***Revised on**: 05 April, 2026* ***Published on**: 07 April, 2026*

***Abstract** – Agriculture plays a vital role in the economy, but traditional farming methods lack efficiency and accuracy. This review paper analyses various machine learning and IoT-based approaches used for crop disease prediction and smart irrigation. The study highlights different algorithms, sensors, and communication technologies used in modern agriculture systems. The objective of this paper is to provide a comparative analysis of existing methods and identify research gaps for future work. In recent years, modern technologies such as Machine Learning and the Internet of Things have been used to improve agricultural practices. Machine learning techniques help in identifying crop diseases by analysing images of plant leaves. IoT-based systems use sensors to monitor soil moisture, temperature, and humidity in real time and control irrigation automatically. These technologies help farmers make better decisions and reduce manual effort.*

Keywords - Machine Learning, IoT, Smart Agriculture, Crop Disease Detection

I -INTRODUCTION

Agriculture plays a significant role in supporting global food demand and economic stability, particularly in developing countries. Traditionally, farming practices relied on manual labor, seasonal patterns, and farmers' experience for decision-making. These conventional methods often lacked precision and efficiency, resulting in inconsistent crop yields and excessive use of resources such as water and fertilizers. Additionally, factors like climate change, soil degradation, and population growth have further increased the pressure on agricultural systems, making traditional approaches less effective in meeting modern demands. To address these challenges, the concept of smart agriculture has emerged as a promising solution. Smart agriculture integrates advanced technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) to improve farming practices. The primary objective is to enhance productivity, optimize resource utilization, and support sustainable agricultural development. IoT enables the deployment of sensors and connected devices that continuously monitor environmental and soil conditions, including temperature, humidity, and moisture levels. This real-time data collection allows farmers to gain accurate insights into field conditions.

Artificial Intelligence further enhances the system by analyzing the collected data and generating meaningful predictions and recommendations. Machine learning models can assist in applications such as crop disease detection, yield prediction, irrigation management, and weather forecasting. Unlike traditional farming, which is largely reactive, smart agriculture enables proactive decision- making based on data analysis and automation. A general architecture of an IoT-based smart agriculture system is illustrated in **Fig. 1**, showing typical

https://doi.org/10.46335/IJIES.2026.11.2.4 e-ISSN: 2456-3463
Vol. 11, No. 2, 2026, PP. 12-15

components such as sensors, microcontroller units, power supply, and control mechanisms used in such systems In earlier agricultural systems, decisions were primarily based on observation and experience, which often led to inefficiencies and resource wastage. In contrast, modern smart agriculture systems rely on data-driven approaches, improving accuracy, reducing human effort, and minimizing risks. This transition from conventional to intelligent farming represents a significant advancement in agricultural practices.

The system presented in this work is based on the integration of IoT and AI technologies. It consists of both hardware and software components. The hardware layer includes sensor-based data acquisition using microcontrollers such as ESP32 to collect real-time field data. The software layer is divided into backend and frontend modules. The backend is developed using Python, where data processing, application logic, and machine learning models are implemented. Components such as model training, testing datasets, and execution modules are organized systematically to ensure efficient processing. A virtual environment is used for dependency management and system stability.

The frontend is developed using a modern web framework, enabling an interactive and user-friendly interface. It includes structured components, styling modules, and public assets to visualize system outputs and provide an accessible platform for users. Integration between the frontend and backend ensures smooth data flow and real-time interaction. This paper presents a comprehensive analysis of smart agriculture systems based on IoT and AI, highlighting their applications, benefits, challenges, and future scope. The study aims to provide a clear understanding of how these technologies contribute to transforming traditional agriculture into an efficient, intelligent, and sustainable system

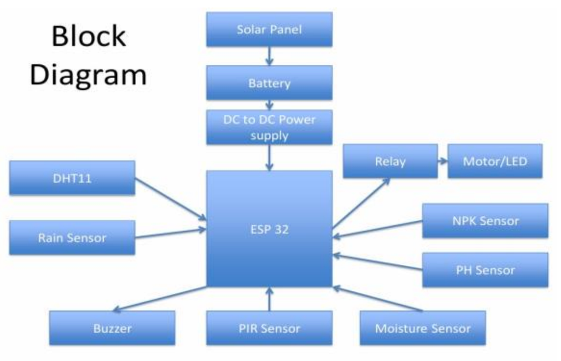

Fig 1: General block diagram representing a smart irrigation system.

II. LITERATURE REVIEW

Sayantan Goon, Suari Debbarma *et al.* (2022) proposed a low-cost smart agriculture system based on IoT technology. The system utilizes sensors to monitor soil moisture, temperature, humidity, and animal movement. A microcontroller processes sensor data and sends alerts to the farmer via Wi-Fi/3G/4G connectivity. The irrigation process is manually controlled but supported by sensor-based recommendations. The study focuses on improving crop yield and water conservation, without incorporating machine learning, thus serving as a baseline IoT model.

Md. Najmul Mowla, Neazmul Mowla *et al.* (2023) presented a comprehensive survey on IoT and Wireless Sensor Networks (WSN) for smart agriculture[2]. The paper reviews various sensor-based farming systems and discusses communication technologies such as ZigBee, Wi-Fi, SigFox, and LoRaWAN. It highlights applications including irrigation management, soil monitoring, and pest control. The study mainly focuses on network performance, power efficiency, and scalability challenges, without implementing specific machine learning models.

Ahmed A. Esmail, Manar A. Ibrahim *et al.* (2023) proposed a smart irrigation system integrating IoT and machine learning techniques. The system uses sensors connected to Arduino Uno and NodeMCU to collect environmental data. Machine learning algorithms such as Logistic Regression, Decision Tree, and SVM are applied for irrigation prediction. The Decision Tree model achieved the highest accuracy of 89.68%, outperforming other models. The system also includes cloud-based APIs for real-time monitoring and automated irrigation control.

Pavithra S., S. Shenbagavadivu *et al.* (2024) proposed an integrated smart agriculture platform using multiple AI and ML algorithms. The system includes modules for crop recommendation, disease detection, irrigation monitoring, and field mapping. Random Forest is used for crop prediction, while CNN is applied for plant disease detection using leaf images. The platform also utilizes tools like Pandas and Streamlit to provide a user-friendly web-based dashboard for real-time analytics.

Ghulam Mohyuddin, Muhammad Adnan Khan *et al.* (2024) conducted a review of machine learning approaches in precision farming. The study evaluates algorithms such as Decision Trees, Random Forest, SVM, ANN, and Deep Learning models for applications like soil analysis, crop recommendation, and disease detection. The paper reports that many models achieve accuracy above 90% and emphasizes the role of IoT and sensor data in enhancing ML model performance.

Dr. Dattatray Sambhajirao Waghole, Sonali Ramalingappa Betageri *et al.* (2024) presented a survey on smart agriculture systems combining IoT, AI, and ML technologies. The system architecture includes sensors such as soil moisture, DHT11, and ultrasonic sensors integrated with NodeMCU. It supports automated irrigation using relay control and mobile applications like Blynk. The study reviews machine learning models including regression, decision trees, and neural networks, along with cloud and edge computing frameworks.

Abdennabi Morchid, Abdennacer Elbasri *et al.* (2025) proposed an innovative smart irrigation system using embedded systems and regression-based machine learning. The system is built using ESP32 and multiple sensors to collect real-time environmental data. A linear regression model is used to predict soil moisture and irrigation needs. The model shows efficient performance with low computation time, making it suitable for real-time embedded applications, and demonstrates reduced water consumption.

Avinash Pawar and S. B. Deosarkar (2023) proposed an IoT-based smart agriculture system focusing on data-driven farming practices. The study highlights the use of sensors and connected devices to monitor environmental conditions and improve agricultural productivity. It emphasizes the transition from traditional farming to intelligent systems using IoT technologies for efficient resource management.

Rekha J Patil, Indira Mulage *et al.* (2023) proposed a smart agriculture system integrating IoT and machine learning. The system collects real-time data such as soil moisture, temperature, and pH levels and uses ML techniques to improve crop productivity and decision-making. The study shows how IoT-based monitoring combined with predictive models enhances farming efficiency.

Majid Nawaz and Muhammad Inayatullah Khan Babar (2025) discussed the integration of IoT and AI for smart agriculture in resource-constrained environments. The paper focuses on challenges such as climate change, limited resources, and the need for efficient farming techniques. It highlights AI-driven decision-making and smart monitoring systems for sustainable agriculture.

A study published on ScienceDirect (2023) presents a comprehensive review of smart farming technologies including IoT, wireless communication, sensors, and automation hardware. The paper analyzes how these technologies contribute to agricultural automation and discusses the importance of selecting appropriate sensors and communication systems for efficient farming.

Another review on ScienceDirect (2023) explores IoT technologies for sustainable agriculture. The study examines different sensors, controllers, and communication protocols used in farming systems. It highlights how IoT integration improves resource utilization and supports sustainable crop production practices.

Nabila ElBeheiry and Robert S. Balog (2023) presented a review in IEEE discussing the transition from traditional agriculture to smart farming. The study reviews multiple technologies such as IoT, data analytics, and automation systems, and identifies key challenges including climate impact, labor shortage, and system integration.

CONCLUSION

This review paper analysed recent studies on smart agriculture using IoT, AI, and machine learning techniques. The reviewed literature shows that sensor-based data collection and intelligent algorithms improve irrigation efficiency and crop productivity. Machine learning models are widely used for crop prediction, disease detection, and soil monitoring. IoT technologies enable real- time monitoring and automated decision-making in precision farming. However, many existing systems are tested only on small-scale or experimental setups. High cost, energy consumption, data security, and lack of standard datasets remain major challenges. Scalability and real- world deployment issues also limit practical adoption. Future research should focus on low-cost, scalable, and energy-efficient smart agriculture solutions. Overall, smart agriculture has strong potential to support sustainable and intelligent farming practices.

https://doi.org/10.46335/IJIES.2026.11.2.4 **e-ISSN: 2456-3463**
Vol. 11, No. 2, 2026, PP. 12-15

International Journal of Innovations in Engineering and Science, www.ijies.net

REFERENCES

[1] *Sayantan Goon, Suari Debbarma et al., 'A Research Paper on Smart Agriculture System Using IOT,' 2022.*

[2] *Md. Najmul Mowla, Neazmul Mowla et al., 'Internet of Things and Wireless Sensor Networks for Smart Agriculture Applications: A Survey,' 2023.*

[3] *Ahmed A. Esmail, Manar A. Ibrahim et al., 'Smart irrigation system using IoT and machine learning methods,' 2023.*

[4] *Pavithra S., S. Shenbagavadivu et al., 'Smart Agriculture using ML and AI Algorithms,' 2024.*

[5] *Ghulam Mohyuddin, Muhammad Adnan Khan et al., 'Evaluation of Machine Learning Approaches for Precision Farming in Smart Agriculture System,' 2024.*

[6] *Dr. Dattatray Sambhajirao Waghole, Sonali Ramalingappa Betageri et al., 'Smart Agriculture System Using IoT and AI/ML: A Survey,' 2024.*

[7] *Abdennabi Morchid, Abdennacer Elbasri et al., 'An Innovative Smart Irrigation Using Embedded and RegressionBased Machine Learning Technologies,' 2025.*

[8] *Avinash Pawar, S. B. Deosarkar, "IoT-Based Smart Agriculture Monitoring System for Precision Farming," 2023*

[9] *Rekha J. Patil, Indira Mulage, "Smart Agriculture System Using IoT and Machine Learning Techniques," 2023.*

[10] *Majid Nawaz, Muhammad Inayatullah Khan Babar, "Integration of IoT and Artificial Intelligence for Smart Agriculture in Resource-Constrained Environments," 2025.*

[11] *"Smart Farming Technologies: A Comprehensive Review of IoT-Based Agricultural Systems," 2023, ScienceDirect.*

[12] *"Internet of Things (IoT) Applications for Sustainable Agriculture: A Review," 2023, ScienceDirect.*
Nabila ElBeheiry, Robert S. Balog, "Technologies Driving the Shift to Smart Farming: A Review," 2023, IEEE.