International Journal of Engineering & Extended Technologies Research (IJEETR)

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802365

Data-Driven Smart Agriculture using IoT and Machine Learning

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Publication History: Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03. 2026; Published: 28.03.2026.

ABSTRACT: The advancement of precision agriculture has enabled the adoption of data-driven technologies to improve crop productivity and efficient resource utilization. This paper presents a smart agriculture system that integrates Internet of Things (IoT) devices with machine learning techniques to support intelligent decision-making in farming practices. Sensors are deployed to continuously monitor environmental and soil parameters such as moisture, temperature, humidity, and light intensity, and the collected data is transmitted to a centralized platform for analysis. Machine learning algorithms are used to identify patterns, predict crop requirements, optimize irrigation scheduling, and detect early signs of plant diseases.

The system also enables automation and remote monitoring, reducing manual intervention and operational costs. By minimizing water consumption and excessive use of fertilizers, the proposed approach promotes sustainable farming practices.

Experimental results indicate that the system enhances crop yield, improves efficiency, and provides a scalable solution to address modern agricultural challenges.

KEYWORDS: Smart agriculture, Internet of Things, machine learning, precision farming, Data analytics, irrigation optimization, crop monitoring, sustainable agriculture.

I. INTRODUCTION

Agriculture is a fundamental sector that sustains human life by providing food, employment, and raw materials, particularly in developing countries like India. Despite its importance, agriculture faces numerous challenges such as unpredictable climate conditions, water scarcity, declining soil fertility, and increasing food demand due to population growth. Traditional farming methods, which rely heavily on manual observation and farmers' experience, often lack precision and are insufficient to address these modern challenges effectively.

Recent advancements in digital technologies, especially the Internet of Things (IoT) and machine learning, have opened new possibilities for transforming agriculture into a smart and data-driven system. IoT devices, including sensors, enable real-time monitoring of critical parameters such as soil moisture, temperature, humidity, and light intensity. The collected data is transmitted to centralized systems where it is analysed using machine learning algorithms.

These algorithms help identify patterns, predict crop requirements, optimize irrigation schedules, and detect early signs of plant diseases. As a result, farmers can make informed decisions, reduce resource wastage, and improve productivity. This integration promotes sustainable farming practices, enhances crop yield, and offers an efficient solution to modern agricultural challenges.

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II. LITERATURE REVIEW

The Recent advancements in precision agriculture have encouraged the use of IoT and Machine Learning technologies to improve farming efficiency and crop productivity. Early agricultural monitoring systems mainly focused on collecting environmental data such as soil moisture, temperature, humidity, and light intensity through sensor networks. These systems provided farmers with real-time information but lacked intelligent decision-making capabilities.

With the development of Machine Learning, modern smart agriculture systems are now able to analyse large amounts of sensor data and provide predictive insights. Algorithms such as Decision Trees, Random Forest, and Support Vector Machines (SVM) are widely used to predict crop yield, irrigation needs, soil conditions, and disease occurrence. These techniques help farmers make accurate decisions and reduce unnecessary use of water, fertilizers, and pesticides.

Recent studies have also explored Deep Learning methods for advanced agricultural applications. Convolutional Neural

Networks (CNNs) are used for plant disease detection through leaf image analysis, while Long Short-Term Memory (LSTM) networks are applied to forecast weather conditions and crop growth patterns. In addition, IoT-based automation systems allow remote monitoring and control of irrigation systems, making farming more efficient and less labor - intensive.

Overall, the integration of IoT and Machine Learning has significantly improved smart agriculture by supporting sustainable farming, reducing costs, and increasing crop productivity.

III. RESEARCH METHODOLOGY

The proposed smart agriculture system follows a data-driven methodology by integrating IoT devices with machine learning techniques. Initially, different sensors are deployed in the agricultural field to collect real-time data related to soil moisture, temperature, humidity, and light intensity. These sensors are connected to a microcontroller such as Arduino or Raspberry Pi, which gathers and transmits the sensor data to a cloud-based storage platform through the internet.

After data collection, the gathered information is pre-processed to remove missing values, noise, and duplicate records. The cleaned dataset is then used for training machine learning models. Algorithms such as Decision Tree, Random Forest, and Support Vector Machine are applied to analyse patterns in environmental conditions and predict irrigation needs, crop health, and disease occurrence.

The trained model is integrated into the smart agriculture system to provide automated recommendations and alerts to farmers. For example, if the soil moisture level is low, the system can automatically activate irrigation. Similarly, if abnormal environmental conditions are detected, the system sends notifications for preventive action. This methodology helps improve crop productivity, reduce water wastage, and support sustainable farming practices.

IV. RESULTS AND DISCUSSION

The experimental results of the proposed smart agriculture system show that the combination of IoT sensors and machine learning techniques can greatly improve the efficiency of farming operations. The deployed sensors continuously monitored soil moisture, temperature, humidity, and light intensity with good accuracy and transmitted the data successfully to the cloud platform. This real-time monitoring helped farmers understand field conditions at any time and respond quickly to unfavourable environmental changes.

The machine learning models were trained using historical and real-time sensor data to predict irrigation requirements, crop conditions, and possible disease occurrence. Among the tested algorithms, Random Forest provided the highest prediction accuracy because it can process large datasets and reduce overfitting. Decision Tree produced faster results but was less accurate, while Support Vector Machine performed well for smaller datasets but required more processing time.

The irrigation automation feature proved to be one of the most useful parts of the system. When the soil moisture level dropped below the required threshold, the irrigation pump was automatically activated. This reduced water wastage

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and ensured that crops received the required amount of water. Compared to traditional irrigation methods, the proposed system helped reduce unnecessary water usage and labour costs.

The system also showed promising results in disease prediction and crop monitoring. By identifying abnormal temperature and humidity conditions, the model provided early warnings about possible plant diseases or stress conditions. This allowed farmers to t ake preventive measures before the problem spread across the field.

Overall, the proposed system demonstrated better crop management, improved productivity, reduced manual effort, and supported sustainable agricultural practices through intelligent and data-driven decision-making.

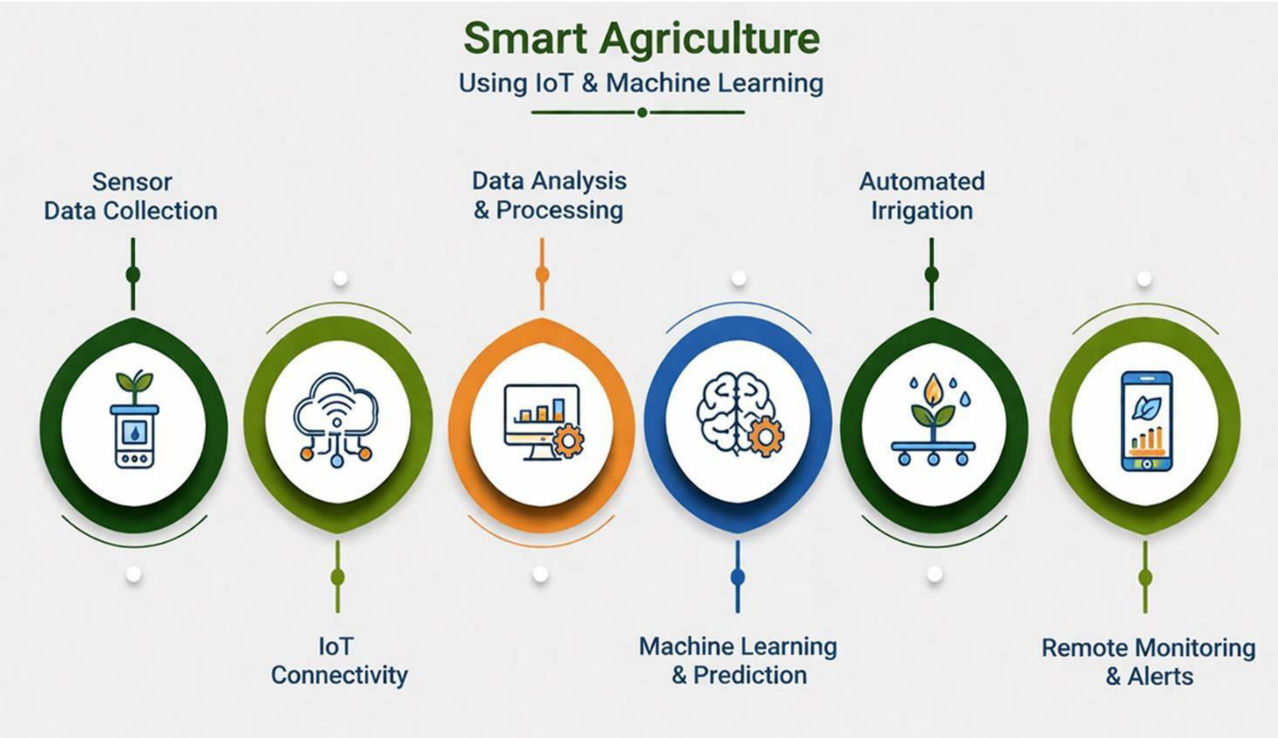

FIG: 1

V. CONCLUSION

In conclusion, the proposed smart agriculture system successfully demonstrates the benefits of integrating IoT and machine learning technologies in modern farming. By continuously monitoring environmental conditions such as soil moisture, temperature, humidity, and light intensity, the system enables accurate and timely decision-making. Machine learning algorithms help predict irrigation requirements, detect possible crop diseases, and improve overall farm management.

The automation of irrigation and remote monitoring reduces manual effort, saves water, and lowers operational costs. The system also supports sustainable agricultural practices by minimizing the excessive use of fertilizers and other resources. Experimental results show that the proposed approach can improve crop productivity, enhance resource utilization, and provide better support for farmers. Overall, this project offers an effective, scalable, and cost-efficient solution for smart farming, making it suitable for addressing the challenges of modern agriculture and ensuring better crop yield in the future.

VI. FUTURE WORK

1. Integrate advanced machine learning models such as Deep Learning for more accurate crop prediction and disease detection.
2. Develop a mobile application for farmers to monitor field conditions and receive alerts in real time through smartphones.

3. Add weather forecasting integration to improve irrigation scheduling and crop planning.
4. Use drone technology for aerial monitoring of crops, pest detection, and field analysis.
5. Implement automatic fertilizer recommendation systems based on soil nutrient levels and crop type.
6. Integrate image-based disease detection using Convolutional Neural Networks to identify plant diseases at an early stage.
7. Expand the system to support multiple crops and different soil conditions for wider agricultural use.
8. Introduce renewable energy sources such as Solar Energy to power IoT sensors and irrigation systems in remote farming areas.

REFERENCES

1) Jaiswal, N., & Kumar, T. V. (2025). Smart Drip Irrigation Systems Using IoT: A Review of Architectures, Machine Learning Models, and Emerging Trends. Discover Agriculture, 3, 253.
2) Kumar, P., Sharma, R., & Singh, A. (2024). Smart Agriculture using Ensemble Machine Learning Techniques in IoT Environment. Procedia Computer Science, 235, 2269–2278.
3) Kalpana, P., Smitha, L., Madhavi, D., Nabi, S. A., & Kalpana, G. (2024). A Smart Irrigation System Using the IoT and Advanced Machine Learning Model: A Systematic Literature Review. International Journal of Computational and Experimental Science and Engineering, 10(4).
4) C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor &Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
5) C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of Electrical Engineering, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
6) C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
7) S.Tamilselvi, R.Prakash, C.Nagarajan,"Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller" Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering, DOI10.1007/s40998-025-00917-z,2025
8) S.Tamilselvi, R.Prakash, C.Nagarajan," Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance" Electric Power Systems Research 253 (2026) 112428, doi.org/10.1016/j.epsr.2025.112428
9) S.Thirunavukkarasu, C. Nagarajan, 2024, "Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," Journal of Electrical Engineering And Technology, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w
10) C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- *Acta Electrotechnica et Informatica Journal ,* Vol.13 (2), pp.18-31,April-June.2013, DOI: 10.2478/aeei-2013-0025.
11) C.Nagarajan and M.Madheswaran - 'DSP Based Fuzzy Controller for Series Parallel Resonant converter'- *Springer, Frontiers of Electrical and Electronic Engineering*, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
12) C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- *Iranian Journal of Electrical & Electronic Engineering*, Vol.8 (3), pp.259-267, September 2012.
13) C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007
14) Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", Revista Materia (Rio J.) Vol. 30, 2025, DOI: https://doi.org/10.1590/1517-7076-RMAT-2024-0721
15) M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022
16) Ramesh, M., Verma, A., & Gupta, A. (2024). Smart Agriculture: IoT and Machine Learning for Crop Monitoring and Precision Farming. International Journal of Intelligent Systems and Applications in Engineering, 12(21s), 266–273.
17) Ali, T., Rehman, S. U., Ali, S., et al. (2024). Smart Agriculture: Utilizing Machine Learning and Deep Learning for Drought Stress Identification in Crops. Scientific Reports, 14, 30062.

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18) Dharashive, P., & Sawale, M. (2024). Smart Irrigation System Techniques Using Artificial Intelligence and IoT. International Journal of Intelligent Systems and Applications in Engineering, 12(11s), 96–102.
19) Wang, C. (2024). Intelligent Agricultural Greenhouse Control System Based on Internet of Things and Machine Learning. arXiv Preprint.
20) Gopinathan, V. R. (2024). Real-Time Fault-Tolerant Multi-Cloud Database Architectures for High Availability Applications. International Journal of Future Innovative Science and Technology (IJFIST), 7(4), 13148.
21) Chandra, S., Rengarajan, A., Sahoo, G. S., & Sharma, S. (2023, December). Identifying Neuronal Damage and Plasticity by Analyzing Changes in Diffusion Tensor Imaging. In International Conference on Data Science, Machine Learning and Applications (pp. 433-438). Singapore: Springer Nature Singapore.
22) Sugumar, R. (2025). Federated AI in Offline-First Mobile Health Architectures for Privacy-Preserving Clinical Intelligence. International Journal of Science, Research and Technology, 8(4), 14589-14600.
23) Murugeshwari, B., Rajalakshmi, S., & Sudharson, K. (2023). Hybrid Approach for Privacy Enhancement in Data Mining Using Arbitrariness and Perturbation. Computer Systems Science & Engineering, 44(3).
24) Pandey, V. K., Mishra, S., Rengarajan, A., Savita, & Roomi, M. M. (2024, March). Enhancing Weather Forecasting with Machine Learning Techniques. In International Conference on Renewable Power (pp. 147-156). Singapore: Springer Nature Singapore.
25) Soundappan, S. J. (2025). Next Generation AI Enabled Holistic Cognitive Platform for Secure Cloud Network Intelligence Enterprise Systems and Digital Trust Optimization. International Journal of Computer Technology and Electronics Communication, 8(5), 11534-11542.
26) Mathew, A. (2022). Leveraging Big Data Analytics to Power AI and ML (Machine Learning) Automation. Educational Research (IJMCER), 4(5), 131-134.
27) Sugumar, R. (2024). AI-Augmented Quality Engineering for Performance Optimization and Test Orchestration in Distributed Systems. International Journal of Science, Research and Technology, 7(5), 12835-12846.
28) Akila, R. (2024). A deep reinforcement learning approach for optimizing inventory management in the agri-food supply chain. J. Electrical Systems, 20(4s), 2238-2247.
29) Mahendran, M., Anbazhagan, K., Pavithran, G., Nivas, A., & Pandey, S. D. (2022). Earthquake Damage Prediction using Machine Learning. Grenze International Journal of Engineering & Technology (GIJET), 8(1).
30) Gopinathan, V. R. (2025). Enterprise AI Frameworks for Financial Data Engineering Behavioural Analytics and Intelligent Cloud Solutions. International Journal of Research Publications in Engineering, Technology and Management (IJRPETM), 8(4), 12499-12506.
31) Kondalsamy, P., & Kaliappan, K. (2025). An Optimal Prediction of Leaf Disease Based on Hybrid Deep Learnings and Metaheuristic Technique. Traitement du Signal, 42(1), 363.
32) Deivendran, P., Babu, P. S., Malathi, G., Anbazhagan, K., & Kumar, R. S. (2023). Emotion Recognition for Challenged People Facial Appearance in Social using Neural Network. arXiv preprint arXiv:2305.06842.
33) Sugumar, R. (2025). Unified AI Framework for Predictive Data Engineering and Real Time Prescription and Billing Systems. International Journal of Advanced Engineering Science and Information Technology (IJAESIT), 8(5), 17261.
34) Vekariya, V., Kumar, S., & Rengarajan, A. (2024). A distinctive and smart agricultural knowledge-based framework using ontology. In Sustainability in Digital Transformation Era: Driving Innovative & Growth (pp. 207-213). CRC Press.
35) Gopinathan, V. R. (2025). Software engineering practices for AI-driven systems: From development to deployment (MLOps perspective). International Journal of Science, Research and Technology, 8(1), 13493-13500.
36) Mathew, A. R. (2022). Threats and protection on E-sim: a prospective study. Novel Perspectives of Engineering Research, 8, 76-81.
37) Naveena, S., & Kavitha, K. (2025). Gossypium herbaceum: Folium disease identification and classification using Efficient Net-Coordinate Convolutional Neural Network (EcoNet). Engineering Applications of Artificial Intelligence, 152, 110701.
38) Rengarajan, A., Mishra, A., Kulhar, K. S., Shrivastava, V. P., & Alawneh, Y. J. J. (2024, March). Role of Deep Reinforcement Learning in Mitigating Cyber Security Issues: A Review. In International Conference on Renewable Power (pp. 37-48). Singapore: Springer Nature Singapore.
39) Achari, A. P. S. K., & Sugumar, R. (2024, November). Performance analysis and determination of accuracy using machine learning techniques for naive bayes and random forest. In AIP Conference Proceedings (Vol. 3193, No. 1, p. 020199). AIP Publishing LLC.
40) Mathew, A., & Alex, H. (2022). Detect & protect-medical device cybersecurity. Curr. Overview Sci. Technol. Res, 1, 60-68.
41) Sammy, F., Chettier, T., Boyina, V., Shingne, H., Saluja, K., Mali, M., ... & Shobana, A. (2025). Deep Learning-Driven Visual Analytics Framework for Next-Generation Environmental Monitoring. Journal of Applied Science and Technology Trends, 114-122.

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42) Anbazhagan, K. (2024). Trustworthy and Adaptive AI Systems for Enterprise Analytics Cybersecurity and Decision Optimization Using API-First and Cloud-Native Architectures. International Journal of Technology, Management and Humanities, 10(03), 65-74.
43) Mathew, A. (2021). Deep reinforcement learning for cybersecurity applications. Int J Comput Sci Mob Compu, 10(12), 32-38.
44) Dhinakaran, D. (2022). Joe Prathap P. M, Selvaraj D, Arul Kumar D and Murugeshwari B," Mining Privacy-Preserving Association Rules based on Parallel Processing in Cloud Computing,". International Journal of Engineering Trends and Technology, 70(3), 284-294.
45) Karthika, K., Anusha, K., Kavitha, K., Harshadha, R., Dharshini, D. S., & Sundhar, N. A. (2025, April). Frequency Reconfigurable Antenna using Advanced Materials: A Study. In 2025 3rd International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA) (pp. 1-6). IEEE.
46) Thavamani, C., & Rengarajan, A. (2024). Clustering related behaviour of users by the use of partitioning and parallel transaction reduction algorithm. International Journal of Advanced Intelligence Paradigms, 29(2-3), 122-132.
47) Sugumar, R. (2025). Unified AI Framework for Predictive Data Engineering and Real Time Prescription and Billing Systems. International Journal of Advanced Engineering Science and Information Technology (IJAESIT), 8(5), 17261.
48) Soundappan, S. J., & Sugumar, R. (2016). Optimal knowledge extraction technique based on hybridisation of improved artificial bee colony algorithm and cuckoo search algorithm. International Journal of Business Intelligence and Data Mining, 11(4), 338-356.
49) SakthiPreetha, A., Kavitha, K., Karthika, K., & Manohari, R. G. (2025, April). A Novel Metasurface-Embedded Antenna for WBAN Communications. In 2025 3rd International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA) (pp. 1-4). IEEE.
50) Murugeshwari, B., Selvaraj, D., Sudharson, K., & Radhika, S. (2023). Data Mining with Privacy Protection Using Precise Elliptical Curve Cryptography. Intelligent Automation & Soft Computing, 35(1).
51) Gopinathan, V. R. (2025). Software engineering practices for AI-driven systems: From development to deployment (MLOps perspective). International Journal of Science, Research and Technology, 8(1), 13493-13500.
52) Anbazhagan, K., Kumar, R., Thilagavathy, R., & Anuradha, D. (2024, March). Shortest Job First with Gateway-based Resource Management Strategy for Fog Enabled Cloud Computing. In 2024 4th International Conference on Data Engineering and Communication Systems (ICDECS) (pp. 1-6). IEEE.
53) Kannadhasan, S., Vasuki, S., Kavitha, K., Karthikeyan, P., & Usha, S. G. A. (Eds.). (2025, April). Preface: Role of Artificial Intelligence and IoT in Engineering, Technology & Science [ICRAETS 2024]. In AIP Conference Proceedings (Vol. 3258, No. 1, p. 010001). AIP Publishing LLC.
54) Dhinakaran, D., Prathap, P. J., Selvaraj, D., Kumar, D. A., & Murugeshwari, B. (2022). Mining privacy-preserving association rules based on parallel processing in cloud computing. International Journal of Engineering Trends and Technology, 70(3), 284-294.