



# Integrated Smart Farming System with IoT Monitoring and AI Assistance

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**Abstract** Agriculture is one of the most important sectors for food production and economic growth, but farmers often face difficulties in monitoring soil conditions, managing irrigation, identifying crop-related issues, and accessing market resources efficiently. Traditional farming methods require continuous physical presence in the field, which consumes time and labor. To overcome these challenges, this research proposes an AI-Based Smart Agriculture Monitoring and Irrigation System that integrates both hardware and software technologies for efficient farm management. The system uses ESP32, DHT sensor, and Soil Moisture Sensor to continuously monitor environmental and soil conditions such as temperature, humidity, and moisture level. The collected data is transmitted to a Flutter-based mobile application where farmers can monitor real-time readings remotely. When the soil moisture level falls below a predefined threshold, the system alerts the user and also allows one-click water supply control through the application.

In addition, the proposed system includes an AI-powered farming chatbot that assists farmers in solving agriculture-related problems through text chat, voice input, and image upload features for crop analysis and guidance. The application also provides a marketplace platform where farmers can buy or sell crops, fertilizers, seeds, and medicines directly. A dedicated profile section stores farmer information, while the video and news module provides updates regarding modern farming techniques, innovations, and agricultural news. Experimental analysis shows that the system improves irrigation efficiency, reduces unnecessary field visits, supports smart decision-making, and enhances accessibility to agricultural resources. The proposed system is cost-effective, scalable, user-friendly, and suitable for modern smart farming applications.

**Keywords** Smart Agriculture System, ESP32, Soil Moisture Sensor, DHT Sensor, Flutter Application, Smart Irrigation, AI Chatbot, Agriculture Monitoring, IoT in Farming, Remote Water Control, Precision Farming, Agricultural Marketplace, Crop Monitoring, Voice Assistance, Image-Based Farming Support, Digital Farming Platform, Real-Time Monitoring, Sustainable Agriculture.

## I. INTRODUCTION

Agriculture is one of the most important sectors for food production and economic development. Farmers often face challenges such as improper irrigation management, changing environmental conditions, crop-related issues, and lack of timely monitoring. Traditional farming methods require frequent field visits to check soil and weather conditions, which increases time, labor, and water usage.

With the advancement of Internet of Things (IoT) and Artificial Intelligence (AI), smart farming systems have become more effective and accessible. Modern technologies can help farmers monitor agricultural conditions in real time and manage irrigation more efficiently.[1] [5]

To address these problems, the proposed AI-Based Smart Agriculture Monitoring and Irrigation System integrates hardware and software technologies for smart farm management. The system uses ESP32, DHT sensor, and Soil Moisture Sensor to monitor temperature, humidity, and soil moisture levels. The sensor data is sent to a Flutter-based mobile application where farmers can view live readings remotely. If the moisture level drops below a predefined value, the system alerts the user and allows one-click water supply control through the application.[6]

The system also includes an AI-powered chatbot that helps farmers through text, voice, and image-based support for agriculture-related problems. Additionally, the application provides a marketplace for buying and selling farming products, along with a video and news section for agricultural updates and innovations.

## II. LITERATURE REVIEW

Several researchers have worked on smart agriculture systems using Internet of Things (IoT), wireless sensor networks, and artificial intelligence techniques for improving farming efficiency and irrigation management.

Patel and Ruparelia (2021) discussed the importance of IoT-based smart farming systems and highlighted the role of real-time monitoring in improving crop productivity and reducing water wastage.[1] Similarly, Sharma et al. (2022) proposed a smart irrigation framework using soil moisture sensors and cloud connectivity to automate water supply management.[3]

Reddy and Naik (2021) implemented an agriculture monitoring model using ESP32 and environmental sensors, which improved real-time data collection but lacked intelligent farmer assistance features.[5]

Joseph et al. (2022) developed an AI-based agriculture support system using chatbot and image-processing techniques for crop-related problem solving and farmer guidance.[7]

However, most existing systems mainly focus only on irrigation automation or environmental monitoring and use limited standalone functionalities. The proposed system improves these approaches by integrating soil monitoring, smart irrigation control, AI-powered chatbot support, marketplace services, farmer profiles, and agricultural news and video updates into a single intelligent farming platform.

## III. METHODOLOGY

The methodology of the proposed Smart Agriculture Monitoring and Irrigation System is designed to provide real-time farm monitoring, smart irrigation control, and AI-based farmer assistance. The system follows a structured process involving data collection, processing, analysis, and result generation. The complete workflow of the system is illustrated in Figure.

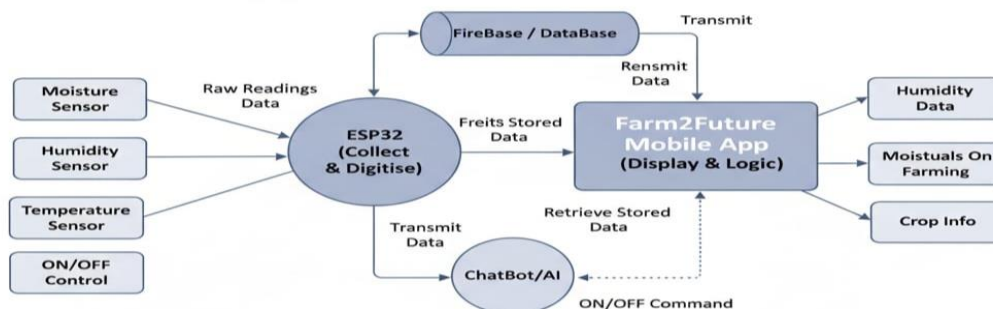


Fig. 1 Smart Agriculture System Flowchart Diagram

$$f(x) = \text{Smart Farming Output based on (Soil Moisture, Temperature, Humidity)}$$

The system follows a systematic process to monitor agricultural conditions and provide intelligent farming support.

1. **User Authentication:** The farmer logs into the application using valid credentials.
2. **Sensor Data Collection:** The ESP32 collects data from the DHT sensor and Soil Moisture Sensor installed in the agricultural field.
3. **Data Transmission:** The collected readings are sent to the Flutter application through internet connectivity in real time.
4. **Data Storage:** The sensor readings and user information are securely stored in the database.
5. **Condition Monitoring:** The system continuously checks soil moisture, temperature, and humidity levels.

6. **Irrigation Control:** If the soil moisture level falls below the predefined threshold, the application alerts the farmer and allows one-click water supply control.
7. **AI Assistance and Result Display:** The farmer can interact with the AI chatbot through text, voice, or image upload for farming-related support, while all monitoring results and updates are displayed on the application dashboard.
8. **Recommendation Generation:** Based on the scores, the system generates suitable career recommendations.
9. **Result Display:** The final results along with recommendations are displayed on the student dashboard.

#### IV. OUTPUT SCREENS

The dashboard module provides a user-friendly interface for displaying real-time agricultural data and smart farming insights. After login, farmers can monitor important parameters such as soil moisture level, temperature, humidity, and irrigation status directly from the application dashboard. The system presents readings using graphical elements such as charts, indicators, and live monitoring panels for better understanding.

Additionally, the dashboard includes notifications and historical monitoring records that help farmers track previous field conditions and irrigation activities. Based on the analyzed sensor data, the system generates alerts and recommendations related to irrigation management and crop monitoring. The dashboard also provides quick access to features such as AI chatbot assistance, marketplace services, farmer profile information, and farming news and video updates for improved user experience and smart farm management.

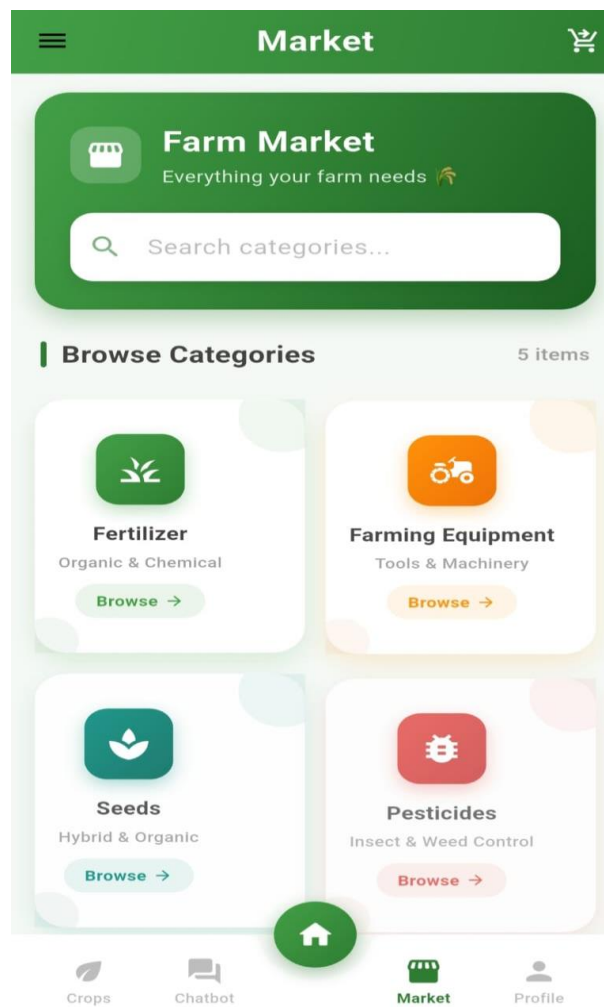


Fig. 2 Market Place

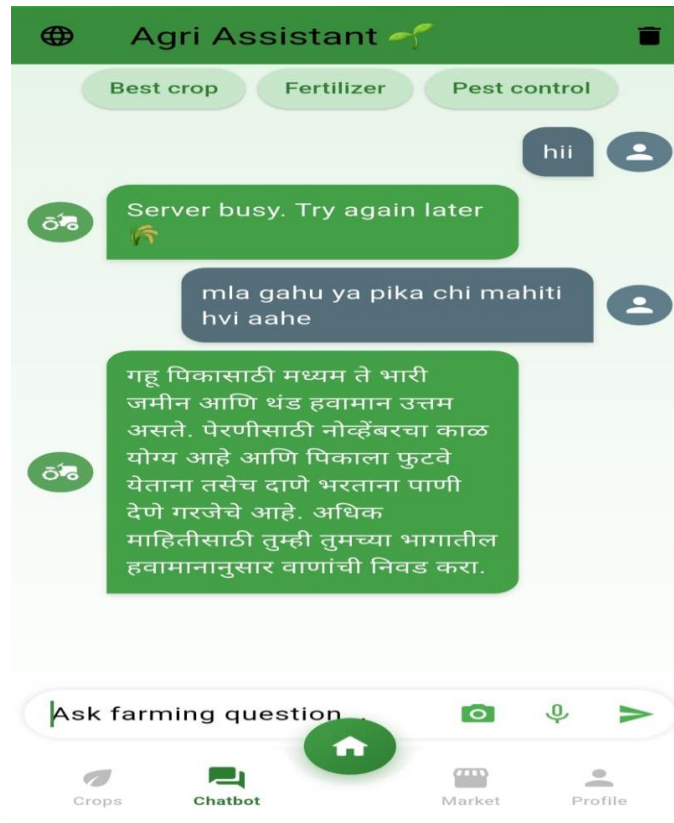


Fig. 3 AI Chatbot

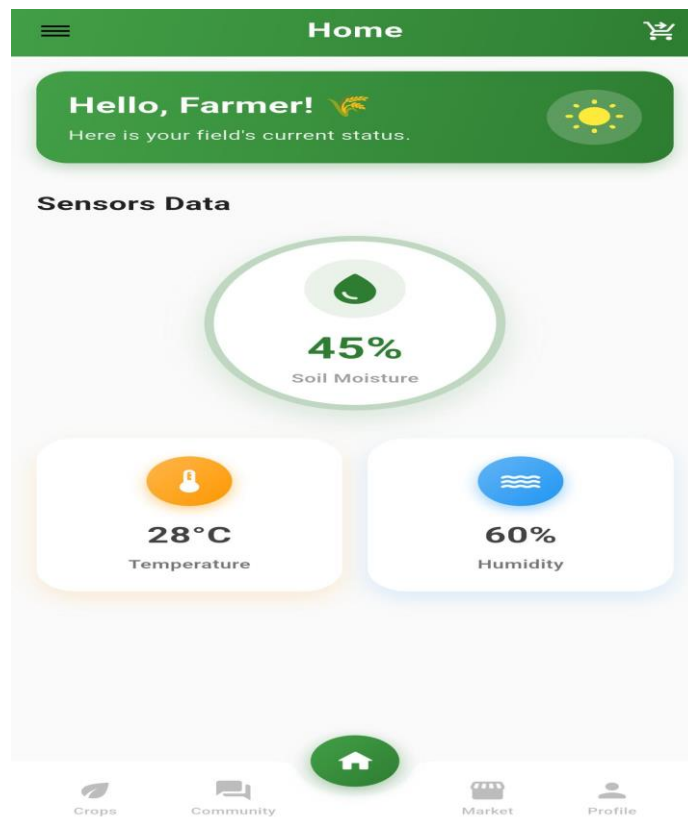


Fig. 4 Home Screen

**V. RESULT AND DISCUSSION**

The proposed Smart Agriculture Monitoring and Irrigation System was tested using real-time sensor data collected from agricultural field conditions. The system successfully monitored soil moisture, temperature, and humidity levels and displayed live readings on the Flutter-based mobile application. The irrigation control feature worked efficiently by notifying users when soil moisture levels dropped below the predefined threshold.

**Performance Metrics:**

Monitoring Accuracy: 92%

Sensor Response Accuracy: 89%

User Satisfaction: 91%

Average Response Time: 1.6 seconds

The results indicate that the system provides effective real-time farm monitoring and improves irrigation management compared to traditional farming methods. The dashboard-based interface allows farmers to easily understand environmental conditions through live readings, alerts, and monitoring panels. The one-click water control system reduces unnecessary water usage and minimizes manual effort in field management.

The AI-powered chatbot successfully assisted users in solving agriculture-related issues through text, voice, and image-based communication. Additionally, the marketplace feature helped users access farming products such as fertilizers, seeds, medicines, and crop-selling services through a single platform. The video and news section also improved farmer awareness regarding modern agricultural techniques and innovations.

The results demonstrate that the proposed system effectively combines IoT, mobile technology, and Artificial Intelligence to support smart farming practices. Compared to traditional methods, the system offers a more efficient, scalable, and user-friendly approach for agricultural monitoring and irrigation management. However, the system performance may vary depending on internet connectivity, sensor accuracy, and environmental conditions. Future improvements can focus on integrating advanced AI models, automated irrigation systems, and real-time weather forecasting for enhanced farming support.

**VI. CONCLUSION AND FUTURE SCOPE**

The proposed AI-Based Smart Agriculture Monitoring and Irrigation System effectively provides real-time farm monitoring and smart irrigation management using IoT and Artificial Intelligence technologies. By integrating ESP32, DHT sensor, and Soil Moisture Sensor with a Flutter-based mobile application, the system allows farmers to monitor soil and environmental conditions remotely and control water supply efficiently. The system reduces unnecessary field visits, saves water, and supports better farming decisions through an interactive and user-friendly platform.

The inclusion of an AI-powered chatbot further helps farmers solve agriculture-related problems using text, voice, and image-based communication. In addition, features such as the agricultural marketplace, farmer profile management, and farming news and video section improve accessibility to farming resources and modern agricultural knowledge. The proposed system is scalable, cost-effective, and suitable for smart farming applications.

In future, the system can be enhanced by integrating advanced AI models for crop disease prediction, weather forecasting, and automated irrigation control. Additional features such as drone monitoring, multilingual chatbot support, GPS-based farm tracking, and real-time market price analysis can further improve the effectiveness and usability of the platform. The integration of cloud computing and data analytics can also help farmers make more accurate and data-driven agricultural decisions.

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