



AGRIBOT: AN INTELLIGENT CHATBOT FOR FARMERS WITH CROP RECOMMENDATION AND DISEASE PREDICTION USING MACHINE LEARNING

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Abstract: Agriculture remains one of the most important sectors contributing to economic growth and food security across the world. In developing countries such as India, a large percentage of the population depends directly or indirectly on agriculture for their livelihood. Despite technological advancements, farmers continue to face challenges such as improper crop selection, lack of agricultural expertise, unpredictable environmental conditions, and delayed disease identification. These issues often result in reduced productivity, crop loss, and financial instability. To address these challenges, this paper proposes Agribot, an intelligent agricultural chatbot that integrates Machine Learning and Deep Learning techniques to provide personalized crop recommendations and plant disease prediction. The system utilizes a Random Forest Classifier to recommend suitable crops based on soil nutrient parameters and a Convolutional Neural Network (CNN) to identify plant diseases from leaf images. A chatbot interface allows farmers to interact with the system in a simple and user-friendly manner. Experimental results demonstrate that the crop recommendation model achieves an accuracy of 92.7%, while the disease prediction model achieves an accuracy of 94.2%. The proposed system supports smart farming practices by providing timely, accurate, and accessible agricultural guidance.

Keywords: Agriculture, Machine Learning, Deep Learning, Crop Recommendation, Disease Prediction, Random Forest, CNN, Chatbot.

1. INTRODUCTION

Agriculture plays a crucial role in the economic development of many nations, particularly India, where a significant portion of the population relies on farming. Farmers face various challenges including soil degradation, climate variability, pest attacks, and plant diseases. The absence of immediate expert guidance often forces farmers to make decisions based on assumptions rather than scientific evidence.

Traditional agricultural advisory systems rely on agricultural officers, government extension services, and manual consultations. These approaches are limited by geographical accessibility, operational constraints, and insufficient manpower. Furthermore, obtaining accurate disease diagnosis often requires farmers to physically visit agricultural centers.

Recent developments in Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) have enabled the development of intelligent systems capable of solving complex agricultural problems. Machine Learning algorithms can analyze agricultural data and predict suitable crops, while Deep Learning models can identify plant diseases through image analysis.

Agribot is proposed as an integrated solution combining crop recommendation and disease prediction capabilities within a conversational chatbot platform. Farmers can enter soil nutrient values and receive crop recommendations or upload leaf images to obtain disease diagnoses and treatment suggestions. The proposed system aims to improve agricultural productivity and support sustainable farming practices.



2. LITERATURE REVIEW

Several researchers have developed agricultural advisory systems using Machine Learning techniques. Pruthviraj et al. developed a crop and fertilizer recommendation system based on soil classification techniques. Their system utilized machine learning algorithms to recommend crops according to soil properties and nutrient availability. The study demonstrated the effectiveness of data-driven crop prediction methods.

Reddy et al. proposed a precision farming framework that employed machine learning models to analyze soil conditions and provide crop recommendations. The system achieved improved prediction accuracy and demonstrated the potential of AI in agricultural decision-making.

Various studies have also explored disease prediction using image processing and deep learning approaches. Convolutional Neural Networks have shown remarkable performance in identifying plant diseases from leaf images with high accuracy.

Despite these advancements, most existing systems focus only on crop recommendation or disease prediction individually. Few systems provide an integrated platform combining both functionalities along with chatbot-based user interaction. Agribot addresses this gap by providing a unified agricultural advisory platform.

Research Gap

- Lack of integrated crop and disease advisory systems.
- Limited real-time interaction for farmers.
- Absence of conversational AI interfaces.
- Difficulty accessing agricultural experts in remote areas.

3. PROPOSED SYSTEM

Agribot is designed as a web-based intelligent agricultural assistant that combines Machine Learning, Deep Learning, and chatbot technologies.

Objectives

- Recommend suitable crops based on soil nutrients.
- Detect plant diseases using leaf images.
- Provide treatment suggestions.
- Deliver recommendations through a chatbot interface.

System Architecture

The architecture consists of three layers:

User Interface Layer

Provides chatbot interaction, soil parameter forms, and image upload functionality.

Application Layer

Handles request processing, validation, routing, and communication with Machine Learning models.

Machine Learning Layer

Contains crop recommendation and disease prediction models.

4. METHODOLOGY

Crop Recommendation Module

The crop recommendation engine uses the Random Forest Classifier algorithm. Input parameters include:

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)
- pH Value

The trained model analyzes the input parameters and predicts the most suitable crop.

Disease Prediction Module

The disease prediction module uses a Convolutional Neural Network (CNN). Farmers upload leaf images, which are processed through image preprocessing techniques including resizing and normalization.



The CNN extracts visual features and classifies diseases accurately.

Disease Prediction Module

The Disease Prediction Module is one of the most important components of the proposed Agribot system, designed to identify plant diseases accurately and provide timely recommendations to farmers. Plant diseases are among the major factors responsible for significant agricultural losses worldwide. Early detection and diagnosis of diseases can help farmers take preventive measures, reduce crop damage, and improve overall agricultural productivity. However, traditional disease identification methods often require expert consultation, laboratory testing, and field inspections, which may be time-consuming and expensive for farmers, especially those living in remote rural areas.

To overcome these challenges, the proposed system utilizes a Deep Learning-based Disease Prediction Module powered by a Convolutional Neural Network (CNN). CNN is a specialized deep learning architecture widely used for image classification and computer vision applications due to its ability to automatically extract meaningful features from images. Unlike traditional machine learning techniques that require manual feature extraction, CNN models can learn important visual patterns directly from image data, making them highly effective for plant disease detection.

The disease prediction process begins when a farmer uploads an image of a plant leaf through the Agribot web interface. The uploaded image serves as the input to the disease detection system. Since images collected from different sources may vary in size, quality, lighting conditions, and orientation, several image preprocessing techniques are applied before the image is passed to the CNN model. These preprocessing operations improve image quality and ensure consistency across all input samples.

The first preprocessing step involves image resizing. All uploaded leaf images are resized to a fixed dimension of 224×224 pixels. Standardizing image dimensions is essential because deep learning models require uniform input sizes during both training and prediction. After resizing, image normalization is performed to scale pixel values into a specific range, typically between 0 and 1. Normalization helps improve model convergence, reduces computational complexity, and enhances prediction performance.

Chatbot Module

The chatbot serves as the communication interface between farmers and the prediction modules. It guides users through data entry and presents recommendations in natural language.

5. DATASET DESCRIPTION

Crop Recommendation Dataset

The crop dataset contains over 2200 agricultural records. Features include Nitrogen, Phosphorus, Potassium, and pH values. The dataset covers 22 crop categories.

Plant Disease Dataset

The PlantVillage dataset contains over 54,000 annotated leaf images across multiple crop species and disease categories.

4.X Mathematical Modeling of Disease Prediction Module

The Disease Prediction Module utilizes a Convolutional Neural Network (CNN) to classify plant diseases from leaf images. The mathematical framework consists of image preprocessing, convolution operations, activation functions, pooling, and final classification.

4.X.1 Image Representation

The uploaded leaf image is represented as:

$$\begin{bmatrix} I(x,y) \end{bmatrix}$$

Where:

- (I) = Input leaf image
- (x,y) = Pixel coordinates

After preprocessing, the image is resized to:

$$\begin{bmatrix} 224 \times 224 \times 3 \end{bmatrix}$$



where 3 represents RGB color channels.

4.X.2 Image Normalization

Pixel values are normalized to improve training efficiency:

$$I_{\text{norm}} = \frac{I}{255}$$

Where:

- (I) = Original pixel value
- (I_{norm}) = Normalized pixel value

4.X.3 Convolution Operation

Feature extraction is performed using convolution filters.

$$F(i,j) = \sum_m \sum_n I(i+m,j+n) \times K(m,n)$$

Where:

- (F(i,j)) = Feature map
- (I) = Input image
- (K) = Convolution kernel
- (m,n) = Kernel dimensions

This operation extracts disease-related features such as spots, lesions, discoloration, and texture patterns.

4.X.4 ReLU Activation Function

The Rectified Linear Unit (ReLU) introduces non-linearity:

$$\text{ReLU}(x) = \max(0, x)$$

Where:

- If ($x > 0$), output = (x)
- If ($x < 0$), output = 0

4.X.5 Max Pooling

Pooling reduces feature dimensions while retaining important information.

$$P = \max(F)$$

Where:

- (P) = Pooled feature value
- (F) = Feature map

4.X.6 Fully Connected Layer

The extracted features are combined for classification:

$$Z = \sum_{i=1}^n W_i X_i + b$$

Where:

- (W_i) = Weight
- (X_i) = Input feature
- (b) = Bias

4.X.7 Softmax Classification

The probability of each disease class is calculated using:

$$P(y_i) = \frac{e^{z_i}}{\sum_{j=1}^n e^{z_j}}$$



Where:

- $(P(y_i))$ = Probability of disease class (i)
- (z_i) = Output score
- (n) = Number of disease classes

4.X.8 Disease Prediction Function

The final disease prediction is represented as:

[
Disease = CNN(Image)
]

Where:

- Image = Uploaded leaf image
- CNN = Trained Convolutional Neural Network model

4.X.9 Accuracy Calculation

The prediction accuracy is calculated as:

[
 $Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$
]

Where:

- TP = True Positive
- TN = True Negative
- FP = False Positive
- FN = False Negative

The CNN model achieved an accuracy of 94.2%, demonstrating its effectiveness in identifying plant diseases from leaf images

Data Preprocessing

Crop Dataset

- Missing value removal
- Feature scaling
- Normalization
- Train-test split

Disease Dataset

- Image resizing
- Pixel normalization
- Data augmentation
- Dataset balancing

6. IMPLEMENTATION

Software Requirements

- Python 3.10
- Flask
- React JS
- Express JS
- TensorFlow
- Scikit-Learn
- Pandas
- NumPy

Hardware Requirements

- Intel Core i5 Processor
- 8 GB RAM
- 256 GB SSD
- Windows 10/11

**Development Environment**

Visual Studio Code and Jupyter Notebook were used for model development and system implementation.

7. RESULTS AND DISCUSSION**Crop Recommendation Performance****Metric Value**

Accuracy 92.7%

Precision 92.1%

Recall 91.9%

F1 Score 92.0%

Disease Prediction Performance**Metric Value**

CNN Accuracy 94.2%

Top-5 Accuracy 98.6%

Analysis

The Random Forest Classifier outperformed the Decision Tree algorithm due to its ensemble learning capabilities. The CNN model effectively identified plant diseases even under varying image conditions.

The chatbot interface improved user accessibility and simplified interaction with complex machine learning models.

Advantages

- High prediction accuracy.
- User-friendly interface.
- Real-time recommendations.
- Cost-effective deployment.
- Supports sustainable agriculture.

8. CONCLUSION AND FUTURE WORK

Agribot successfully integrates crop recommendation and disease prediction into a single intelligent platform. The system utilizes Machine Learning and Deep Learning techniques to assist farmers in making informed agricultural decisions. Experimental results demonstrate high prediction accuracy and practical usability.

The proposed solution reduces dependency on manual expert consultations and provides immediate guidance to farmers. By delivering personalized recommendations through a chatbot interface, the system improves accessibility and encourages adoption of digital farming technologies.

Future Scope

- Weather forecasting integration.
- Market price prediction.
- Voice-enabled chatbot.
- Mobile application development.
- Regional language support.
- IoT sensor integration.
- Fertilizer recommendation enhancement.

REFERENCES

- [1]. M. Karthikeyan and R. Prakash (2024), "AI-Based Crop Recommendation and Disease Prediction System for Smart Agriculture," IEEE International Conference on Intelligent Computing and Smart
- [2]. S.NaveenKumar and P.Rajalakshmi (2024), "Deep Learning Approach for Plant Disease Detection Using Leaf Images," IEEE International Conference on Artificial Intelligence and Data Engineering (AIDE), pp. 221–226.



- [3]. A.Sharma and K. Verma (2024), “**Precision Farming Using Machine Learning and Weather-Based Crop Prediction,**” International Journal of Agricultural Informatics, Vol. 15, Issue 2, pp. 45–53.
- [4]. R.Balaji and S.Kumar (2025), “**Web-Based Intelligent Chatbot for Agricultural Advisory Services,**” Journal of Smart Agriculture and Technology, Vol. 9, Issue 1, pp. 30–38.
- [5]. P.Harish and M.Deepika (2025), “**CNN-Based Plant Leaf Disease Classification for Sustainable Farming,**” International Journal of Computer Vision and AI Applications, Vol. 6, Issue 3, pp. 90–98.
- [6]. T.Aravind and N.Keerthana (2025), “**Integrated Crop Recommendation and Disease Prediction Using Machine Learning,**” Journal of Artificial Intelligence in Agriculture, Vol. 11, Issue 4, pp. 102–110.
- [7]. V.Surya and R.Mahalakshmi (2025), “**Smart Farming Assistance System Using AI Chatbot and Deep Learning Techniques,**” International Journal of Advanced Research in Engineering and Technology, Vol. 16, Issue 1, pp. 55–63.