iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VII **Month of publication:** July 2026

DOI: https://doi.org/10.22214/ijraset.2026.84029

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VII July 2026- Available at www.ijraset.com

Farm Aadhar: An Intelligent Integrated System for Precision Agriculture Management

Kavita Dige[1], Aniket Sadakale[2], Anushka Patil[3]
[1]Dept. of AI & AIML, G. H. Raisoni College of Engineering & Management, Wagholi, Pune, Maharashtra, India
[2, 3]Final Year B.Tech Students, Dept. of AI & AIML, G. H. Raisoni College of Engineering & Management, Wagholi, Pune, Maharashtra, India

Abstract: Farm Aadhar is an intelligent precision-agriculture man-agement system designed to improve monitoring and decision sup-port in controlled-environment farming, especially polyhouse culti-vation. The system integrates low-cost ESP32-based sensing nodes, environmental sensors, a Supabase cloud backend, and an interactive web dashboard to support continuous observation of temperature, hu-midity, air quality, and gas concentration. Unlike manual inspection practices that depend heavily on periodic human observation, Farm Aadhar provides real-time data synchronization, configurable crop-specific thresholds, alert generation, and automation support for de-vices such as exhaust fans, humidifiers, and cooling units. The proto-type was tested at Weikfood Foods Pvt. Ltd., Bakori, Maharashtra, to evaluate its practical suitability in a commercial farming environment. The proposed system demonstrates how IoT and AI-enabled analytics can make polyhouse management more responsive, resource-efficient, and scalable for farmers.
Keywords: Precision Agriculture, Internet of Things, ESP32, Su-pabase, Smart Farming, Polyhouse Monitoring, Automation, Dash-board Monitoring.

I. INTRODUCTION

Agriculture continues to be a major source of livelihood and food security, but conventional farm management still relies on manual observation, delayed decision-making, and experience-based intervention. These limitations become more visible in polyhouse farming, where crop growth is strongly affected by temperature, humidity, air quality, and harmful gas concentra-tion. Even small deviations from the desired microclimate can influence plant health, disease incidence, resource consump-tion, and yield quality.

Recent developments in the Internet of Things (IoT), cloud computing, and artificial intelligence have created practical op-portunities for data-driven farm management. IoT sensors can continuously collect field-level information, cloud platforms can store and distribute the data with low latency, and intelligent dashboards can convert raw readings into alerts and rec-ommendations. Prior studies on smart agriculture have shown that sensor-based monitoring and automated control can reduce uncertainty in protected cultivation and improve the efficiency of irrigation, ventilation, and climate regulation [1, 2, 3].

Farm Aadhar is developed as an integrated system for preci-sion agriculture management. It connects ESP32-based hard-ware, DHT22, MQ-135, and MQ-2 sensors, Supabase backend services, and a React/Node.js dashboard into a three-tier ar-chitecture. The system focuses on real-time monitoring, crop-wise threshold configuration, historical review, and closed-loop device control. The prototype was tested in a real poly-

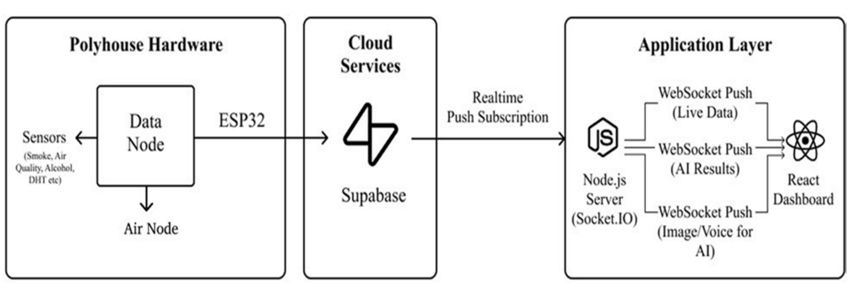

Fig. 1 Three-tier Farm Aadhar system architecture.

house setup at Weikfood Foods Pvt. Ltd., Bakori, Maharash-tra, which helped validate the usefulness of the design beyond a laboratory environment.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VII July 2026- Available at www.ijraset.com

II. LITERATURE REVIEW

Precision agriculture combines sensing, communication, ana-lytics, and control to support site-specific and need-based farm decisions. IoT-based agriculture systems commonly use mi-crocontrollers and wireless communication modules to collect environmental data and transmit it to a cloud server for visual-ization and analysis [2]. In greenhouse and polyhouse applica-tions, such systems are particularly useful because the growing environment is partially controllable and quick corrective ac-tions can prevent plant stress.

Existing smart farming solutions have explored temperature and humidity monitoring, soil moisture sensing, irrigation au-tomation, and greenhouse ventilation control [1, 3]. How-ever, many low-cost implementations remain limited to basic data display or single-parameter control. Practical farming en-vironments require a more integrated workflow that includes real-time readings, threshold customization for different crops, alerting, remote access, historical analysis, and a simple inter-face that farm operators can use without technical difficulty.

Cloud backends are important in this workflow because they separate field hardware from user-facing applications. Real-time database services and WebSocket-based synchronization allow dashboards to update quickly when new sensor readings arrive [5]. Farm Aadhar builds on these ideas by combining low-cost sensing, cloud synchronization, and dashboard-based automation into a unified system suitable for polyhouse operations.

III. OBJECTIVES

The main objective of this work is to design and implement a stable, affordable, and user-friendly precision agriculture man-agement system for polyhouse farming. The specific objectives are as follows:

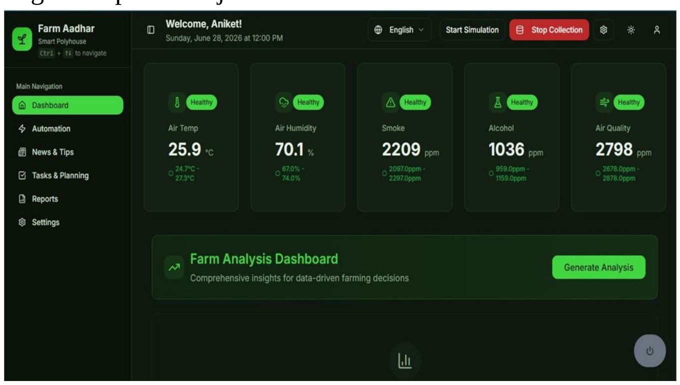

Fig. 2 Live dashboard view showing sensor readings and system status.

1) To develop a three-tier system for monitoring temperature, humidity, air quality, and gas concentration in real time.
2) To implement a low-latency data pipeline between ESP32 hardware, Supabase cloud storage, and the web dashboard.
3) To support threshold-based automation for devices such as AC units, exhaust fans, and humidifiers.
4) To provide a dashboard for live visualization, crop-specific threshold configuration, alerts, and historical data review.
5) To evaluate the prototype in a practical farming environ-ment at Weikfood Foods Pvt. Ltd., Bakori, Maharashtra.

IV. PROPOSED SYSTEM

The proposed Farm Aadhar system is organized into hardware, cloud, and application layers. Fig. 1 shows the overall struc-ture. The polyhouse layer contains sensors and the ESP32 con-troller. The cloud layer receives and stores readings through secured endpoints. The application layer presents data to users and supports automation decisions through the dashboard.

A. *Hardware Sensing Module*

The hardware sensing module uses an ESP32 microcontroller because it provides built-in Wi-Fi, sufficient processing capa-bility, and low deployment cost. The DHT22 sensor measures temperature and humidity, while MQ-135 and MQ-2 sensors help observe air quality and gas concentration. The ESP32 pe-riodically reads the sensor values, formats the data, and trans-mits it to the backend through Wi-Fi.

B. Cloud and Data Synchronization Module

The cloud module uses Supabase as the backend for data stor-age and realtime synchronization. Sensor readings are sent us-ing secured HTTPS endpoints and stored in database tables. Supabase Realtime then distributes updates to the dashboard through WebSocket-based subscriptions. This design reduces the delay between field sensing and user visualization and sup-ports near real-time monitoring during farm operations.

C. Application and Automation Module

The application module is implemented as a React/Node.js web dashboard. It displays live readings, threshold status, alert messages, and device-control states. The dashboard al-lows users to set crop-specific thresholds so that each crop can be managed according to its preferred environmental range. When readings exceed configured limits, the system can notify the user and trigger connected devices such as fans, humidi-fiers, or cooling units.

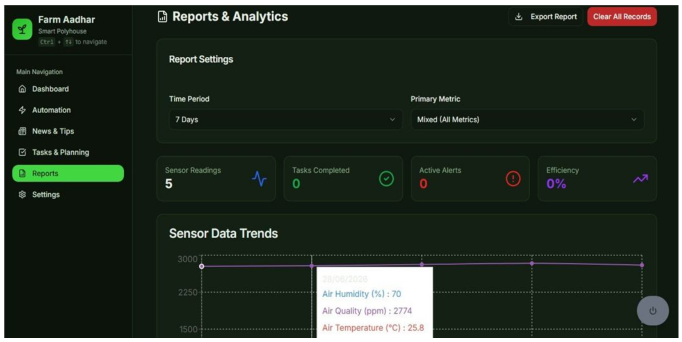

Fig. 3 Reports and analytics interface for reviewing environmental trends.

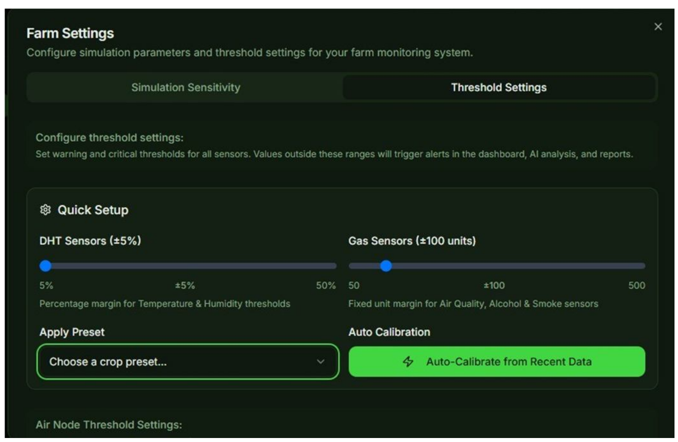

Fig. 4 Crop-wise threshold configuration for automated farm control.

V. SYSTEM IMPLEMENTATION

The implementation follows a modular approach so that hard-ware, backend, and user interface components can be tested independently and then integrated.

A. Sensor Data Acquisition

The ESP32 reads the connected sensors at fixed intervals. Each reading includes temperature, humidity, air quality, gas con-centration, timestamp, and device identification. Basic valida-tion is applied before transmission so that missing or abnormal readings can be filtered or flagged. This helps maintain the reliability of the dashboard and historical records.

B. Realtime Dashboard

The dashboard is designed for farm operators who need quick interpretation rather than complex raw data. It uses cards, charts, and status indicators to show current microclimate con-ditions. Fig. 2 presents the main monitoring interface, while Fig. 3 shows reporting and analytics features used for review-ing trends over time.

C. Threshold Configuration

Different crops require different environmental conditions. Therefore, the system includes threshold settings for parame-ters such as temperature, humidity, air quality, and gas concen-tration. As shown in Fig. 4, users can adjust limits according to crop type and farming requirements. This makes the system more flexible than fixed-threshold monitoring tools.

D. Automation Logic

The automation logic compares incoming sensor readings with the configured thresholds. If a value crosses the safe range, the system generates an alert and determines the required cor-rective action. For example, high temperature can activate a Remote dashboard access for real-time visualization and alerts.

- Better resource use through need-based climate control.
- Scalable architecture suitable for future AI recommendation modules.

Fig. 5 Prototype testing at Weikfood Foods Pvt. Ltd., Bakori, Maharashtra.

cooling unit or exhaust fan, low humidity can activate a hu-midifier, and poor air quality can increase ventilation. This rule-based logic provides the foundation for future AI-driven recommendations.

VI. TESTING AND RESULT DISCUSSION

The Farm Aadhar prototype was tested at Weikfood Foods Pvt. Ltd., Bakori, Maharashtra. The field test helped observe the be-havior of the sensor unit, cloud synchronization, and dashboard under practical farming conditions. The model setup used in the test is shown in Fig. 5.

During testing, the system successfully collected environ-mental readings and displayed them on the dashboard. The web interface made it easier to observe changes in the poly-house without repeatedly visiting the sensor location. The low-latency cloud pipeline supported quick updates, which is important for time-sensitive decisions such as ventilation and humidity correction. The threshold configuration module also showed practical value because farmers can tune settings for different crops rather than depending on one fixed range.

The testing indicated that the proposed system can reduce manual monitoring effort and support faster response to en-vironmental changes. The main limitations observed are re-lated to sensor calibration, long-term outdoor durability, and the need for extended validation across multiple crops and sea-sons. These limitations can be addressed through improved enclosure design, periodic calibration, and larger field trials.

VII. ADVANTAGES

Farm Aadhar offers the following advantages:

1) Continuous monitoring of important polyhouse parameters.
2) Reduced dependency on manual inspection and delayed intervention.
3) Crop-specific threshold settings for flexible farm management.

VIII. FUTURE SCOPE

Future development can extend Farm Aadhar from rule-based automation to predictive and prescriptive intelligence. Ma-chine learning models can be trained on historical sensor read-ings, crop stages, and yield outcomes to recommend optimal actions. Additional sensors for soil moisture, light intensity, pH, electrical conductivity, and nutrient levels can provide a more complete view of crop health. The system can also be ex-panded with mobile notifications, multilingual farmer support, solar-powered sensor nodes, and integration with irrigation and fertigation controllers.

IX. CONCLUSIONS

Farm Aadhar presents an intelligent integrated system for pre-cision agriculture management in polyhouse farming. By com-bining ESP32-based sensing, Supabase cloud synchronization, and a real-time dashboard, the system provides continuous monitoring, configurable thresholds, alerts, and automation support. Field testing at Weikfood Foods Pvt. Ltd., Bakori, Maharashtra, showed that the system is practical for real farm-ing conditions and can help reduce manual effort while improv-ing microclimate awareness. With further calibration, extended trials, and AI-based recommendation features, Farm Aadhar can become a scalable decision-support platform for sustain-able smart farming.

X. ACKNOWLEDGMENT

The authors express sincere gratitude to G. H. Raisoni College of Engineering & Management, Wagholi, Pune, for academic support and guidance. The authors also thank Weikfood Foods Pvt. Ltd., Bakori, Maharashtra, for providing an opportunity to test the prototype in a practical farming environment.

REFERENCES

[1] K. A. Patil and N. R. Kale, “A model for smart agriculture using IoT,” in Proc. International Conference on Global Trends in Signal Processing, Information Computing and Communication, Jalgaon, India, 2016, pp. 543–545.
[2] M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour, and E. H. M. Ag-goune, “Internet-of-Things (IoT)-based smart agriculture: Toward mak-ing the fields talk,” IEEE Access, vol. 7, pp. 129551–129583, 2019.
[3] M. S. Farooq, S. Riaz, A. Abid, K. Abid, and M. A. Naeem, “A survey on the role of IoT in agriculture for the implementation of smart farming,” IEEE Access, vol. 7, pp. 156237–156271, 2019.
[4] S. Wolfert, L. Ge, C. Verdouw, and M.-J. Bogaardt, “Big data in smart farming–a review,” Agricultural Systems, vol. 153, pp. 69–80, 2017.
[5] Supabase, “Supabase Realtime documentation,” 2026. [Online]. Avail-able: https://supabase.com/docs/guides/realtime
[6] Espressif Systems, “ESP32 series datasheet,” 2024. [Online]. Avail-able: https://www.espressif.com/sites/default/files/documentation/ esp32 datasheet en.pdf
[7] Aosong Electronics, “DHT22 digital-output relative humidity and tem-perature sensor module datasheet,” 2022.

- -