

# Smart Agriculture – Crop Recommendation and Plant Disease Detection System

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*Abstract- The Smart Agriculture platform is a comprehensive intelligent farming system designed to modernize agricultural practices. The system integrates crop recommendation, soil analysis, environmental monitoring, and plant disease detection into a unified cross-platform application. The frontend application is developed using Flutter, while Firebase services provide authentication and real-time cloud synchronization. Python FastAPI is used as the backend framework for machine learning inference and API communication. The platform analyzes environmental parameters such as Nitrogen (N), Phosphorus (P), Potassium (K), temperature, humidity, and soil moisture to recommend suitable crops for cultivation. MobileNetV2 transfer learning architecture is used for soil classification, achieving >95% accuracy, while EfficientNetB4 is implemented for disease detection using crop leaf images, yielding >92% accuracy across 16 pathology classes. The system also integrates R Programming-based analytical visualization to generate crop health and disease risk reports. Experimental evaluation demonstrates high prediction accuracy and stable environmental monitoring performance under simulated IoT conditions, with an end-to-end crop recommendation accuracy of 97.3%. The proposed system contributes toward precision farming by enabling intelligent, data-driven, and sustainable agricultural practices.*

*Keywords: Smart Agriculture, Crop Recommendation, Plant Disease Detection, Artificial Intelligence, IoT Simulation, Flutter, Firebase, Deep Learning.*

## I. INTRODUCTION

### 1.1 Overview

Agriculture remains one of the most important sectors supporting economic growth and food production. However, modern farming continues to face several challenges including unpredictable climatic conditions, improper crop selection, soil

degradation, and plant disease outbreaks. Traditional farming approaches often depend on manual observation, which may lead to reduced agricultural productivity and inefficient resource utilization. Recent developments in Artificial Intelligence, Machine Learning, Internet of Things (IoT), and cloud computing have created opportunities to modernize agricultural processes through intelligent monitoring and predictive analytics. The proposed Smart Agriculture platform combines these technologies to support farmers with real-time monitoring, crop recommendation, and disease diagnosis.

### 1.2 Objectives

- To develop an intelligent crop recommendation system.
- To implement deep learning-based plant disease detection.
- To integrate IoT simulation for environmental monitoring.
- To provide a user-friendly cross-platform Flutter application.
- To generate analytical reports using R Programming.
- To support sustainable and precision farming practices.

## II. LITERATURE SURVEY

Several researchers have explored the integration of Artificial Intelligence and IoT technologies into agriculture. Mohanty et al. [1] proposed deep learning-based plant disease detection using convolutional neural networks. Ferentinos [2] improved classification accuracy using transfer learning architectures for agricultural image analysis.

Patel et al. [3] demonstrated IoT-enabled precision farming systems capable of monitoring environmental parameters such as soil moisture and humidity. Existing systems mainly focus either on crop recommendation or disease detection individually. The proposed SmartAgriculture platform combines crop recommendation, disease diagnosis, environmental monitoring, cloud synchronization, and analytical visualization within a unified intelligent ecosystem.

Dr. J. Narendra Babu [11][12][13][18][19][20][21] explored IoT applications in smart systems and emphasized combining embedded hardware with cloud connectivity for scalable IoT solutions, providing theoretical grounding for design decisions in this project.

### III. PROPOSED METHOD

#### 3.1 System Architecture

The Smart Agriculture platform follows a modular architecture consisting of frontend, backend, cloud, and analytical layers. Flutter is used for frontend development, Firebase [4] provides cloud synchronization, and Python FastAPI [7] serves machine learning models for crop recommendation and disease detection.

#### 3.2 Crop Recommendation Workflow

The crop recommendation module analyzes soil classification outputs and IoT sensor parameters including NPK values, humidity, temperature, and soil moisture. The system compares these values against a predefined crop knowledge database and generates compatibility-based crop recommendations using a continuous range scoring algorithm.

#### 3.3 Disease Detection Workflow

The disease detection module accepts crop leaf images through the Flutter [5] application. Images are preprocessed and passed through the EfficientNetB4 [10] deep learning model. The system identifies diseases and generates confidence-based treatment recommendations.

#### 3.4 Technologies Used

- Flutter for multi-platform application development [5].
- Firebase Authentication and Firestore for cloud synchronization [4].
- Python FastAPI backend for API communication [7].
- TensorFlow and Keras for deep learning implementation [6].
- R Programming for analytical visualization [8].

### IV. RESULTS

The SmartAgriculture platform demonstrated reliable performance under simulated IoT conditions. The MobileNetV2-based [9] soil classification model achieved 95.2% accuracy, while the EfficientNetB4-based [10] disease detection model achieved 92.4% accuracy. The crop recommendation module generated highly compatible crop suggestions based on environmental conditions with an accuracy of 97.3%. Latencies averaged 120ms for crop recommendation, 510ms for soil classification, and 2.1s for disease detection.



Figure 1: Smart Agri Home Dashboard displaying active crop health, telemetry logs, and alerts.



Figure 2: Step 3 recommendation output screen outlining crop suitability and disease risks.



Figure 3: Crop Maintenance cockpit demonstrating circular health gauges, IoT logs, and fertilizer tracks



Figure 4: Pathology detection screen displaying diagnosed disease, severity level, and chemical remedy.

## V. CONCLUSION

The Smart Agriculture system demonstrates the successful integration of Artificial Intelligence, IoT simulation, cloud technologies, and deep learning for modern precision farming applications. The proposed platform supports farmers through intelligent crop recommendation, disease detection, environmental monitoring, and agricultural analytics. The system contributes toward sustainable agriculture by enabling data-driven farming decisions and reducing dependency on manual observation. Future enhancements may include integration with real-time hardware sensors, satellite-based monitoring systems, multilingual farmer assistance, and weather forecasting services.

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