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# Artificial Intelligence in Agriculture

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**ABSTRACT:** Plant diseases are a major challenge in agriculture, affecting crop productivity and threatening global food security. They can lead to heavy financial losses and create serious difficulties for farmers. Traditionally, detecting plant diseases depends on manual inspection, which is time-consuming, requires expert knowledge, and may not always give accurate results. This project presents a Plant Disease Detection and Prediction System that uses modern machine learning and deep learning techniques to provide a faster and more reliable solution. The system uses Convolutional Neural Networks (CNN) and MobileNet to accurately identify diseases from plant leaf images. In addition, machine learning models like CatBoost and Gaussian Naïve Bayes (GNB) are used to analyze soil conditions and recommend suitable crops based on important agricultural factors. To make the system easy to use, a web-based application is developed using Django. Farmers and users can upload plant images, enter soil details, and receive useful insights such as the type of disease, its causes, suggested treatments (both organic and chemical), and the best crops to grow.

Overall, this system helps reduce the need for expert intervention, enables early detection of plant diseases, and encourages sustainable farming practices. It provides a complete solution that improves productivity, supports better decision-making, and promotes environmentally friendly agriculture

**KEYWORDS:** Plant Disease Detection, Machine Learning, Deep Learning, Convolutional Neural Network, Mobile Net, Soil Fertility Prediction, Crop Recommendation, CatBoost, Gaussian Naïve Bayes, Image Classification, Smart Agriculture, Artificial Intelligence, Django Web Application, Agricultural Decision Support System, Data Preprocessing, Feature Engineering, Random Forest, Logistic Regression, Support Vector Machine, MLP Classifier, Data Augmentation, Image Processing, Precision Agriculture, Sustainable Farming, Crop Yield Prediction.

## I. INTRODUCTION

Agriculture plays a crucial role in global food security, yet plant diseases pose significant challenges, leading to reduced crop yields and economic losses. Traditional disease detection methods rely on manual inspection, which is time-consuming, error-prone, and often requires expert knowledge. To address these challenges, this project presents a Plant Disease Detection and Prediction System that leverages deep learning to identify plant diseases accurately and provide actionable insights for farmers and agricultural researchers.

The system utilizes Convolutional Neural Networks (CNN) and MobileNet for image classification, enabling real-time disease detection from plant leaf images. Additionally, it incorporates Soil Fertility Prediction using the CatBoost model and Crop Recommendation using a Gaussian Naïve Bayes (GNB) classifier. The combination of these models enhances agricultural productivity by offering a comprehensive, AI-powered decision support system.

## II. LITERATURE SURVEY

Several research works have explored the application of machine learning and deep learning techniques for agricultural prediction and plant disease detection. Previous studies focused on soil classification and crop suggestion using machine learning algorithms, where soil properties such as mineral composition and nutrient levels were analyzed to recommend suitable crops. Data mining approaches have also been applied for crop yield prediction by analyzing soil datasets and environmental conditions using algorithms like Naïve Bayes and K-Nearest Neighbors.

Weather-based prediction models using regression techniques and neural networks have been developed to forecast rainfall and improve agricultural planning. Additionally, image processing techniques combined with machine learning

models such as Random Forest have been used to identify plant diseases by analyzing leaf features. Recent advancements include the use of deep convolutional neural networks (CNN) for plant disease classification, which demonstrated higher accuracy compared to traditional feature-based approaches.

Transfer learning models such as MobileNet have further improved performance by reducing computational cost while maintaining high classification accuracy. These studies highlight the effectiveness of artificial intelligence in agriculture; however, many existing systems focus on a single task such as disease detection or crop recommendation. The proposed system integrates plant disease detection, soil fertility prediction, and crop recommendation into a unified platform, providing a comprehensive solution for smart agriculture.

### III. METHODOLOGY

The proposed Plant Disease Detection and Prediction System follows a structured approach integrating machine learning and deep learning techniques to provide accurate agricultural decision support. Initially, datasets consisting of plant leaf images and soil parameters such as nitrogen, phosphorus, potassium, pH, temperature, humidity, and rainfall are collected from publicly available agricultural sources. The collected data undergoes preprocessing, which includes cleaning missing values, removing duplicates, resizing images, normalization, and data augmentation to improve model performance.

Relevant features are extracted and selected to enhance prediction accuracy and reduce computational complexity. For plant disease detection, deep learning models such as Convolutional Neural Networks (CNN) and MobileNet are employed for image classification. For soil fertility prediction and crop recommendation, machine learning algorithms including Random Forest, Logistic Regression, Support Vector Machine, Gaussian Naïve Bayes, MLP Classifier, and CatBoost are utilized.

The dataset is divided into training and testing subsets, and the models are trained and evaluated using performance metrics such as accuracy, precision, recall, F1-score, and confusion matrix. The best-performing models are integrated into a Django-based web application that allows users to upload plant images and input soil parameters. The system processes the inputs, generates predictions, and displays plant disease diagnosis, soil fertility status, and recommended crops. Finally, the system is tested for accuracy and deployed to provide real-time predictions, enabling farmers to make informed decisions and promote sustainable agricultural practices.

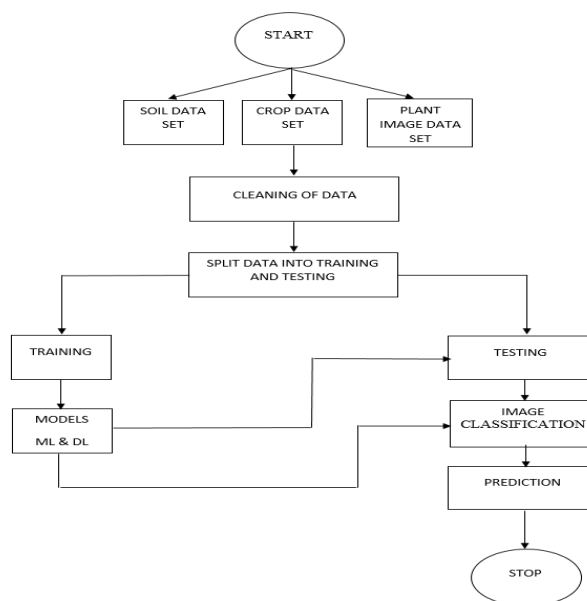


Fig 3.1 Plant Disease Detection and Prediction System Methodology

#### IV. SYSTEM ARCHITECTURE

The system architecture of the proposed Plant Disease Detection and Prediction System is designed using a layered approach consisting of user interface, processing modules, and database components. The user provides input in the form of plant leaf images and soil parameters such as nitrogen, phosphorus, potassium, pH, temperature, and humidity through a web-based interface. The input data is sent to the backend where preprocessing is performed, including image resizing, normalization, and data cleaning. The processed image data is passed to deep learning models such as Convolutional Neural Network (CNN) and MobileNet for plant disease detection, while the soil parameters are analyzed using machine learning algorithms such as Random Forest, CatBoost, and Gaussian Naïve Bayes for soil fertility prediction and crop recommendation. The trained models generate predictions, which are then stored and managed through the database. The system integrates all modules using a Django-based web application that handles user requests, model execution, and result visualization. Finally, the output is displayed to the user in the form of detected plant disease, soil fertility status, and recommended crops, enabling farmers to make informed agricultural decisions.

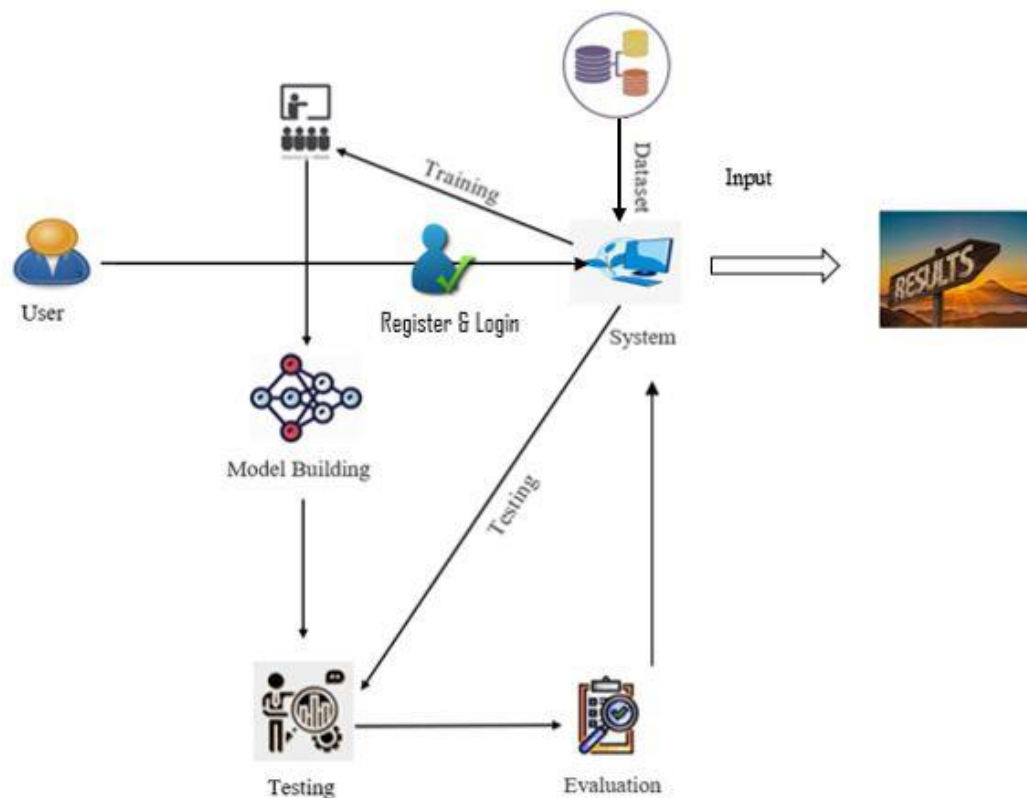


Fig 4.1 System Architecture

#### V. OUTPUT SCREENS

The system is designed with a simple and user-friendly interface that makes it easy to understand the results. After processing the input data, the system displays the outputs in a clear and organized way.

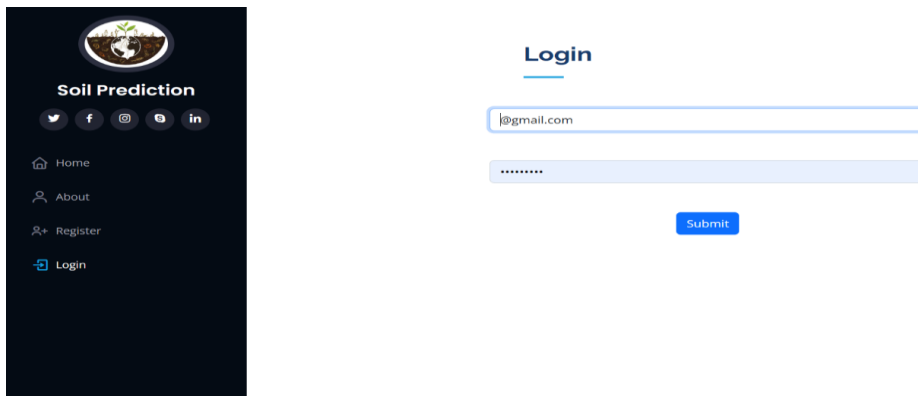
The first output screen shows the plant disease detection results. Once a leaf image is uploaded, the system analyzes it and displays the detected disease along with its possible causes and suggested remedies.

The second output screen focuses on soil fertility. Based on the soil parameters provided by the user, the system indicates whether the soil is fertile or not. The third output screen provides crop recommendations. It suggests the most suitable crops that can be grown based on the soil nutrients and environmental conditions.

In addition, the system may also display prediction accuracy, useful insights, and graphical representations to help users better understand the results. Overall, these output screens make it easy for users to quickly interpret the information and take appropriate agricultural decisions



Fig 5.1 Home Page



5.2 Login Page

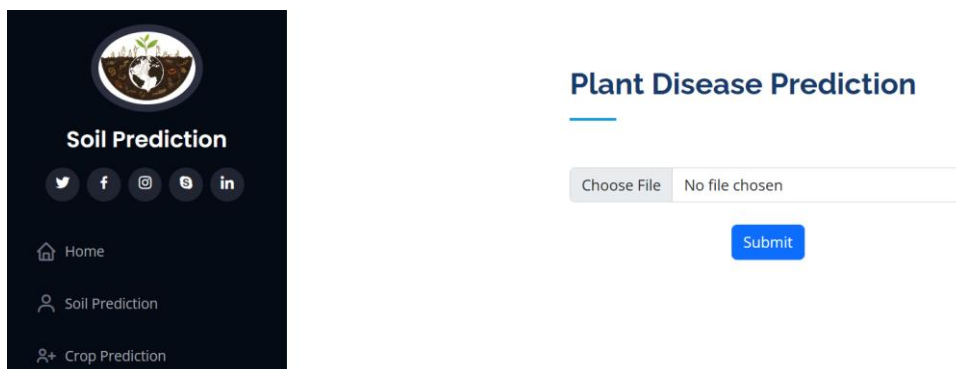
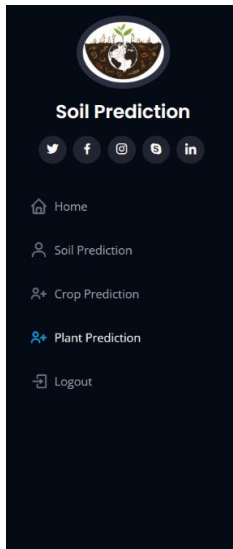


Fig 5.3 Input



### Plant Disease Prediction



**Prediction:** Apple\_\_Cedar\_apple\_rust

**Causes:** Fungus spread from junipers.

**Remedies:** Apply fungicides, remove junipers, enhance air circulation.

**Organic:** Pruning infected branches and applying neem oil.

**Inorganic:** Spraying affected trees with copper fungicides

Fig 5.4 visualization Result

## VI. CONCLUSION

The proposed Plant Disease Detection and Prediction System demonstrates the effective use of machine learning and deep learning techniques in improving agricultural productivity. By integrating Convolutional Neural Networks and MobileNet for plant disease detection along with machine learning algorithms such as Random Forest, CatBoost, and Gaussian Naïve Bayes for soil fertility prediction and crop recommendation, the system provides accurate and reliable results. The user-friendly web interface allows farmers to upload plant images and enter soil parameters easily, making the system accessible even to non-technical users. The implementation of this system helps in early detection of plant diseases, efficient soil analysis, and selection of suitable crops, thereby reducing crop losses and improving yield. Overall, the proposed solution supports smart agriculture by providing data-driven decision-making and promoting sustainable farming practices.

## VII. FUTURE SCOPE

The proposed Plant Disease Detection and Prediction System can be improved further by adding new features that enhance both accuracy and ease of use. In the future, the system could include real-time image capture through mobile devices, allowing farmers to instantly detect plant diseases directly in the field. It can also be expanded to support a broader range of crops and diseases by training the model on larger and more diverse datasets.

Additionally, integrating weather forecasting data along with IoT-based sensors to monitor soil moisture, temperature, and humidity can help provide more accurate crop recommendations. Adding multilingual support would make the system more accessible to farmers from different regions. The system could also be developed as a mobile application and connected to cloud platforms to ensure scalability and real-time updates. Overall, these improvements will make the system more efficient, user-friendly, and practical for modern smart agriculture.

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