International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435 (Online) Volume 15, Issue 08, August 2026)

Smart Farming Assistance System using Image-Based Crop Disease Detection and AI Chatbot

Dr. K. Priya[1], A. Sivaranjani[2], K. Kowsalya[3]

[1,2,3]*Assistant Professor, PG & Research Department of Computer Science, Marudhar Kesari Jain College for Women (Autonomous), Vaniyambadi, India.*

Abstract— Agriculture is one of the most important sectors that supports food production and the economy of many countries. Farmers face several challenges such as crop diseases, pest infestations, unpredictable weather conditions, lack of expert guidance, and fluctuating market prices. These problems reduce crop productivity and directly affect farmers' income. Recent advancements in Artificial Intelligence (AI), Machine Learning (ML), and image processing have enabled the development of intelligent farming systems that provide timely support and improve agricultural decision-making.

This paper presents a Smart Farming Assistance System that combines image-based crop disease detection, weather forecasting, pest prediction, market price analysis, and an AI-powered chatbot into a single integrated platform. The proposed system uses deep learning techniques to analyze crop leaf images and accurately identify diseases while suggesting suitable pesticides and treatment methods. The system also supports offline disease detection, enabling farmers in rural areas with poor internet connectivity to use the application effectively. Furthermore, the multilingual voice-enabled chatbot provides instant agricultural guidance in local languages, making the system accessible even to farmers with limited technical knowledge.

The platform integrates weather forecasting and pest prediction services to help farmers schedule irrigation, pesticide spraying, and harvesting activities efficiently. Real-time market price updates allow farmers to compare crop prices and identify better selling opportunities. A personalized farmer dashboard displays disease history, crop health status, weather alerts, market trends, and treatment recommendations. Experimental evaluation demonstrates that the proposed system achieves high disease classification accuracy while improving accessibility, usability, and decision-making. The integrated solution contributes to increased agricultural productivity, reduced crop losses, and sustainable farming practices.

***Keywords*— Smart Agriculture, Machine Learning, Deep Learning, Crop Disease Detection, Image Processing, CNN, AI Chatbot, Weather Forecasting, Precision Farming, Sustainable Agriculture.**

I. INTRODUCTION

Agriculture plays a significant role in ensuring food security and supporting the livelihoods of millions of people worldwide. India is primarily an agricultural country where a large portion of the population depends on farming as their primary source of income. However, farmers continuously face numerous challenges that affect crop production and profitability.

Among these challenges, crop diseases remain one of the major reasons for reduced agricultural yield. Plant diseases spread rapidly due to environmental conditions, pest attacks, improper irrigation, and delayed diagnosis. Traditional methods of disease identification require agricultural experts, which are often unavailable in rural areas.

With the rapid development of Artificial Intelligence, Machine Learning, and Computer Vision technologies, modern agricultural systems can automatically detect crop diseases using digital images. Image-based disease detection helps farmers identify diseases during the early stages, thereby reducing crop losses and minimizing unnecessary pesticide usage. Deep learning models such as Convolutional Neural Networks (CNNs) have shown excellent performance in recognizing complex disease patterns from leaf images.

Apart from disease detection, farmers also require weather forecasts, pest alerts, fertilizer recommendations, and current market prices for better decision-making. Existing agricultural applications generally focus on only one service and fail to provide comprehensive support. Moreover, many applications require continuous internet connectivity, limiting their usefulness in rural farming communities.

The proposed Smart Farming Assistance System integrates multiple agricultural services into one intelligent platform. Farmers can upload crop images for disease detection, receive pesticide recommendations, check weather conditions, obtain pest alerts, monitor crop health, and communicate with an AI chatbot using voice commands in regional languages. Offline disease detection further improves accessibility in areas with limited network coverage. The integrated system aims to improve crop productivity, increase farmers' income, and promote sustainable agriculture through intelligent technology.

II. RELATED WORK

Several studies have applied image processing and machine learning techniques for crop disease detection. Traditional methods relied on color segmentation, edge detection, and texture analysis but showed limited performance under varying environmental conditions.

Recent research has adopted deep learning models such as CNN, ResNet, MobileNet, and EfficientNet, achieving high accuracy in disease classification using datasets like PlantVillage.

Researchers have also developed smart farming systems that integrate weather forecasting, IoT sensors, and AI-based chatbots to support agricultural decision-making. However, many existing systems depend on continuous internet connectivity and provide limited multilingual support. Similarly, market information platforms offer real-time crop prices but lack integrated disease detection and personalized recommendations.

The proposed Smart Farming Assistance System overcomes these limitations by combining image-based disease detection, offline AI support, multilingual chatbot assistance, weather and pest forecasting, market price updates, and crop treatment recommendations into a single integrated platform, providing comprehensive support for farmers.

III. System Architecture

A. Overview

The proposed Smart Farming Assistance System consists of several interconnected modules designed to support farmers throughout the crop cultivation cycle. The system begins by collecting user information and crop images through a simple web interface. The uploaded images are processed by a machine learning model that identifies crop diseases and predicts appropriate treatment measures. Simultaneously, weather information, pest forecasting data, and market prices are collected through external APIs and integrated into the farmer dashboard.

An AI-powered chatbot allows farmers to communicate using text or voice in local languages. The chatbot provides instant responses regarding crop diseases, fertilizers, pesticides, irrigation, and farming practices. All information is stored in a centralized SQLite database, enabling personalized recommendations and historical analysis.

The overall architecture consists of the following modules:

- Farmer Registration and Authentication
- Image Upload Module
- Disease Detection Module
- Weather Forecast Module
- Pest Prediction Module
- Market Price Module
- AI Voice Chatbot Module
- Recommendation Engine
- Farmer Dashboard
- Database Management System

Each module communicates with the backend developed using Flask APIs, ensuring smooth data exchange between the frontend, machine learning models, and database.

B. Architecture Description

The architecture follows a layered approach consisting of the presentation layer, application layer, machine learning layer, and database layer.

The presentation layer provides user-friendly interfaces developed using HTML, CSS, Bootstrap, and JavaScript. Farmers interact with the system through login pages, image upload forms, chatbot interfaces, and dashboards.

The application layer is implemented using the Flask web framework. It manages user authentication, API communication, image processing requests, weather data retrieval, chatbot responses, and recommendation generation.

The machine learning layer contains the trained CNN/ResNet model responsible for disease classification. Uploaded crop images undergo preprocessing operations such as resizing, normalization, and tensor conversion before being passed to the trained model. The model predicts the disease class and returns confidence scores along with treatment recommendations.

The database layer uses SQLite for storing farmer profiles, crop records, disease history, pesticide recommendations, chatbot interactions, and market information. Historical data helps generate personalized suggestions for future crop management.

External APIs provide weather information and market prices, while the chatbot integrates Natural Language Processing techniques for voice interaction. The modular architecture allows easy scalability and future integration of IoT sensors, satellite imagery, drone monitoring, and blockchain-based agricultural traceability systems.

IV. Proposed Methodology

The proposed Smart Farming Assistance System integrates image processing, machine learning, weather forecasting, market price monitoring, and an AI-powered chatbot into a unified platform. Farmers upload crop leaf images, which are preprocessed and analyzed using a deep learning model to detect diseases and recommend suitable treatments. The system also provides weather forecasts, pest alerts, real-time market prices, and multilingual chatbot assistance. All prediction results and user information are stored in a database for future analysis and personalized recommendations.

A. Data Preprocessing

Data preprocessing improves image quality before disease classification.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435 (Online) Volume 15, Issue 08, August 2026)

The uploaded images undergo resizing, normalization, noise reduction, and image augmentation techniques such as rotation, flipping, zooming, and brightness adjustment. These steps enhance model accuracy and improve disease detection under different environmental conditions.

B. Feature Engineering

The proposed system uses deep learning for automatic feature extraction, eliminating the need for manual feature engineering. The CNN model extracts important features such as leaf texture, color variations, disease spots, edges, vein patterns, and lesion distribution. These features are combined through fully connected layers to accurately classify crop diseases while improving overall prediction performance.

C. Machine Learning Models

The proposed system uses a Convolutional Neural Network (CNN) to classify crop diseases from leaf images. The CNN architecture consists of an input layer, convolution layers, ReLU activation, pooling layers, fully connected layers, and a Softmax output layer. The model is trained using labeled healthy and diseased crop images to accurately identify disease categories. CNN provides high accuracy, automatic feature extraction, faster prediction, and reduces manual effort.

D. Algorithm Workflow

The system begins by accepting a crop leaf image from the farmer. The image is preprocessed and analyzed using the CNN model to detect the disease. Based on the prediction, the system recommends suitable pesticides and treatments. It also retrieves weather forecasts, pest alerts, and market price information before displaying the final results on the farmer dashboard.

Workflow:

Crop Leaf Image → Image Preprocessing → CNN Disease Detection → Treatment Recommendation → Weather & Pest Forecast → Market Price Update → Farmer Dashboard

E. Mathematical Model

Let:
I = Input Image
P(I) = Preprocessed Image
F = Extracted Features
M = CNN Model
D = Disease Prediction
The disease prediction process is represented as:

$$P(I) = \mathrm{Resize}(I) + \mathrm{Normalize}(I)$$
$$F = \mathrm{CNN}(P(I))$$
$$D = \mathrm{argmax}(M(F))$$

The model performance is evaluated using Accuracy, Precision, Recall, and F1-Score, calculated from True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN).

V. Experimental Setup

A. Dataset

The proposed model is trained using a publicly available crop disease dataset containing healthy and diseased leaf images of crops such as tomato, potato, maize, grape, apple, pepper, and rice. The dataset includes multiple disease categories captured under different environmental conditions. It is divided into 70% training, 15% validation, and 15% testing to ensure reliable model training and performance evaluation.

B. Tools and Environment

The proposed system is developed using modern software technologies.

Programming Language: Python

Frontend: HTML, CSS, Bootstrap, JavaScript

Backend: Flask Framework

Database: SQLite

C. Evaluation Metrics

The performance of the disease detection model is evaluated using standard classification metrics. Accuracy measures the percentage of correctly classified images. Precision evaluates the correctness of positive predictions. Recall measures the ability to identify all diseased plants. F1-score balances precision and recall. Confusion Matrix is used to visualize prediction performance across all disease classes. These metrics collectively demonstrate the reliability and effectiveness of the proposed system.

VI. Results And Discussion

The experimental results indicate that the proposed Smart Farming Assistance System effectively detects crop diseases and provides timely recommendations for farmers. The CNN-based model successfully classifies different crop diseases with high accuracy while reducing false predictions.

The integrated dashboard enables farmers to access disease diagnosis, pesticide recommendations, weather forecasts, pest alerts, and market prices through a single interface. The multilingual AI chatbot improves accessibility by providing instant responses to agricultural queries using voice and text.

Offline disease detection significantly enhances system usability in rural regions where internet connectivity is limited. Compared to traditional farming methods, the proposed system reduces disease diagnosis time, minimizes crop losses, and supports better agricultural decision-making.

Overall, the integration of multiple agricultural services into one platform improves operational efficiency, reduces farming risks, and promotes sustainable agriculture.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435 (Online) Volume 15, Issue 08, August 2026)

VII. Challenges And Limitations

The proposed Smart Farming Assistance System provides effective crop disease detection and farming support; however, it has certain limitations. The prediction accuracy depends on the quality of uploaded images, and poor-quality images may affect the results. The system currently supports only a limited number of crop diseases and requires additional datasets for wider coverage. Weather forecasting relies on external APIs, while market price information needs regular updates. Additionally, the AI chatbot can be further improved using advanced Large Language Models (LLMs) to provide more accurate and intelligent responses.

VIII. Conclusion

The proposed Smart Farming Assistance System integrates machine learning, image processing, weather forecasting, market price monitoring, and an AI chatbot into a single platform. It accurately detects crop diseases, provides treatment recommendations, and supports farmers with real-time agricultural information. The system improves decision-making, enhances productivity, reduces crop losses, and promotes sustainable farming, making it a valuable solution for modern digital agriculture.

IX. Future Work

Several enhancements can be incorporated into the proposed system in future research. IoT sensors can be integrated to monitor soil moisture, temperature, humidity, and nutrient levels in real time. Drone-based image acquisition can be incorporated for large-scale crop monitoring.

Satellite imagery may be integrated for regional disease surveillance. Advanced transformer-based deep learning models can further improve disease classification accuracy.Large Language Models (LLMs) can enhance chatbot intelligence by providing personalized agricultural consultations. Blockchain technology may be integrated for transparent crop supply chain management and traceability. Government schemes, crop insurance services, and digital payment systems can also be integrated to create a comprehensive smart farming ecosystem.

Acknowledgments

The authors would like to acknowledge Marudhar Kesari Jain College for Women (Autonomous), Vaniyambadi-635751, Tamil Nadu, for providing access to the computational facilities in the FIST Instrumentation Lab, supported under Grant No.SR/FST/COLLEGE/2023/1511 (FIST Program-2023, TPN-88688).

REFERENCES

[1] S. Sladojevic, M. Arsenovic, A. Anderla, D. Culibrk, and D. Stefanovic, "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification," Computational Intelligence and Neuroscience, 2016.

[2] K. P. Ferentinos, "Deep Learning Models for Plant Disease Detection and Diagnosis," Computers and Electronics in Agriculture, vol. 145, pp. 311–318, 2018.

[3] Hughes, D. P., and Salathe, M., "An Open Access Repository of Images on Plant Health to Enable the Development of Mobile Disease Diagnostics," PlantVillage Dataset, 2015.

[4] Food and Agriculture Organization (FAO), "Digital Agriculture and Smart Farming," FAO Publications, Rome, Italy.