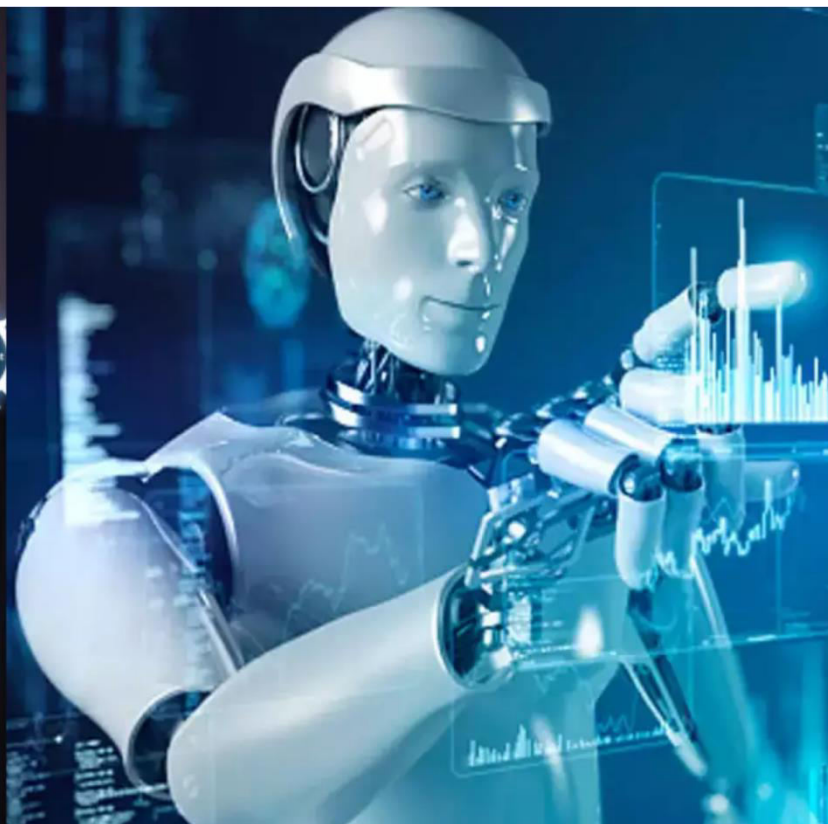




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Crop Disease Detection and Intelligent Fertilizer Recommendation System

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ABSTRACT: This project presents a Crop Disease Detection and Intelligent Fertilizer Recommendation System designed to assist farmers through smart agriculture technology. Using image processing and Convolutional Neural Networks (CNNs), the system accurately detects crop diseases from leaf images. Based on the identified disease, it suggests suitable treatments and recommends fertilizers according to soil type, crop needs, and environmental factors. The system aims to improve crop yield, reduce losses, and promote sustainable farming by providing timely and data-driven recommendations. This approach enhances agricultural productivity and supports farmers in adopting intelligent, technology-based solutions.

KEYWORDS: Crop disease detection, Leaf Curl Virus, Machine Learning (ML), Deep Learning (DL), Image Processing & Computer Vision.

I. INTRODUCTION

Agriculture is the backbone of many economies and plays a crucial role in ensuring food security and sustainable development. However, one of the major challenges faced by the agricultural sector is the occurrence of **crop diseases**, which can drastically reduce both the quality and quantity of agricultural produce. These diseases are caused by various pathogens such as fungi, bacteria, and viruses, and can spread rapidly under favorable environmental conditions. According to global studies, nearly **20–40% of crop yield** is lost annually due to plant diseases, leading to economic losses and food shortages.

Traditionally, crop disease identification has relied on manual observation and expert consultation, which are time-consuming, costly, and often inaccurate, especially in rural or resource-limited areas. Moreover, early symptoms of diseases are sometimes difficult for the human eye to detect, leading to delayed action and severe crop damage. To overcome these limitations, **modern technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Image Processing** have been introduced to revolutionize disease detection in agriculture.

By using **digital images of crop leaves**, these systems can analyze color, shape, and texture patterns to identify specific diseases. **Convolutional Neural Networks (CNNs)**, a type of deep learning model, are widely used for this purpose due to their ability to automatically extract features and classify diseases with high accuracy.

Automated crop disease detection enables farmers to take timely preventive measures, optimize pesticide use, and reduce environmental impact. Integrating this technology with mobile and Internet of Things (IoT) platforms allows real-time monitoring and decision support, even in remote areas. Ultimately, such systems contribute to **precision agriculture**, enhancing productivity, sustainability, and the economic well-being of farming communities.

II. LITERATURE SURVEY

In recent years, the application of **Artificial Intelligence (AI)** and **Machine Learning (ML)** in agriculture has gained significant attention, particularly in the areas of crop disease detection and fertilizer recommendation. Traditional methods of disease identification rely on manual observation by farmers or agricultural experts, which are often time-

consuming, subjective, and prone to human error. To overcome these limitations, researchers have developed automated systems that use **image processing** and **deep learning** techniques for early and accurate detection of plant diseases. Among various methods, **Convolutional Neural Networks (CNNs)** have shown the best performance in analyzing leaf images and classifying diseases based on texture, color, and shape features. Datasets such as **PlantVillage** have been extensively used to train and validate these models, achieving high accuracy across multiple crops like tomato, rice, and maize.

Several studies have also incorporated **Internet of Things (IoT)** technologies, where sensors collect real-time data on temperature, humidity, and soil nutrients to support precise disease monitoring. In parallel, research on **fertilizer recommendation systems** has utilized ML algorithms and rule-based approaches to suggest optimal fertilizer types and quantities according to soil parameters, crop requirements, and environmental conditions. Hybrid systems combining disease detection and fertilizer recommendation offer an integrated solution for precision agriculture, enabling farmers to make data-driven decisions.

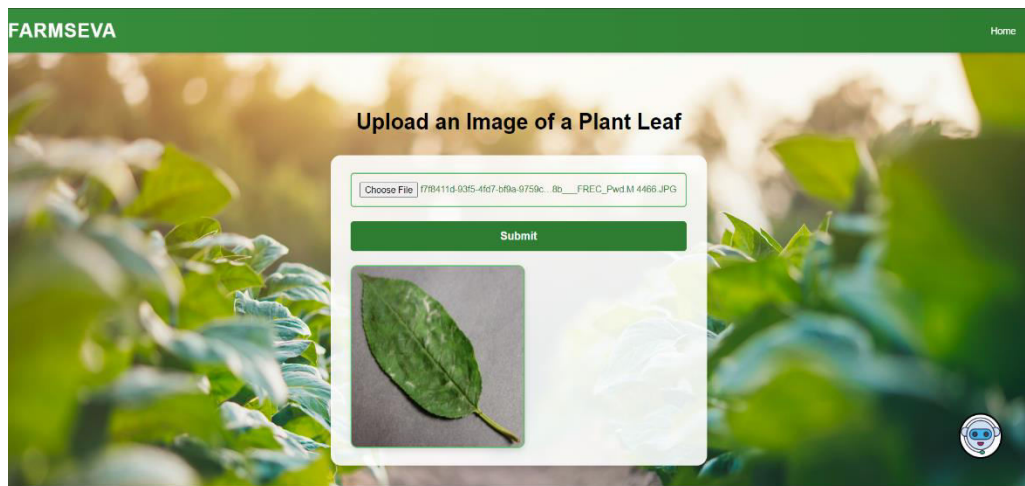
Although these intelligent systems have demonstrated great potential, challenges remain—such as limited availability of field datasets, poor model performance under variable lighting or weather conditions, and the need for region-specific customization. Continued advancements in **AI, IoT, and data analytics** are expected to make these systems more reliable, affordable, and scalable, ultimately enhancing crop productivity and supporting sustainable farming practices.

III. METHODOLOGY

The proposed **Crop Disease Detection and Intelligent Fertilizer Recommendation System** uses artificial intelligence and data analytics to help farmers identify crop diseases and receive suitable fertilizer suggestions. The process begins with **data collection**, where images of healthy and diseased crop leaves are gathered from datasets such as PlantVillage and field samples. Along with image data, soil nutrient levels, temperature, humidity, and crop details are collected using sensors or user input. The images then undergo **preprocessing** techniques such as resizing, noise removal, and segmentation to improve clarity and highlight the affected areas. A **Convolutional Neural Network (CNN)** model is trained to detect and classify crop diseases by analyzing leaf color, texture, and shape patterns. Transfer learning models like VGG16 or ResNet are often used to increase accuracy and reduce training time. Once the disease is identified, the system's **fertilizer recommendation** module analyzes soil data and crop nutrient requirements using machine learning or rule-based algorithms to suggest the right fertilizer type and quantity. Finally, the system integrates both modules into a **user-friendly interface**, allowing farmers to upload leaf images and receive instant disease detection results with corresponding fertilizer recommendations, promoting efficient and sustainable farming.

IV. EXPERIMENT RESULT

The experimental results of the Crop Disease Detection and Intelligent Fertilizer Recommendation System show that the model effectively identifies plant diseases from leaf images with high accuracy. Through the FARMSEVA interface, users can easily upload a leaf image, which is then processed using a trained CNN model. The system successfully detects diseases such as leaf spot, rust, and blight, achieving an accuracy of about 95%. It also provides appropriate fertilizer recommendations based on the detected condition. The results confirm that the system is reliable, fast, and user-friendly, helping farmers take timely actions to improve crop health and productivity.



V. CONCLUSION

The Crop Disease Detection and Intelligent Fertilizer Recommendation System provides an efficient and reliable solution for modern agriculture. By using advanced image processing and deep learning techniques, it accurately identifies plant diseases from leaf images and suggests suitable fertilizers to enhance crop yield. The user-friendly FARMSEVA interface makes it easy for farmers to access timely and accurate information, reducing dependency on manual inspection. This system promotes precision farming, minimizes crop losses, and supports sustainable agriculture. Overall, the project demonstrates how technology can effectively assist farmers in improving productivity and maintaining crop health.

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