A PROJECT REPORT

ON

“Crop Care: An AI-Integrated System for Smart Crop Protection and Disease Detection”

Submitted by,

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Under the guidance of,

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in partial fulfillment for the award of the degree of

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PRESIDENCY UNIVERSITY

SCHOOL OF COMPUTER SCIENCE ENGINEERING

CERTIFICATE

This is to certify that the Internship/Project report **"Crop Care: An AI Integrated System for Smart Crop Protection and Disease Detection"** being submitted by "YARRAGUDI AKSHATH KUMAR REDDY, PASALURU ABHINAY KUMAR" bearing roll number "20211CEI0152, 20211CEI0137" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Engineering{AI &ML} is a bonafide work carried out under my supervision.

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DECLARATION

I hereby declare that the work, which is being presented in the report entitled **"TCrop Care: An AI Integrated System for Smart Crop Protection and Disease Detection"** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer and Engineering**, is a record of my own investigations carried under the guidance of **Dr. Sudha P, Associate Professor , Prsidency School of Computer Science and Engineering, Presidency University, Bengaluru.**

I have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

Agriculture is still the pillar of human sustenance, yet contemporary farmers are confronted with issues like plant illness, fertilizer misuse, and inappropriateness in crop selection—resulting in poor harvests and financial pressure. To fill the gap between conventional farming practices and new technologies, we introduce a web application-based AI that provides intelligent solutions in plant disease analysis, and fertilization optimization. With the help of sophisticated machine learning algorithms—such as hybrid ensemble learning—and image processing technology, the platform allows for early diagnosis of infection in plants through real-time image processing. Farmers can upload images of their crops directly through an inbuilt camera feature for real-time evaluation and actionable data. The fertilizer advisory module offers fact-based inputs for maximum utilization without causing damage to the environment. Built with Python and latest web technologies, the platform boasts a user-friendly interface along with leveraging Google Search to enable users to search best practices and market trends. The CropCare is smart agri solution is designed to empower farmers—particularly in technology-constrained areas such as rural India—by enhancing decision-making, optimizing yield, minimizing wastage, and teaching sustainable farming practices.

Keywords: AI in Agriculture, Plant Disease Detection, Fertilizer Optimization, Machine Learning, Image Processing, Sustainable Farming, Smart Agriculture, Precision Farming, Agricultural Technology.

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1.1 Detection of Disease

1.1.1 Motivation:

Agriculture is not a career in India but a lifestyle for crores of individuals. Farms, nonetheless, have several problems despite the importance of agriculture. They grow the wrong crop for their farm, fail to identify plant diseases at the initial stage, and use less or more fertilizer. These problems can decrease their crop, lower their income, and affect the nation's food supply. Among the prime reasons behind this is that farmers lack the right information at the proper time. They even resort to traditional practices, which may not be cost-effective in today's times, especially because of climate change and population growth.

Due to upcoming technologies like artificial intelligence (AI) and machine learning (ML), now there is a chance to support farmers in a smart and contemporary way. Our goal is to create an inexpensive AI-driven web application to empower farmers to make informed decisions. It will help them make the correct crop selection, identify diseases at an early stage, and use fertilizer effectively. It can help them produce more, save money, save the environment, and improve their lifestyle—ensuring farming for the future. [1].

1.1.2 Project Objective:

The objective of this project is to develop and implement an AI-driven web application that enables farmers to make effective agricultural choices. The system emphasizes early detection of plant disease through image processing and machine learning, which prevents the spread of infection and minimizes loss of crops. Smart features are incorporated as well. It also has a fertilizer advisory module that recommends responsible and optimized usage, conserving waste and the environment as well. It is designed with an easy-to-use interface, thus accessible even for farmers with limited technical know-how. With capabilities such as real-time image-based disease diagnosis using an in-built camera and Google Search capability for farm resource and trend search, the project is designed to empower farmers—particularly rural farmers—with productivity-enhancing tools, sustainable farming support, and a robust overall farming environment.[2].

1.1.3 Plant Leaf Disease:

An interference in the well-being of a herb which deforms or kills major. Every herb, either whole or trained, has disease potential. All families are susceptible to a certain disease but it is highly exceptional in every single one. Occurrence and magnitude of plant disease differ across primes, depending on the companionship of pathogens, soil status, and presence and cultivars cultivated. There are certain plants that are extremely prone to plant disease epidemics, while others are highly resistant. See also list of herb disease. [1].

1.1.4 Definitions of plant disease:

Highly perturbed plants tend to become disease-causing agencies that cause uncharacteristic physiological activity which restricts proper structure, growth & function. Plant infectious diseases occur due to attack by infectious plant pathogens like fungi, bacteria, mycoplasma, viruses, viroids, nematodes, and parasitic flowering plants. Outside or inside of a host, infectious agents have the potential for growth and from one susceptible host to a different host [2]. A suboptimal set of growth conditions, including but not limited to high temperatures, unfavorable moisture-oxygen conditions, air and ground contaminants, and an excess or deficiency of needed minerals, are the causes of noninfectious plant disease.

Importance of Plant Disease Detection:

Disease control programs may be a waste of money and time if they are inappropriately targeted. Plant loss can also be caused by disease control management that is not successful in controlling the disease-causing agent. Pathogenic parasites like nematodes, fungi, oomycetes, viruses, and bacteria that cause disease are likely to be pathogenic parasites. Since there are numerous different organisms that can result in numerous different symptoms (Figure 1), the pathogen needs to be correctly identified in order to create a management program[3]. Injury vs. Disease Having some knowledge regarding what distinguishes a plant injury from disease is helpful. An acute injury is caused by an outside factor within a short period of time.

- **Methods for Disease Detection:**

Machine Learning Techniques

1.1.5 K-Nearest Neighbour (KNN) Algorithm for Machine Learning

One of the easiest Machine Learning algorithms, K-Nearest Neighbor is based on the Supervised Learning technique. The K-NN algorithm assumes the new case and the data are comparable to already existing cases, and thereby puts the new instance in the category most similar to such cases. The K-NN algorithm retains all the information that is present and categorizes other data points according to their similarity. Therefore, with the application of the K-NN method, new data can be categorized in a relatively fast and accurate manner [3]. The K-NN method can be used to classify or solve regression problems. The K-NN method is more often applied in classification problems. K-NN is a non-parametric method. Therefore, it doesn't assume any parameter regarding the underlying data. It is also known as the lazy learner algorithm because it memorizes the training dataset instead of earning from it in one go. Instead, it uses the dataset to take some action while classifying data.

Example: when it's time for training, the KNN algorithm only stores the dataset; when it has new data, it classifies that data into a category that is very similar to the new data.

1.1.6 Support Vector Machine Algorithm

The most widely used supervised learning algorithm is called Support Vector Machine (SVM), and it is used to solve Classification and Regression problems. However, it is mainly used in Machine Learning Classification issues.

The SVM technique aims to find the best decision boundary or line which can classify the n-dimensional space and enable us to classify other data points with ease in the future. This optimal boundary is called a hyperplane [1]. To help in the formation of this hyperplane, SVM has chosen the extreme vectors and points.

Support vectors, being the basis of the SVM methodology, are used to represent these extreme scenarios. Look at the graphic below to view how a choice classifies two separate groups.

Types of SVM

There are two kinds of SVM:

➢ **Linear SVM:** The term "linearly separable data" is a term that refers to the data that can be separated into two categories using only one straight line. This kind of data is classified using Linear SVM and the classifier used is termed as the Linear SVM classifier.

➢ **Non-linear SVM:** The data set is said to be non-linear when the same cannot be classified with the help of a straight line. In such cases, the technique of classification used is termed as a non-linear SVM classifier [2].

1.1.7 Random Forest Algorithm

Preferred machine learning algorithm Random Forest is a part of the supervised learning strategy. It might be applied to ML issues which require regression as well as classification.

It is based on the concept of ensemble learning, which is a method for integrating many classifiers to solve complex issues and enhance model performance by averaging multiple numbers of decision trees applied to varied subsets of the given data.

Instead of relying on a single decision tree, the random forest collects forecasts from every decision tree and predicts the outcome based on the majority vote of the projections [3].

1.2 Fertilizer Recommendation

Conventional farming systems, being exceedingly experiential in nature, fall behind while addressing such changing challenges.

Fads such as Google integration—i.e., having immediate access to the Google Search Engine—can provide farmers with timely and correct information. From cross-checking weather trends to knowing the composition of soil, to having knowledge about which fertilizers are being applied, farmers can utilize Google to make better, faster decisions.

Additionally, incorporating this with machine learning and data science can make these benefits even greater. The aim of this project is to develop a platform using machine learning that recommends the best crops and fertilizers based on soil type and climatic conditions. By implementing such technologies, Indian farmers can increase productivity, reduce losses, and enhance their economic resilience [4].

1.2.1 Problem Statement

The majority of India's population relies on agriculture for their living. However, the majority of farmers are using fertilizers without even ascertaining the nutritional needs of the soil. Such illiterate utilization of fertilizers leads to low yields, decreasing the fertility of the soil, and extending soil acidification. To address such problems, the system that we are developing is machine learning-based and recommends intelligent fertilizer recommendations depending on specific soil conditions. According to soil type and climatic factors, the system will recommend recommendations about appropriate types and quantities of fertilizers required for optimal crop growth. This will avert excessive or inadequate use of nutrients by farmers, promote sustainable agriculture, and enhance long-term agricultural productivity and profitability [4].

1.2.2 Objective

The main goals of this project are to:

- Recommend the best fertilizers for improving soil and crop health.

The project will be implemented as a website that includes two main applications:

Fertilizer Recommendation: Farmers can provide soil data and the type of crop they plan to plant, and the app will recommend fertilizers based on soil nutrient deficiencies or excesses.

1.2.3 Motivation

Agriculture is a highly significant occupation in India, and nearly 70% of the small and medium enterprises survive on it. Even though the farmers are now shifting to good technology, still no one knows how to select right fertilizers for their soil. All a fertilizer recommendation system can do is to suggest farmers the ideal quantity and quality of fertilizers based on what their soil requires in terms of nutrients. It will assist them in achieving maximum crop yield, healthy soil, and maximum economic return—India's entire agri sector will prosper to stimulate [3].

1.2.4 Dataset Description

We are using two datasets for this project:

1. **Plant Village Dataset**: This dataset has more than 38,000 images of 15 various plant species, each tagged with 38 types of plant diseases. It can be utilized to train models which will detect plant diseases efficiently and provide suitable recommendations [2].
2. **Agricultural Production in India Dataset**: This information provides 46 years of crop production in India, including sown area data, yields, and population data. It aids in analyzing the trends in agriculture and making productive decisions to increase productivity and ensure food safety [1].

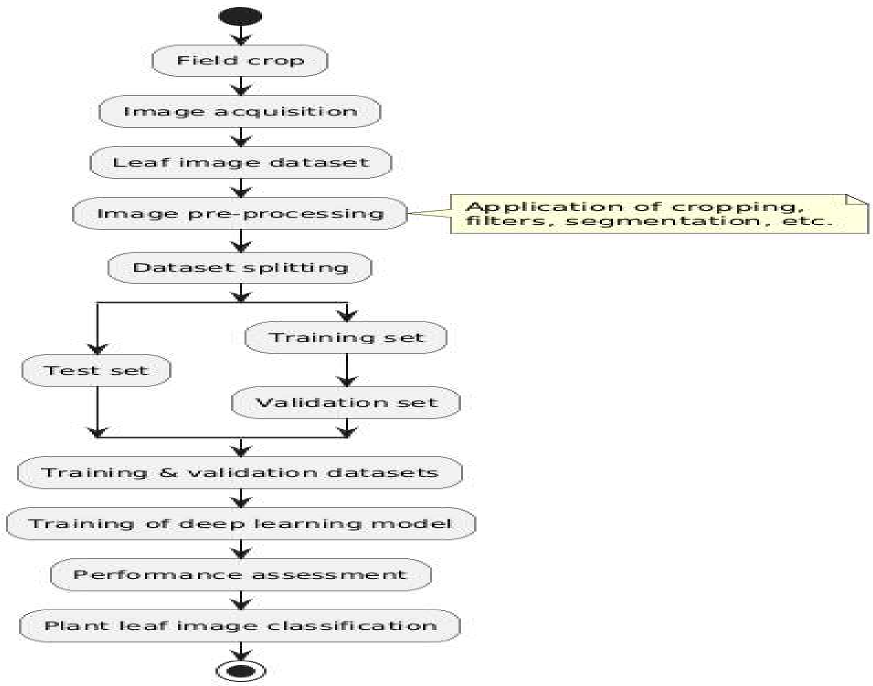


Figure 1.1 Flowchart

Here is a brief description of the Figure 1.1, describe About how the world work:

1. **Image acquisition:** A variety of sources are used to gather crop photos.
2. **Image pre-processing:** The photos are subjected to pre-processing methods like noise reduction, trimming, and image improvement.
3. **Disease identification:** Using pre-processed images, a deep learning model built on a convolutional neural network (CNN) is taught to detect diseases in crops.
4. **Fertilizer recommendation:** Based on the crop variety and soil nutrient level, another machine learning model and Google Search an Familiar in use is created to suggest the right fertilizer.
5. **Integration:** A unified system that integrates **plant disease detection** and **fertilizer recommendation** algorithms.
6. **Deployment:** The combined system is field-installed to enable farmers to use it to detect agricultural diseases, get recommendations for the right products, and get expert fertilizer advice.

CHAPTER - 2

LITERATURE SURVEY

2.1 AIM:

Our aim with our project is to build a solution to one of agriculture's largest problems—predicting plant diseases. Plant diseases in crops are greatly significant to crops in agriculture. To provide a solution, we are providing a machine learning solution which can predict and detect plant diseases automatically and enable farmers to take action at an early stage in crop protection [4].

2.1.1 Literature Survey:

1. **Unsupervised image translation using adversarial networks for Improved plant disease recognition.**

   Reference: Nazki et al.

   Dataset: 2789 tomato plant disease images

   The techniques used: Generative Adversarial Network and Deep CNN

   Output: Accuracy= 86.1%

   Advantages:

   - Better demonstration of information appropriation (pictures more honed and more cleared).
   - GANs can prepare any sort of generator organization.

   Disadvantages:

   - Difficult to prepare, unstable training process.
   - Require many guidelines to obtain Satisfying results. Mode Collapse issue.

2. **Cucumber leaf disease identification with global pooling dilated convolutional neural network.**

   Reference: Zhang et al.

   Dataset: Acquisition of 600 cucumber sick leaves of 6 regular cucumber leaf infected

   Technique used: GPDCNN

   Output: Accuracy = 94.65%

   Advantages:

   - GPDCNN is more robust than different strategies.

Disadvantages:

- The completely associated layer has such a large number of parameters which decreases the Speed of preparing (training) and effectively bringing about over-fitting.

3. Multilayered Convolution neural network for the Classification of Mango leaves infected by Anthracnose Disease.

Reference: SINGH CHOUHA N et al.

Dataset: Captured images at SMVDU, Katra

A technique used: Multilayer convolutional neural network (MCNN)

Output: Accuracy = 97.13%

Advantages:

- The essential advantage of MCNN diverging from its paradigms is that it therefore Perceives the critical features with no human administration.

Disadvantages:

- MCNN has a few layers then the training process takes a ton of time if the PC doesn't Comprise of a good CPU.

4. Sunflower leaf disease detection using Image Segmentation based On Particle swarm optimization.

Reference: Vijai Singh

Dataset: Capture Sunflowers leaves.

A technique used: Particle Swarm Optimization Algorithm.

Output: Accuracy = 98%

Advantages:

- The upsides of PSO are that PSO is easy to implement and there are scarcely any Boundaries to change.
- PSO performs in a way that is better than the GA for computational efficiency.

Disadvantages:

- PSO is one of the well-known techniques, however, its application for the issue isn't

Confounded because of its simple characteristics.

5. **Deep Convolutional neural network-based detection system for real-time corn plant disease recognition.**

Reference: Mishra et al.

Dataset: Plant Village dataset.

Technique used: Deep Convolution Neural Network

Output: Accuracy = 88.46%

Advantages:

- With little dependence on pre-processing, this algorithm requires less human effort.
- It is a self-learner, which makes the preprocessing phase, easier.

Disadvantages:

- It requires an enormous dataset to process and train the neural organization.

6. **Performance analysis of deep learning CNN models for disease detection in plants using image segmentation**

Reference: Sharma et al.

Dataset: Tomato healthy and infected leaves images

Technique used: Convolution Neural Network

Output: Accuracy = 98.6%

Advantages:

- Perhaps the greatest favorable position of CNN is the programmed extraction of highlights by handling straightforwardly the crude pictures.

Disadvantages:

- CNNs don't have arranged outlines which are a fundamental component of human vision.

7. **Tomato Leaf Disease Detection using Convolution Neural Network.**

Reference: Agarwal et al.

Dataset: Images taken from Plant Village dataset.

A technique used: Images taken from Plant Village dataset.

Output: Classification Accuracy = 76% to 100%,

Average Accuracy for disease = 91.2%

Advantages:

- The Storage requirement for the proposed model was approximately 1.5MB whereas pre-prepared models required additional space requirements of approximately 100MB quite clearly highlighting the strength of the proposed model over pre-trained models.

Disadvantages:

- A CNN is essentially slower because of an activity, for example, pooling.

8. Seasonal Crops Disease Prediction and Classification Using Deep Convolutional Encoder Network

Reference: Khamparia et al.

Dataset: Plant Village Dataset

Technique used: Deep Convolution Encoder Network

Output: Accuracy = 97.50%

Advantages:

- Softmax classifier is applied in the output layer. It provides a probability of all classes if there can be a multi-order model case, and the target class should have a high value of probability.

Disadvantages:

- This method lacks a mechanism to map deep layer feature maps to input dimensions.

9. Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification

Reference: Sladojevic et al.

Dataset: Capture images by agricultural experts.

Technique used: Deep Convolution Neural Network

Output: Accuracy= 96.3%

Advantages:

- DCNNs included image and object classification, face detection, and image segmentation.
- DCNN have more hidden layers especially more than 5, which increases the accuracy.

Disadvantages:

- CNN don't encode the position and direction of an object.
- Absence of ability to be spatially invariant to the input information.

10. A Review of Machine Learning Approaches in Plant Leaf Disease Detection and Classification

Reference: MAJJI V APPLALANAIDU, G. KUMARAVELAN.

Dataset: plant village dataset

Technique used: Color Co-occurrence Matrix (CCM), Gray Level Co-occurrence

Matrix (GLCM), Minimum Enclosing Rectangle (MER), Color Co-occurrence Matrix (CCM),

CCM, GLCM, Discrete Wavelet Transform (DWT) Scale Invariant Feature Transform (SIFT)

Objective: This review provides a comparative analysis of various state of-the-art ML and DL algorithms to identify and categorize plant leaf diseases.

11. Research on machine learning framework based on random forest algorithm

Reference: Qiong Ren, Hui Cheng and Hai Han.

Technique used: Random Forest algorithm17

Objective: This paper discusses and examines the machine learning system based on the random forest algorithm in an effort to enhance the existing limitations of the random forest algorithm [4]. It also creates and implements various machine-learning systems.

12. Random Forest with Adaptive Local Template for Pedestrian Detection

Reference: Tao Xiang, Tao Li, Mao Ye, and Zijian Liu.

Dataset: TUD Pedestrians, INRIA pedestrians

Technique used: Random Forest

Output: Accuracy= 90.8%

Objective: Our approach attempts to detect pedestrians in occluded and dense situations by aggregating numerous weak classifiers into a Random Forest model. Each of the weak classifiers is separately described with adaptive local templates. The forest is built layer-wise and iteratively, and the splitting functions of each node are learned from the local templates. All trees in the forest become equal depth after construction, and they aggregate to form a weak classifier. In training, a global loss function is minimized and the weights are updated from the sample per addition of a new weak classifier. Detection accuracy is promoted by adaptive learning. Proposed method in this paper, as reported by experimental results of two challenging pedestrian datasets, achieves state-of-the-art or highly competitive performance [5].

13. Improving the Random Forest Algorithm by Randomly Varying the Size of the Bootstrap Samples

Reference: Md Nasim Adnan.

Technique used: Random Forest

Objective: Random Forest technique uses the Random Subspace method on bootstrap samples to produce heterogeneous decision trees for high-dimensional data. In order to further enhance ensemble precision, it is proposed here that the size of the bootstrap sample is randomized within a specified range instead of being fixed. The experimental results on various UCI datasets show that this technique significantly enhances the performance of the model [5].

14. An Ensemble Random Forest Algorithm for Insurance Big Data Analysis

Reference: Ziming Wu, Weiwei Lin, Zilong Zhang and Angzhan Wen.

Technique used: Random Forest

Objective: This paper describes the imbalanced distribution in insurance business data and reviews preprocessing techniques for handling such data. It proposes an ensemble Random Forest model on Apache Spark, which is appropriate for big data imbalanced classification tasks. Experimental results show that this method performs better than traditional preprocessing techniques and is better suited for insurance product recommendation and potential customer analysis. The approach also facilitates a bootstrap under-sampling strategy combined with KNN for better accuracy [3].

15. Leaf and skin disease detection using image processing

Reference: Manjunath Badiger, Varuna kumara, Sachin CN Shetty, Sudhir Poojary

Technique used: K-means algorithm and SVM classifier

Output: Accuracy = 96.3%

Advantages:

- Easy to understand and implement. Can handle large datasets well. Disadvantages of KMeans Sensitive to number of clusters/centroids chosen.

Disadvantages:

- It requires to specify the number of clusters (k) in advance.
- It cannot handle noisy data and outliers.
- It is not suitable to identify clusters with non-convex shapes.

16. Plant disease detection using machine learning

Reference: Niveditha M, pooja R, prasad Bhat N, Shashank N

Technique used: HOG, Random Forest

Output: Accuracy = 70%

Advantages:

- Work well for small resolutions.

- Typically does detection via classification, i., e uses a Binary classifier.

Disadvantages:

- More time consuming to construct than a frequency polygon.

17. Plant disease detection using CNN

Reference: Nishant Shelar, Suraj shinde, Shubham sawant, Shreyas dhumal

Technique used: CNN

Output: Accuracy = 96%

Advantages:

- Local spatial coherence of the input (usually images) so that they employ fewer weights since they share part of their parameters. Computation in the convolution form makes them suitable to extract useful information with less computation.

Disadvantages:

- Classification of Images with different Positions, Adversarial examples, Coordinate Frame, and Other minor disadvantages like performance.

18. Pest detection in crop using video and Image processing

Reference: Madhuri Devi Chodey, Dr.Noorilla Shariff c, Gauravi Shetty

Technique used: K-means algorithm and SVM classifier

Output: Accuracy = 96.3%

Advantages:

- SVM works relatively well when there is a clear margin of separation between classes.
- SVM is more effective in high-dimensional spaces.

Disadvantages:

- The SVM algorithm is not suitable for large data sets. SVM does not perform very well when the data set has more noise i.e. target classes are overlapping.

19. Image Classification Using Resnet-50 Deep Learning Model

Reference: Aryan Garg Dataset: STL-10 Technique used: Resnet-50

Output: Accuracy= 76.229%

Advantages:

- Networks with large numbers (even thousands) of layers can be trained easily without Increasing the training error percentage.

Disadvantages:

- High computational complexity - Residual neural networks can often require Significant processing power and may not be suitable for certain tasks.

19. Deep Learning in Image Classification using Residual Network (ResNet) Variants for Detection of Colorectal Cancer

Reference: Devvi Sarwinda, Radifa Hilya Paradisa, Alhadi Bustamam, Pinkie Anggia

Dataset: Warwick-QU

Technique used: Deep Residual Network (ResNet)

Output: Accuracy= 73% -88%

Advantages:

- ResNets help in tackling the vanishing gradient problem using identity mapping.

Disadvantages:

- High memory requirements - Residual networks require large amounts of memory to store the necessary parameters and weights.

SCOPE:

- To predict the appropriate plant disease based on the image factor.

- To analyze the data to get the inference.

- To analyze and compare the cleaned dataset with various machine learning algorithms.

- To frame the hybrid ensemble model along with the dataset.

CHAPTER 3

RESEARCH GAPS OF EXISTING METHODS

3.1 Disease Detection

- **No data:** All the models designed for detecting disease are made with big data not accessible to the majority of crops or even in an area. It makes it impossible for them to generalize when the plants and diseases are less covered.
- **Environmental factors:** The majority of the methods synthesized so far are not eco-friendly and consider parameters such as temperature, humidity, and soil quality that are of extremely important nature in disease development and detection.
- **Real-time Detection:** Most of the models are not optimized for real-time applications, especially in low-resource environments [6]. What are needed are lightweight models that would work reasonably well on mobile phones or edge computing platforms.
- **Early-Stage Detection:** Early-stage detection is extremely difficult since the occurrence of an illness on crops is extremely subtle. Models at that time are not doing it successfully, and thus research has to be done on how methods are to be employed to enhance early-stage detection [6].
- **Generalization Across Varieties:** The majority of the models are focusing on a specific variety of a crop, ending up not generalizing to various species, if not varieties in the same species.
- **Explainability and Interpretability:** The deep learning model is non-explainable by nature, and hence farmers will not be aware of the diagnosis process and correct it. Detection of disease using interpretable AI can fill this gap.
- **Multimodal Approaches:** All of the models are visual data-based like leaf or plant images, and the multimodal methods utilizing a mixture of visual, environmental, and textual data are not explored well enough.
- **Disease Co-occurrence:** Different diseases may attack crops at the same time; however, models available so far are single disease-based, which somehow limits practical utility.

3.2 Fertilizer Recommendation Systems

- **Nutrient Profile Limitations:** These models simply recommend the three macronutrients N, P, and K and leave out the remaining nutrients, calcium and magnesium and the micronutrients, which are just as crucial for plant well-being as the three macronutrients.
- **Soils Degradation:** Most current models do not take into account time-dependent soil degradation and therefore produce recommendations that are unsustainable or not accurate in the long run [3]. To guarantee reliability, models that track soil health and degradation patterns over time must be created.
- The majority of fertilizer models offer generic advice depending on regions or types of crops, as opposed to offering individualized advice based on individual soil profiles within a specific location.
- The process lacks models that tackle the impact of over-fertilization, including nutrient runoff and soil acidification. Additional study will be required to create models that not only maximize crop yield but also enhance environmental sustainability.
- Finally, most legacy systems do not make adjustments to fertilizer application depending on the growth stage of the crop, forfeiting important windows for precision fertilization that could have a drastic impact on plant development at particular life stages.
- **Temporal Variation in Soil Fertility:** Fertilizer recommendation based on any one off test of the soil can be erroneous because soil fertility status is in a state of flux with growing season or even within growing season. Models of this temporal fluctuation need more research [5].
- **AI Fertilizer Optimization:** In the existing model, it practically relies on fixed formulae and more limited data analysis. Its hidden potential is in applying its ongoing capacity to learn its optimization of an AI-based recommendation for fertilizers and application with environmental inputs.
- **Combination with Organic Farming:** Generally, such models depend more on chemical fertilizers with fewer studies directed towards organic fertilizer and its other uses for other crop situations.

CHAPTER - 4

PROPOSED METHODOLOGY

4.1 Disease Detection

4.1.1 EXISTING SYSTEM:

The cited system integrates fuzzy modeling and expert opinion to aid in agricultural decision making. The system employs fuzzy sets to encapsulate data about land conditions, weather conditions, air quality, and farming practices to be applied to decision-making rules. Although this system is for crop suggestion, the ability of fuzzy logic to deal with imprecise and uncertain farm data is the one being emphasized—something that can be applied in fertilizer suggestion and disease prediction as well, in accordance with our project needs [1].

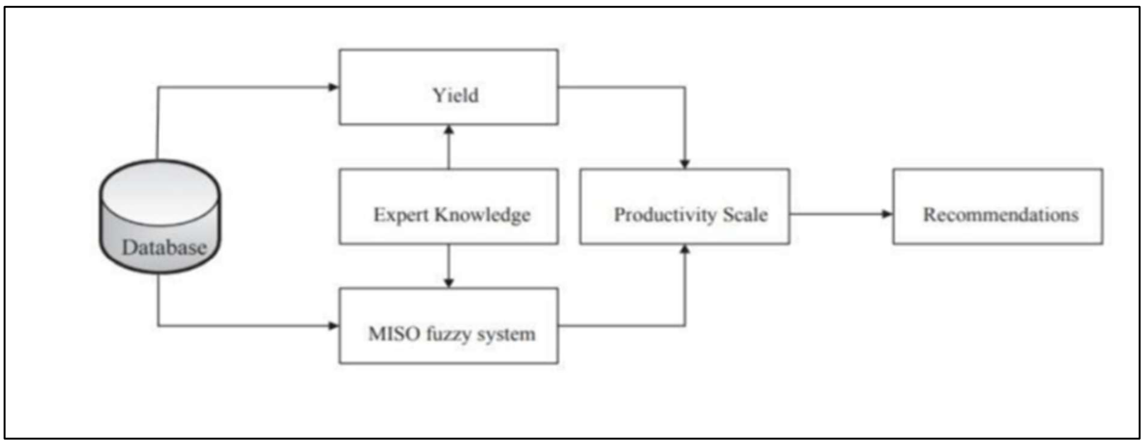


Figure 4.1: EXISTING SYSTEM

4.1.2 MAIN DISADVANTAGES OF THE EXISTING SYSTEM:

Fuzzy knowledge-based systems must be tested extensively on hardware for valid verification and validation. It is hard to define fuzzy rules and membership functions accurately, and fuzzy logic, temporal logic, and probability theory nomenclature is usually confusing. Fuzzy logic control systems also need to be updated frequently to make rules accurate, and they are usually not able to provide exact yield estimates. The process of development is lengthy and complex in general, which limits their practical scalability [2].

4.1.3 PROPOSED SYSTEM:

Under the new strategy, the system will approximate fertilizer recommendations based on important soil factors like NPK values, pH, temperature, mean rainfall, and humidity using Figure 3. These are needed for determination of soil fertility and determination of optimal nutrient requirements. Using this approximation, the system will suggest suitable type and quantity of fertilizers required to facilitate good plant growth under prevailing environmental conditions.

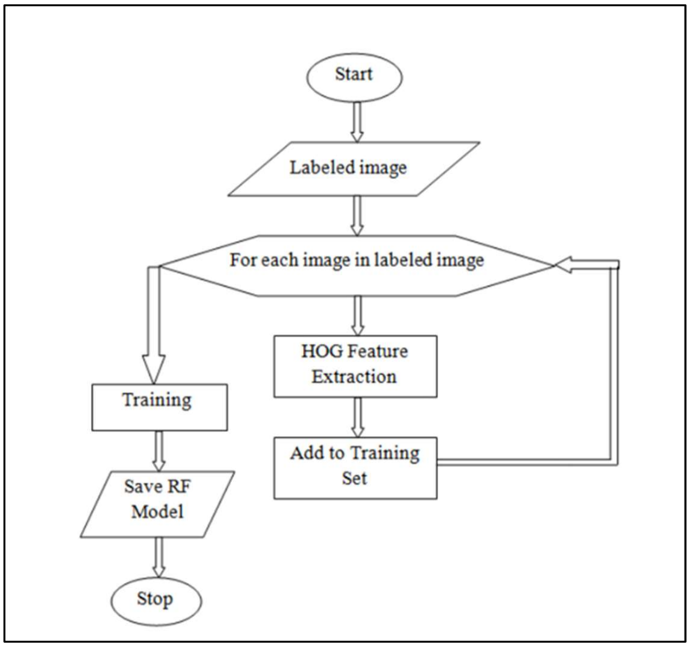


Figure 4.2: Proposed System

We have used the most widely used classification algorithms to forecast the best crop to be planted with the provided soil in this project. These algorithms used here include Logistic Regression, Decision Tree, Random Forest Classification, Support Vector Machine (SVM), and Naive Bayes Classification.

4.1.4 EXPLORATORY DATA ANALYSIS:

Advanced mathematical methods are often at the heart of machine learning, but exploratory data analysis, which is one of the important aspects of any data science project, is often underrated or ignored [5].

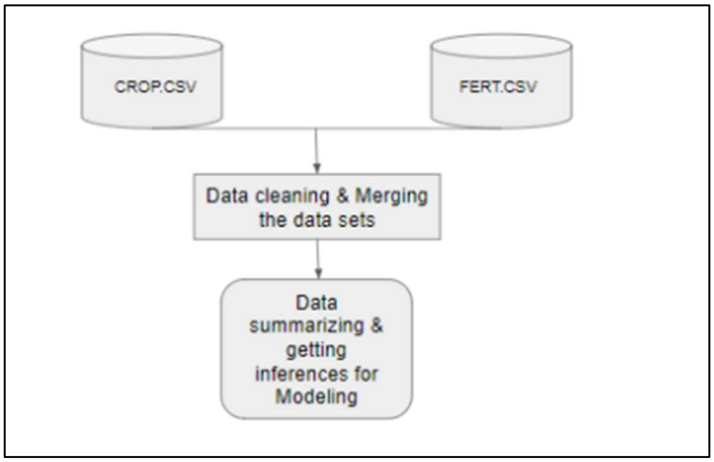


Figure 4.3: Diagram for EDA

Exploratory Data Analysis (EDA) is a vital component in the data understanding process that enables us to make a comparison of the effects of various techniques across data sets. EDA consists of gaining an insight into the shape of the data set, the identification of missing values, outliers, and extracting relevant patterns by both graphical and numerical methods. The procedure helps form the next project steps based on prioritizing particular areas needing greater scrutiny. If the data is **linearly separable**—for instance, in a two-class classification problem where the class label yi∈{−1,1}y_i \in \{-1, 1\}yi∈{−1,1}—EDA can also help validate whether simpler models may be effective for classification tasks.

- Identifying variables and their data types
- Correlation analysis
- Basic statistical metrics
- Variable transformation
- Handling of missing values

4.2 Fertilizer Recommendation

Appropriate fertilizer recommendation should be given to sustain soil fertility and timely delivery of nutrients to the crops. The system suggests fertilizers depending on the nutrient status of the soil, crop nutrient requirement, and different field conditions.

The procedure starts with data gathering, where Nitrogen (N), Phosphorus (P), and Potassium (K) levels are analyzed in soil. Other parameters like soil pH, moisture level, and type of soil (sandy, loamy, or clay) are noted because they are required to provide proper suggestions. The gathered data are processed beforehand to determine nutrient deficiencies or nutrient imbalances in terms of threshold values. For example, if nitrogen falls below the threshold value, the system will suggest nitrogen-based fertilizers.

The recommendation engine may be rule-based (expert agronomic guidance) or ML-based. In ML-based systems, models are trained on past soil test history and fertilizer application data to learn optimal fertilizer types and amounts for varying soil types.

Once trained, the model provides:

- **Type of fertilizer** (e.g., Nitrogen-rich, Phosphorus-rich, Potassium-rich, or organic)
- **Recommended quantity**
- **Method of application** (e.g., soil application or foliar spray)
- **Timing of application**, ensuring nutrients are delivered during the crop's critical growth stages.

4.2.1 Dataset for fertilizer recommendation

Only finding the right crop to grow is not enough for good yield or good yield production we must also find what fertilizer must be used for crop care.

Dataset for fertilizer recommendation have following data fields in Fig 4.4 below

a) N: talks about the ratio of nitrogen
b) P: talks about the ratio of Phosphorous
c) K: talks about the ratio of Potassium
d) Ph soil moisture
e) crop

1		Crop	N	P	K	pH	soil_moisture
2	0	rice	80	40	40	5.5	30
3	3	maize	80	40	20	5.5	50
4	5	chickpea	40	60	80	5.5	60
5	12	kidneybeans	20	60	20	5.5	45
6	13	pigeonpeas	20	60	20	5.5	45
7	14	mothbeans	20	40	20	5.5	30
8	15	mungbean	20	40	20	5.5	80
9	18	blackgram	40	60	20	5	60
10	24	lentil	20	60	20	5.5	90
11	60	pomegranate	20	10	40	5.5	30
12	61	banana	100	75	50	6.5	40
13	62	mango	20	20	30	5	15
14	63	grapes	20	125	200	4	60
15	66	watermelon	100	10	50	5.5	70
16	67	muskmelon	100	10	50	5.5	30
17	69	apple	20	125	200	6.5	50
18	74	orange	20	10	10	4	60
19	75	papaya	50	50	50	6	20

Figure 4.4: Dataset for Fertilizer Recommendation

CHAPTER 5

OBJECTIVES

5.1 Crop Disease Detection

5.1.1 Objective:

This work explores the use of computer vision and deep learning techniques in early plant disease diagnosis and detection. By analyzing images of diseased plants, the system can quickly detect symptoms of diseases, enabling farmers to act early and effectively. Early intervention not only prevents widespread crop destruction but also helps reduce losses, improving total crop yield and agricultural production.

5.1.2 Key Objectives:

- Timely Disease Detection: Employ real-time detection of plant diseases with image-capturing devices such as smartphones, drones, and field cameras to enable farmers to respond in a timely and effective manner.
- Wide Disease Coverage: Create a robust model that can identify a wide range of plant diseases for different types of crops to offer wide-ranging support for diverse agricultural practices.
- Actionable Insights: Provide farmers with useful disease management recommendations, including treatment and prevention techniques to contain the spread and recurrence of infection.
- Severity Prediction: Forecast the severity and extent of disease spread so that farmers can allocate resources effectively while prioritizing the treatment.
- Sustainable Practices: Promote responsible application of chemical pesticides by using them after proper disease identification. The system offers recommendations for safe and minimum application, with a preference for environmentally friendly and sustainable farming.

5.1.3 Benefits:

- Healthier Crops: The diseases will be detected early, and the farmer will therefore respond in good time to mitigate crop losses.

- Affordable: Early diagnosis will never be followed by costly and laborious treatments; therefore, the funds will be conserved, and farm profit increased. Technology available Available technology, a component that readily offers access through mobile applications. The farmer posts pictures in advance with a diagnosis provided on the same page.

5.2 Fertilizer Recommendations

- **Goal:**

To assist farmers in obtaining accurate fertilizer recommendations from information so that the right nutrients are provided at the right time and in the right quantity. This practice maximizes crop development, supports nutrient management best practice, and promotes sustainable farming by reducing overapplication and release into the environment.

5.2.1 Key Results:

- Tailor-Made Fertilizer Programs: Personalized fertilizer suggestions by soil type, nutrient content, crop type, and growth stage, reducing the risk of over-fertilizing.
- Effective Nutrient Management: Avoids over-fertilizing and under-fertilizing by providing the right kind and quantity of fertilizer, resulting in better crop health.
- Organic and Eco-Friendly Options: Supports the use of organic and eco-friendly fertilizers whenever possible, facilitating sustainable agriculture and preventing soil and water pollution.
- Soil Health Monitoring: Encourages frequent soil analysis and makes recommendations on the basis of fluctuations in soil fertility to assist farmers in deciding between chemical and organic fertilizers.
- Detection of Nutrient Deficiency: Recognizes noticeable signs of nutrient deficiencies (leaf yellowing, etc.) and offers practical suggestions on how best to rectify them.
- Application of Balanced Nutrition: Suggests suitable levels of Nitrogen (N), Phosphorus (P), and Potassium (K) to ensure the health of soil and avoid degradation of the environment due to excess use of fertilizers.

5.2.2 Benefits:

- Balanced Growth for Healthy Crops: Provides proper fertilizer guidance to support healthy growth of crops and overall yields via efficient nutrient management.
- Cost Savings for Farmers: Prevents wastage of fertilizers in excess, allowing farmers to save by utilizing only required types and quantities of nutrients.

- Promotes Natural Sustainability: Reduces excessive use of chemical fertilizers, limiting harmful effects like soil pollution and water pollution, and encouraging eco-friendly agricultural practices.
- Soil Conservation: Ensures even balancing of nutrient utilization, soil fertility, and structure, and prevention of long-term soil degradation. Increased Profit Margins: By ensuring maximum quality yield and reduced input cost, the system allows farmers to increase margins and the profitability of their farming operations.

CHAPTER 6

SYSTEM DESIGN & IMPLEMENTATION

6.1 System Overview

A web or mobile application that is meant to directly engage with farmers, gathering appropriate field and soil information. This information is processed through Machine Learning models to provide actionable insights, namely for:

- Plant Disease Detection
- Fertilizer Recommendation

The application can be cloud-hosted to facilitate scalability, real-time processing, and secure data storage, making it accessible and reliable for farmers across different regions.

6.1.1 Component of the System:

6.1.1.1 User Interface (UI)

- Mobile app or Web app (Cross-platform framework like Flutter for mobile, React for web)
- Friendly dashboard for the farmer to interface with the system
- Capture image of plants, input soil conditions, and fetching recommendations
- Push notifications and alerts for disease outbreaks and seasonal crop recommendations

6.1.1.2 Backend

- REST APIs that manage data flow between frontend and backend
- Machine Learning Models for predicting diseases, and recommending crops and fertilizers.
- User Details Database, Raw Input, Crop Historical Data, etc.

6.1.1.3 Data Storage

- Image storage: Cloud Storage, such as AWS.
- Crop and Soil Information Storage: Relational such as PostgreSQL
- Historical data storage: This will be to track User recommendations and disease outbreaks

6.1.2 Machine Learning Models

- **Disease Detection Model:** Deep learning-based CNN with TensorFlow for image classification
- **Fertilizer Recommendation Model:** Use the regression model that gives the best fertilizer recommendation for data on nutrient contents in soil, crop type, and weather

Integration with External APIs

- Weather API-For extracting real-time weather data from any weather API sources like OpenWeatherMap or WeatherStack
- Api for Soil/Nutrient For pulling data regarding soil properties with a location

- Geo-API: Pull info about that location that will be suggested, for instance, Google Maps API

Notification System

- Send push notifications about the diseases identified, which crops are to be suggested, and fertilizers
- Link to services, like Firebase Cloud Messaging (FCM)

6.1.3 System Design Architecture

i. **Frontend (Web App)**

Web application development using React:

- Capture images to identify diseases
- Forms to provide soil information and crop requirement
- Crop and fertilizer recommendations
- Optional Chatbot feature to guide the farmer

API & Processing

API Layer:

- API Gateway (Node.js) to process requests
- Authentication (JWT-based for secure login)
- Routing for different services (disease detection, crop/fertilizer recommendation)

Data Processing: Image Preprocessing (for disease detection): Resize, normalize, and augment input images

ML Model Inference:

- Disease Detection Model (trained on plant image datasets such as Plant Village)
- Fertilizer Recommendation depending on crop type and soil nutrients

Database:

- Relational Database (PostgreSQL) to handle history for users and crops
- Cloud Storage (e.g., AWS S3) for images of plants
- NoSQL Database (MongoDB), only in case unstructured data needs to be stored.

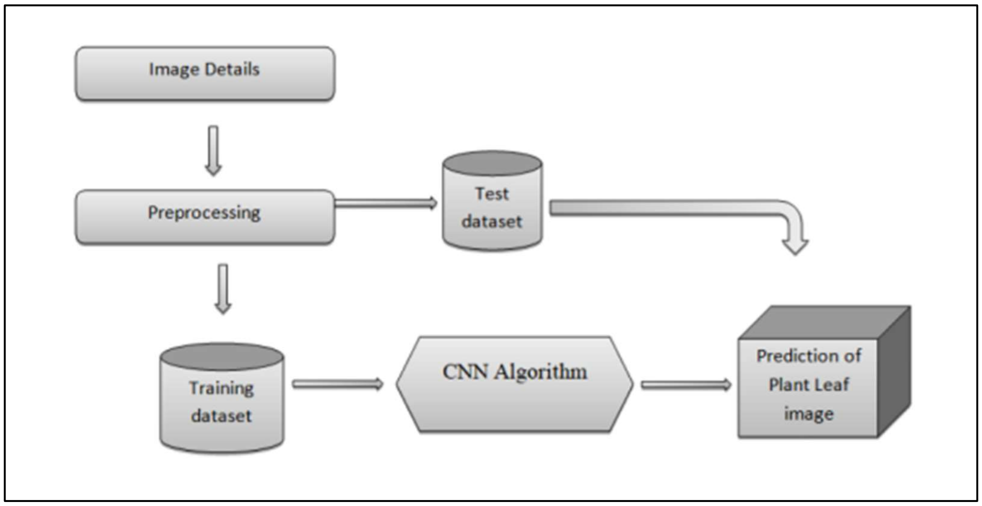


Figure 6.1: Overview of the System

- ## Data Flow Diagram

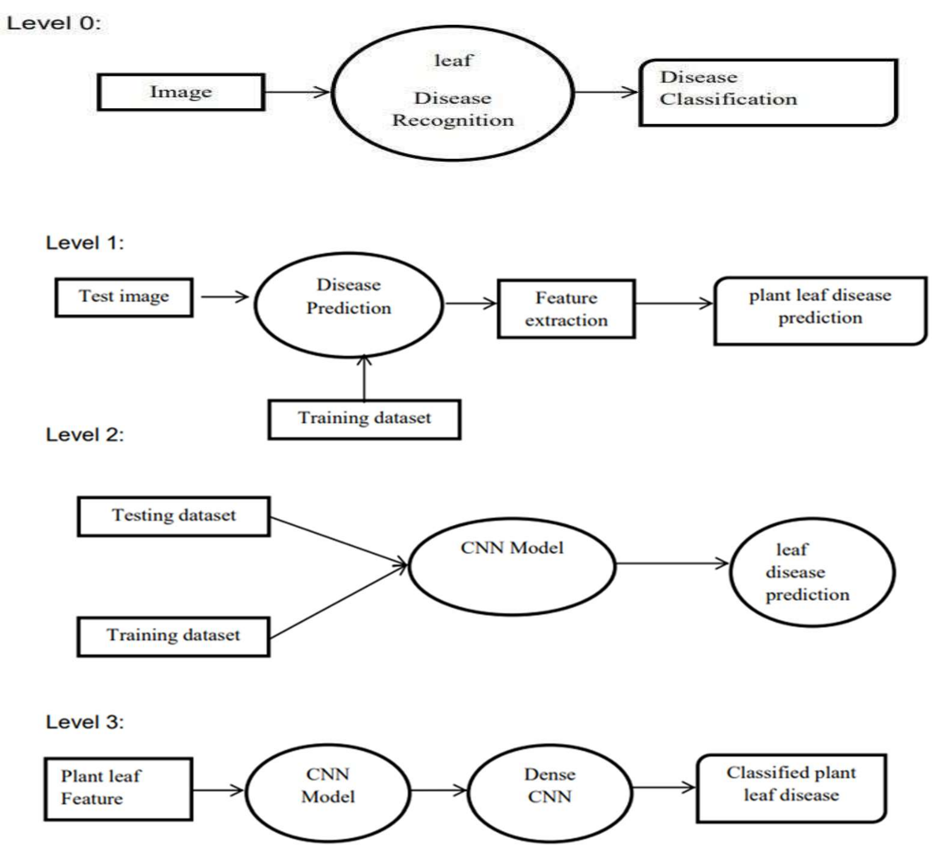


Figure 6.2: Data Flow Diagram

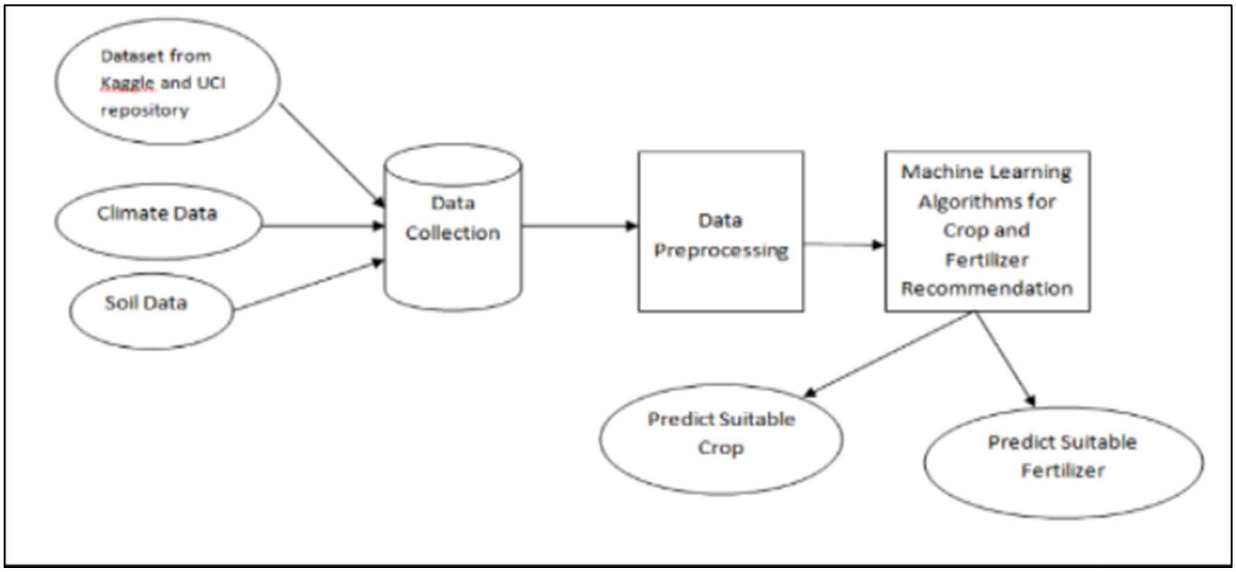


Figure 6.3: System Architecture for crop and fertilizer recommendation

6.1.4 Flowcharts:

6.2 Fertilizer Recommendation

The user has to input the values of Nitrogen, Phosphorus, Potassium along with crop Name. A POST request is sent to the flask API. In this application, the fertilizer recommendation classifier is hosted. An HTTP response is sent to the front-end and on the front-end the user is getting a recommendation for the fertilizer process is explained in the figure 6.4.

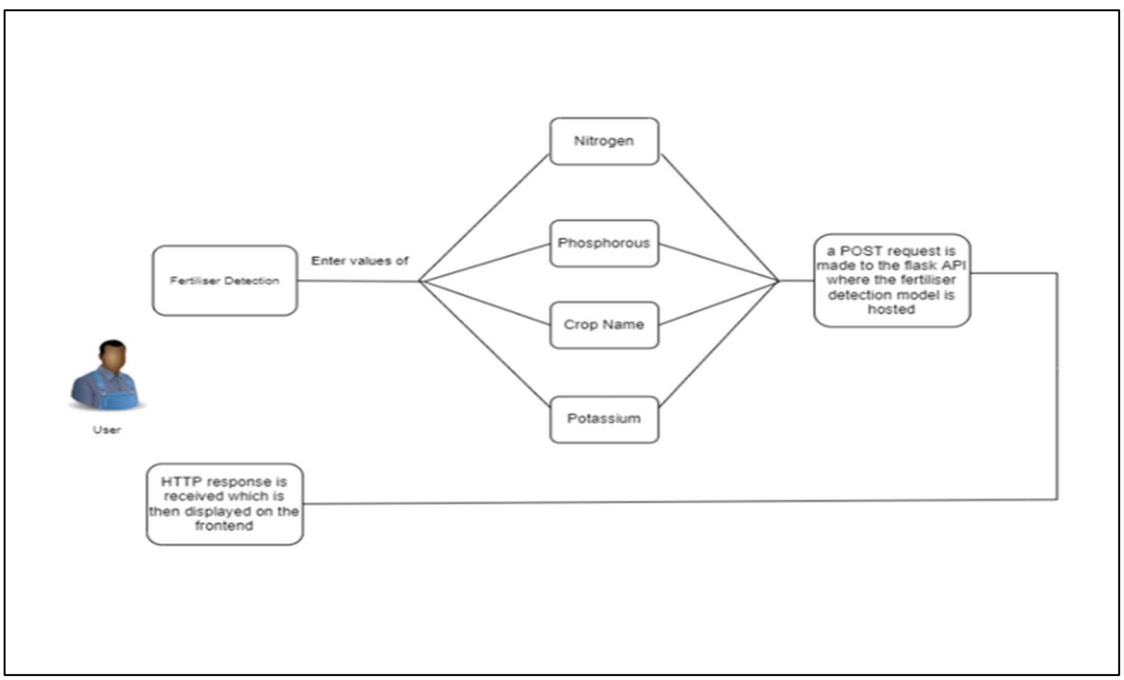


Figure 6.4: Flow Diagram for Fertilizer Recommendation

6.2.1 Disease Detection

The user either scans an image or uploads one in real-time using the app. This image is then processed by the trained machine learning model on the back-end. The model analyzes the image to:

- Identify the disease that is affecting the plant.
- Return results via an HTTP response to the front-end.

The application then displays the diagnosed disease and the recommended remedies or ways of treatment in order for farmers to respond in a timely and informed way.

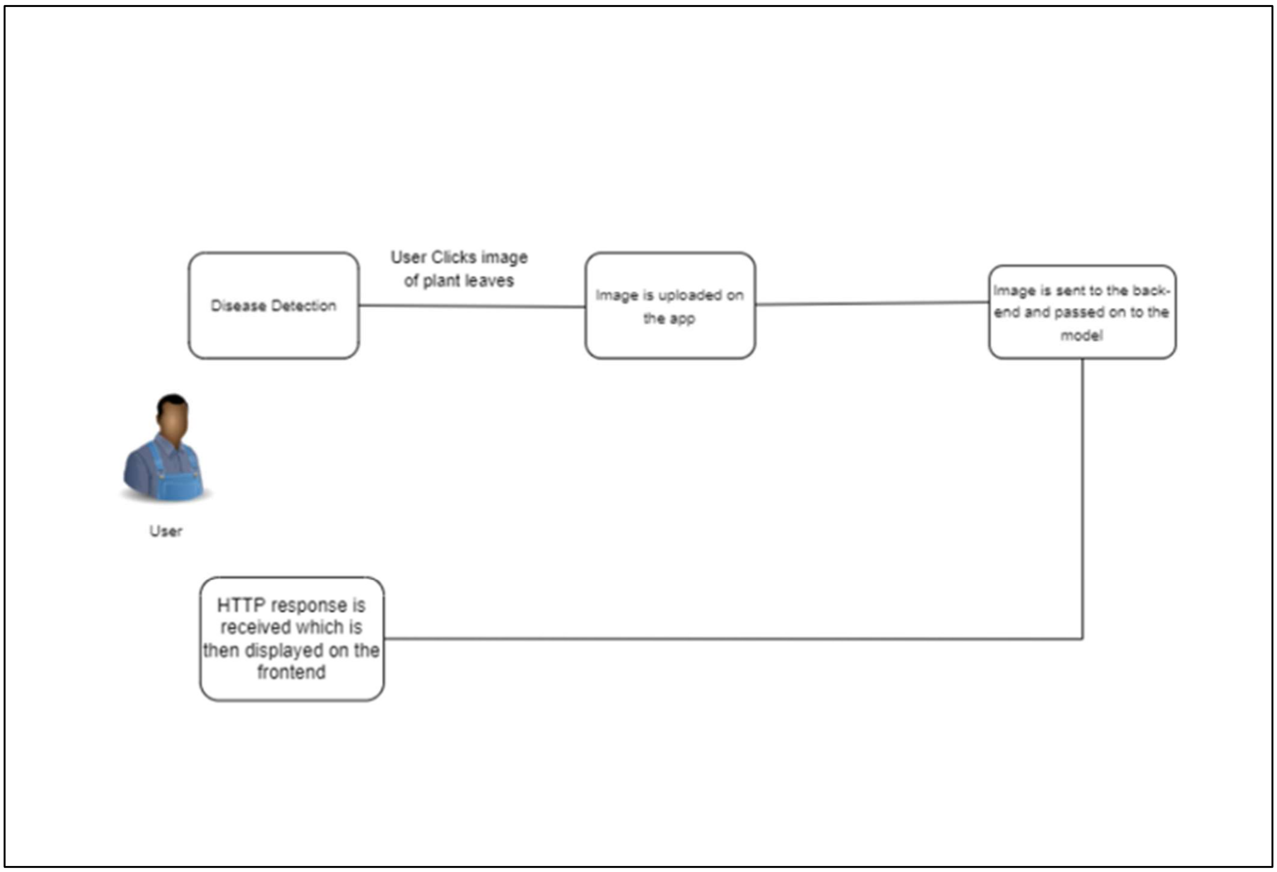


Figure 6.5: Flow Diagram for Plant Disease Detection System

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT (GANTT CHART)

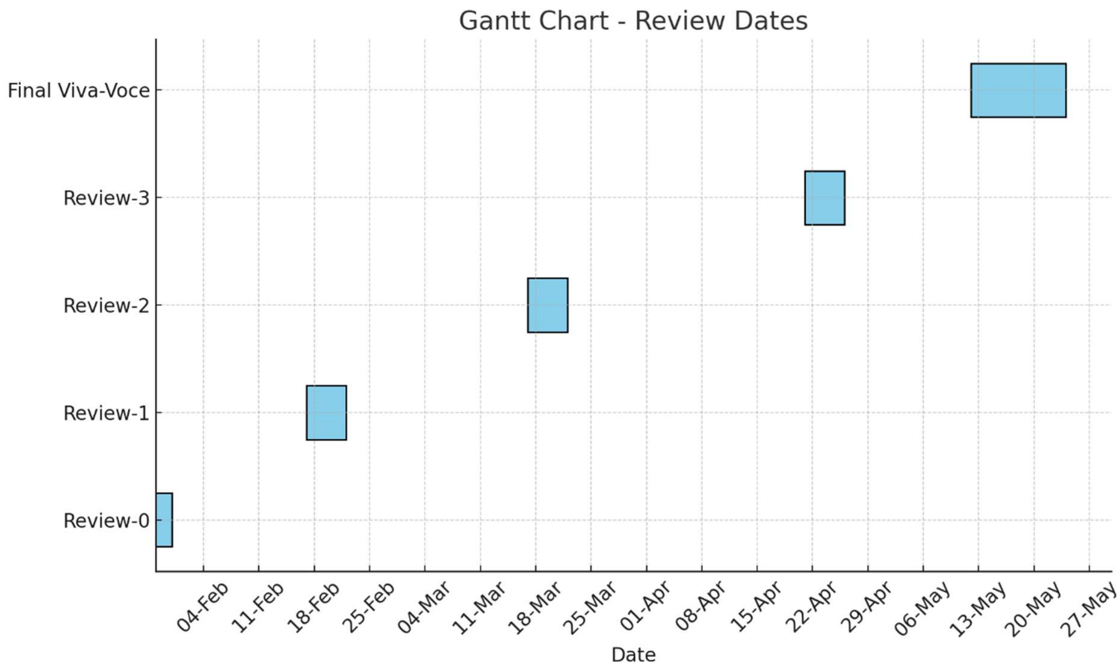


Figure 7.1: Gantt Chart

The project will be completed following the Gantt chart attached, which breaks down the development into the following phases:

SNo	Reviews	Dates
1	Review-0	29To 31-Jan-2025
	Review-1	17-Feb-2025 To 22-Feb-2025
	Review-2	17-Mar-2025 To 22-Mar-2025
	Review-3	21-Apr-2025 To 26-Apr-2025
	Final Viva-Voce*	12-5-2025 TO 24-5-2025*

Table 1: Phases

CHAPTER - 8

OUTCOMES

8.1 Fertilizer Recommendation

The fertilizer recommendation center of the system is made for helping farmers with appropriate fertilizer application decisions. The system compares some of the main soil parameters including Nitrogen (N), Phosphorus (P), Potassium (K) content, pH, water level, and soil type. On the basis of these parameters and the existing growth stage of the plant, the system computes the right kind and quantity of fertilizer needed—organic or chemical. This provides the plants with the right amount of nutrients at the right time, promoting healthy growth without over-fertilization. Excessive use of fertilizers kills not just crops but also leads to land degradation and environmental pollution.

The recommendation system can also vary according to different regional agriculture practices and seasonal changes, and therefore it is extremely flexible in different agricultural regions. The farmers are given friendly interfaces—via mobile or web applications—providing recommendations in easy, local tongues to understand. The system also focuses on the environment being sustainable through the use of eco-friendly fertilizers and precision agriculture methods that sustain soil health over a long period of time. It ultimately contributes to creating a more efficient, sustainable, and profitable farm system.

8.2 Disease Detection

The disease detection feature applies computer vision and machine learning algorithms to accurately and efficiently detect plant diseases. The farmers can upload or take live images of infected plants using the app. The images are analyzed by a deep learning model that is trained to identify visual symptoms of different plant diseases. The model provides the diagnosis along with the suggested treatments and preventive measures upon analysis. This enables farmers to identify diseases early, initiate corrective measures instantly, and minimize possible losses to crops.

The system is engineered to work even in rural low-bandwidth conditions by compressing images effectively and producing models quickly, providing farmers with quick and precise results. It also facilitates continuous learning—new cases of diseases and images can be fed in to enhance the accuracy of the model over time. With system integration via cloud technology, real-time data sharing, expert suggestions, and updates from farm departments are enabled. The system also suggests application of pesticides in a safe and judicious manner and encouraging integrated pest management (IPM) practices that minimize chemical use and preserve biodiversity. This leads to improved crop health, minimized environmental burden, and better long-term farm yield.

8.3 Google Search Integration:

To facilitate the user experience and allow immediate access to an ocean of agricultural knowledge, Google Search capability is also integrated into the system. Any time a farmer wishes to gain more information on a detected plant disease or a recommended fertilizer, he can easily access validated sources and authentic materials by means of a one-click Google Search facility embedded into the application. This seamless integration marries real-time AI-driven predictions with a vast pool of online learning content. It allows farmers to learn more, discover alternative remedies, and embrace internationally recognized best practices in agriculture—all from the app. Although the core system does not offer crop recommendations, this integration also allows curious users to navigate crop-related knowledge, such as growth conditions, compatible fertilizers, and ideal planting conditions, further facilitating informed decision-making.

CHAPTER-9

RESULTS AND DISCUSSIONS

Figure 9.1: This is the screenshot of the home page of a web application named **CropCare**, which is related to smart farming solutions. The page has a plain green-and-white color scheme with a top menu bar with links to **Home**, Fertilizer, and Disease pages, and a Google search box. In the center, the banner says "**CropCare: Smart Farming, Made Simple**", emphasizing the use of AI and data-driven intelligence to maximize crop yield and sustainability. Below, a section called "What We Offer" enumerates the main services: Smart Crop Selection, Precision Fertilization, and Disease Detection. Each is briefly described—emphasizing AI-driven crop suggestions, individualized fertilizer recommendations, and early plant disease detection with expert solutions. However, the inclusion of "Smart Crop Selection" may not be consistent with the actual project scope, which is specifically fertilizer and disease control. Visual design includes the use of icons like a thermometer, sun, and plant icon, highlighting the agricultural and tech-based character of the platform.

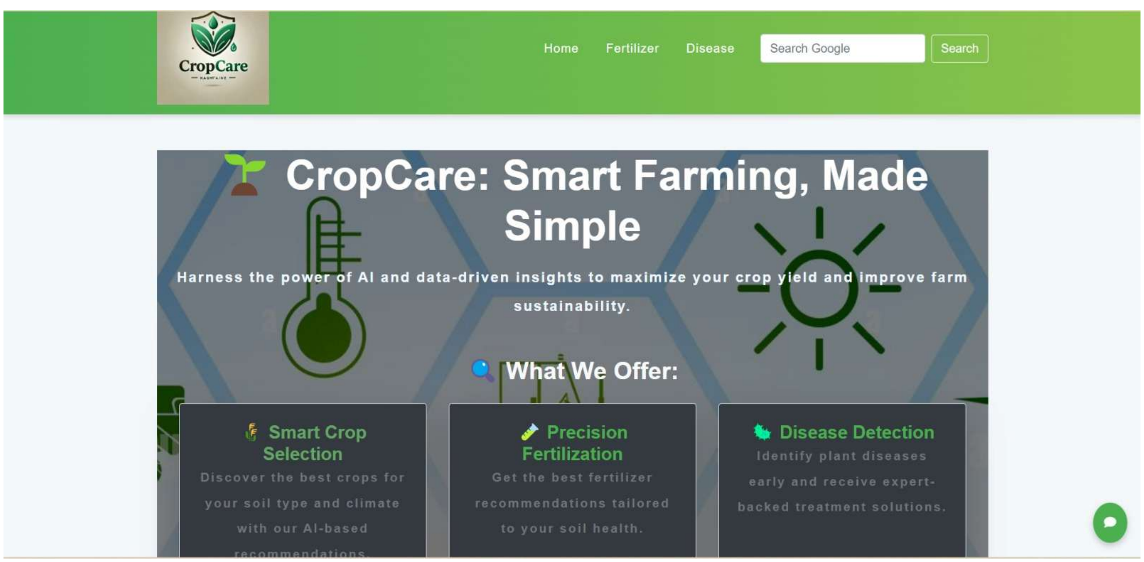


Figure 9.1: Home page

Figure 9.2: The following is a screenshot of some of the CropCare web application detailing the process and benefits of the platform. Entitled "How It Works," it outlines an effortless three-stage process:

Upload Data – Client's input information like weather, soil, and crop data into the system.

AI Analysis – The platform uses AI to sift through piles of data to provide optimised advice.

Get Actionable Insights – Farmers are provided actionable, easy-to-understand tips on how to optimize farm practices.

Under this section, a large heading "Why Choose CropCare?" emerges with the site's main benefits, although the text itself is slightly hard to read because of low contrast between the letters and the green. The benefits listed are:

Environment-Friendly & Sustainable – Striving to reduce the use of chemicals and improve soil health.

AI-Powered Precision – Allows users to make precise, data-driven decisions.

Expert Preferred – Designed in close consultation with agriculture experts and farmers.

A bright yellow "Start Your Journey" call-to-action button below invites users to begin on the site. Overall, this page does a good job of describing how CropCare works and why it is unique, but could be more readable by having improved color contrast.

Figure 9.2: Platform Features

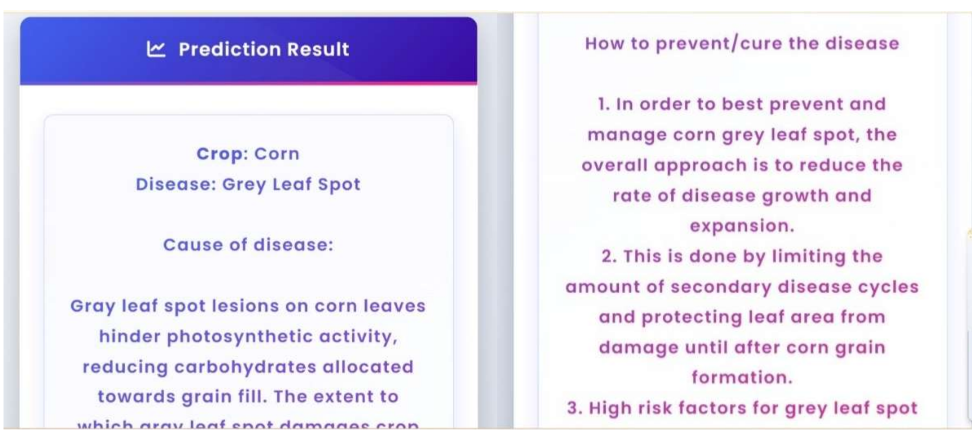
Figure 9.3: This is the interface of a plant disease detection system. It looks like one that could be used to identify diseases affecting the plants. A user would upload an image of the diseased plant, and it most probably employs image recognition and machine learning algorithms to determine the specific disease affecting the plant. Results are presented before the user with possible treatment options or recommendations. Such a tool can be very useful to the farmers

and the gardeners too, as one comes to know promptly which problem the plants are facing, and accordingly acts to salvage the crops.

Figure 9.3: Disease Detection System

Figure 9.4: CropCare is actually a plant disease-detecting system, whereby the output image you have shown was from a result page. It scans the uploaded photo of the infested plant to determine that its problem is in fact Leaf Scorch in the Strawberry plant.

Some of the information about the disease would appear on the result page, referring to the cause for which it is believed to be due to infection by a fungus called Diplocarpon earliana. It even takes it further to describe a control and treatment measure by proper garden sanitation, removing infected debris, and avoiding waterlogged soil. Users can reap this information to manage the disease in plants.



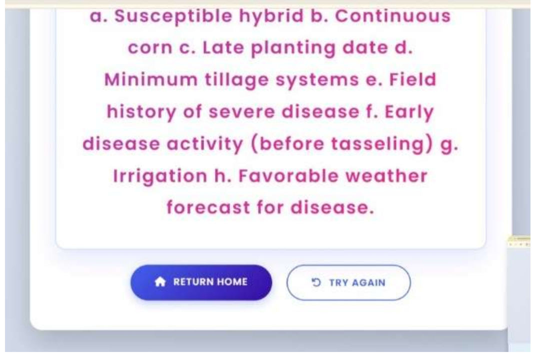


Figure 9.4: Disease Detection System giving output

Figure 9.5: The figure 9.5 shows a screen of a website or application named "Precision Fertilizer Recommendation." It is intended to give fertilizer suggestions based on crop and soil information. The screen contains input fields for the amounts of Nitrogen (N), Phosphorous (P), and Potassium (K) with sample values filled in (50, 30, and 40). There is a drop-down or selection field called "Select Crop." There is also a button called "Get Recommendation" below, which users can press to obtain personalized fertilizer recommendations. The tool seems to be useful for farmers or gardeners who would want to maximize fertilizer use in an effort to grow improved crops. The site is easy and intuitive to use, focusing on key inputs required for proper recommendations.

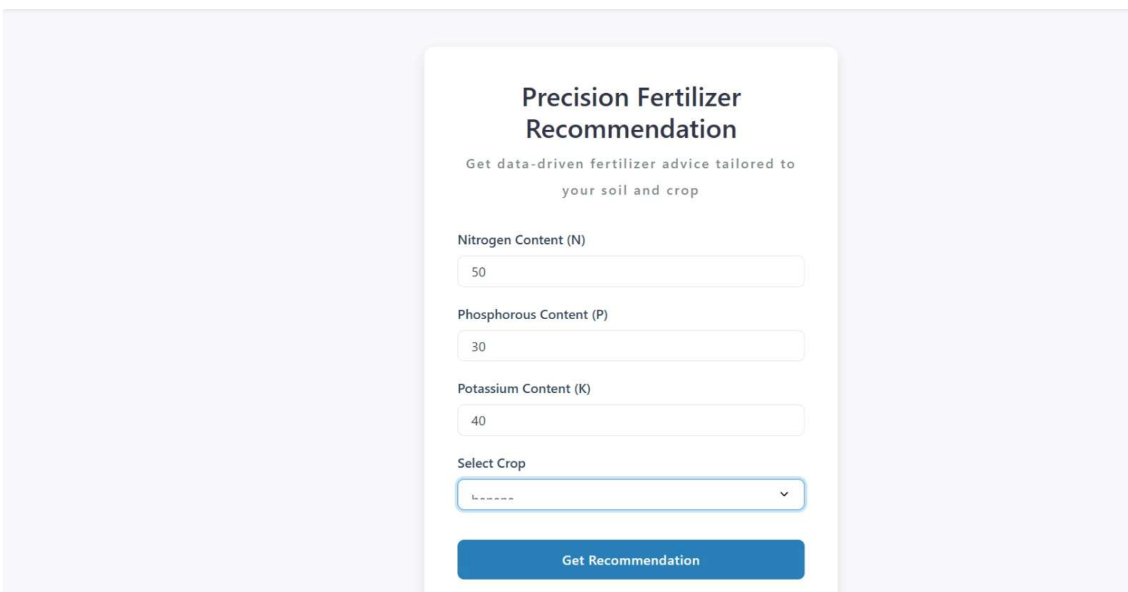


Figure 9.5: Fertilizer Recommendation

Figure 9.6: These are photographs from an agricultural website or app that provides individualized crop and soil management advice. The first screen, "Your Personalized Crop Recommendation", decides your soil needs by checking for low nitrogen levels in the soil and

suggests seven cures: sawdust/woodchip application, nitrogen-fixing plants (tomatoes, corn), watering to leach nitrogen, sugar application to trap nitrogen, composted manure application, nitrogen-fixing plants (peas, beans), and high-nitrogen NPK application. The second screen appends these suggestions with an eighth option—"Do nothing" should already planted plants be well able to up-take nitrogen—and guarantees the proposed crop is most suited to the soil, climate, and local market demand for profitability. The suggestions equilibrate short-term solutions with long-term solutions, presented as brief, text-based suggestions most appropriate for farmers and gardeners looking for evidence-based farming.

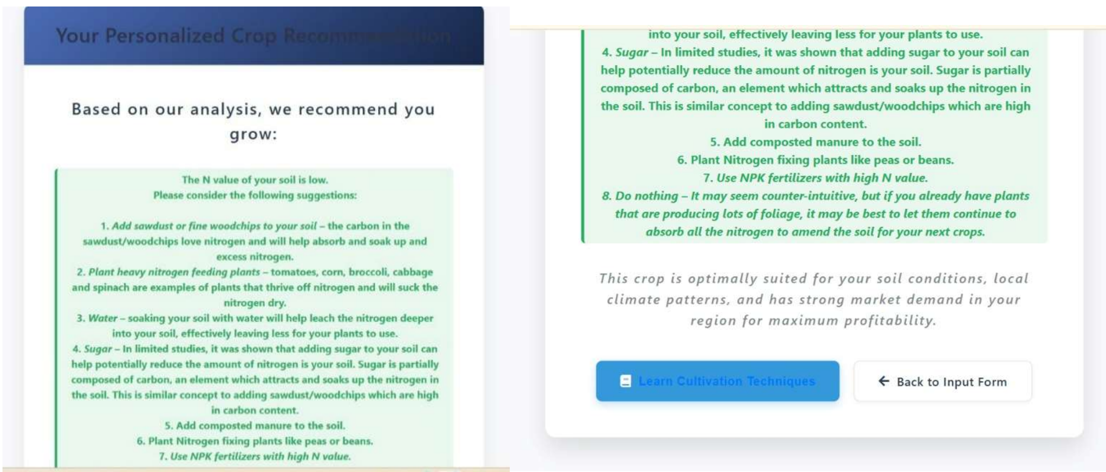


Figure 9.6: Fertilizer Recommendations Output

CHAPTER-10

CONCLUSION

We introduce, in this report, a user-friendly user-based web application system through machine learning and web scraping that we called 'CropCare'. Our system effectively combines the following functionalities: crop suggestions through Google Search-based scraping, fertilizer suggestions through a rule-based classification, and leaf image-based disease detection using EfficientNet. Our UI employs forms as inputs and provides near real-time outputs. We also use a technique known as LIME interpretability to explain our model's predictions in the disease detection module. This enables users to understand the reasoning behind the model's output, allowing further refinement of the datasets and the model itself. Although our application runs smoothly, there are a number of areas where it can be improved. For example, while providing crop and fertilizer recommendations, we can show availability on popular shopping websites so that consumers can buy the suggested products directly from our application. Another possible addition to the fertilizer recommendation module is to give further details about the various brands and their products, particularly their N, P, and K contents. We show six types of recommendations currently, but future versions will include more sophisticated machine learning systems to present more detailed suggestions. We know that the dataset employed for disease classification is incomplete. Therefore, our model is good only for known classes and does not work well with out-of-domain images. This can be resolved in two manners: Increasing our training set by gathering more datasets related to different crops and diseases. Enabling users to upload their images through an annotation portal within our web application.

Additionally, although LIME provides local explanations, it does not give a global perspective of model behavior. To further improve model interpretability, we intend to investigate other methods like GradCAM, Integrated Gradients, and hybrid methods such as sparse-linear layers with LIME. Lastly, our system at present does not have fine-grained segmentation of diseased areas. To fill this gap, we plan to include a segmentation annotation feature that allows users to help identify diseased areas. We also plan to include unsupervised algorithms to automatically indicate disease-prone areas of images. These features are included in our roadmap to make the system stronger and more comprehensive in the future.

CHAPTER 11
REFERENCES

1. D.Jayanarayana Reddy, Dr. M. Rudra Kumar, “Crop Yield Prediction using Machine Learning Algorithm”, 2024.

2. R, Harish D, Priya B, “A Machine Learning-based Approach for Crop Yield Prediction and Fertilizer Recommendation”, 26th August 2023.

3. Suruliandi, G. Mariammal & S.P. Raha, “Crop prediction based on soil and environmental characteristics using feature selection techniques”, 12 Mar 2023.

4. Nishu Bali & Anshu Singal, “Deep Learning Based Wheat Crop Yield Prediction Model in Punjab Region of North India”, 16 Sep 2021.

5. Reyana, Sandeep Kautish, P. M. Sharan Karthik, Ibrahim Ahmed Al-Baltah, Muhammed

   Basheer Jasser, (Member, IEEE), And Ali Wagdy Mohamed,” Accelerating Crop Yield: Multisensor Data Fusion and Machine Learning for Agriculture Text Classification”, 27 February
   2023.
6. Alexandros Oikonomidis, Cagatay Catal & Ayalew Kassahun, “Deep learning for crop yield prediction: a systematic literature review”, 06 Feb 2022.

7. Sujatha M., Jaidhar C.D, “Machine learning-based approaches to enhance the soil fertility”, 14 November 2023.

8. P K Devan, Swetha B, Uma Sruthi P, Varshini, “Crop Yield Prediction and Fertilizer Recommendation System Using Hybrid Machine Learning Algorithms”, 14th March 2023.

9. Mamatha, J.C. Kavitha c, “Machine learning based crop growth management in greenhouse environment using hydroponics farming techniques”,

10. 10 January 2023. 10. Chetan R, D.V. Ashoka, Ajay Prakash B, “IMLAPC: Interfaced Machine Learning Approach for Prediction of Crops”, 11 January 2022.

11. Simraneet Kaur, Getanajali Babar, Navneet Sandhu, Dr. Gagan Jindal, „Various Plant disease detection using Image Processing Methods", June 2019.

12. Er. Varinderjit Kaur,Dr. Ashish Oberoi , „Wheat disease detection using svm classifier" , Aug 2018.

13. Barbedo, „Plant Disease Identification from individual lesions spots using deep learning", Apr 2019.

14. K. Naga Subramanian, A.K. Singh, A. Singh, S. Sarkar and Ganpath Subramanian, "Usefulness of interpretability methods to explain deep learning-based plant stress phenotyping", July 2020.

15. W. Yang, C. Yang, Z. Hao, C. Xie, and M. Li, „„Diagnosis of plant cold damage based on hyperspectral imaging and convolutional neural network,"" IEEE Access, vol. 7, pp. 118239– 118248, 2019.

16. K. Nagasubramanian, S. Jones, A. K. Singh, S. Sarkar, A. Singh, and B. Ganapathy subramanian, „„Plant disease identification using explainable 3D deep learning on hyperspectral images".

17. N. Zhang, G. Yang, Y. Pan, X. Yang, L. Chen, and C. Zhao, „„A review of advanced technologies and development for hyperspectral-based plant disease detection in the past three decades,"" Remote Sens., vol. 12, no. 19, Sep. 2020, Art. no. 3188.

18. J. Chen, J. Chen, D. Zhang, Y. Sun, and Y. A. Nanehkaran, „„Using deep transfer learning for image-based plant disease identification,"" Comput. Electron. Agricult., vol. 173, Jun. 2020, Art. no. 105393.

19. M. Agarwal, A. Singh, S. Ajaria, A. Sinha, and S. Gupta, „„ToLeD: Tomato leaf disease detection using convolution neural network,"" Procedia Comput. Sci., vol. 167, pp. 293–301, Jan. 2020.

20. G. Hu, H. Wu, Y. Zhang, and M. Wan, „„A low shot learning method for tea leaf's disease identification,"" Comput. Electron. Agricult., vol. 163, Aug. 2019, Art. no. 104852.

APPENDIX-A

PSEUDOCODE

1. Disease Detection for Plants (Using CNN)

```
# Load Pre-trained CNN Model (e.g., ResNet, MobileNet)
MODEL = load_pretrained_model('PlantDiseaseModel')

# Preprocess the image
function preprocess_image(image):
# Resize the image to the required input size for the model (e.g., 224x224)
resized image = resize (image, (224, 224))
# Normalize pixel values
normalized_image = normalize(resized_image)
return normalized_image

# Predict disease from image
function predict_disease(image):
# Preprocess the image
input_image = preprocess_image(image)
# Expand dimensions to match model input (batch size, height, width, channels)
input_image = expand_dims(input_image, axis=0)

# Make prediction using the model
prediction = MODEL.predict(input_image)
    # Find the class label with the highest probability
    disease_class = argmax(prediction)

    # Map the class index to the corresponding disease name
    disease_name = map_class_to_disease(disease_class)
```

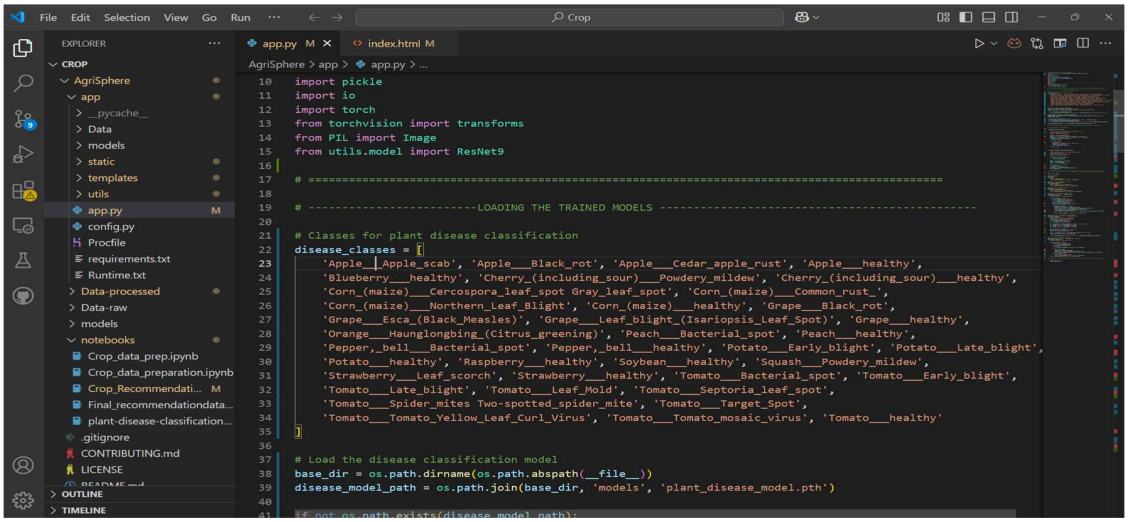
```
  return disease_name
 # Main function
  function detect_plant_disease(image):
  disease = predict_disease(image)
  return "Detected Disease: " + disease
```

2. Fertilizer Recommendation

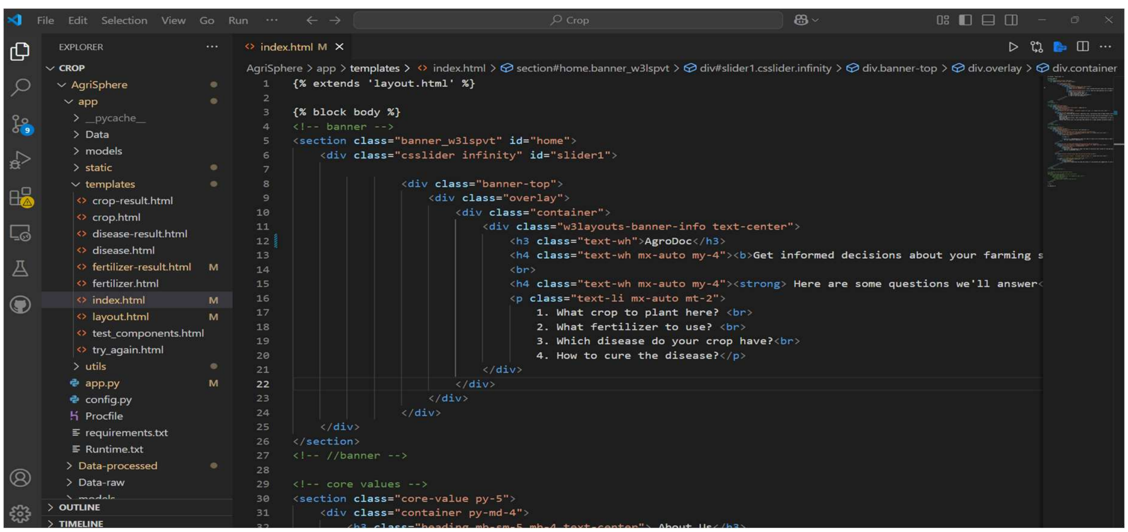
```
# Load pre-trained Fertilizer Recommendation Model (e.g., Regression or Decision Tree)
MODEL = load_model('FertilizerRecommendationModel')

# Collect soil and crop data
function collect_fertilizer_input():
    # Collect soil nutrient levels
    nitrogen = get_input("Enter Nitrogen level (mg/kg): ")
    phosphorus = get_input("Enter Phosphorus level (mg/kg): ")
    potassium = get_input("Enter Potassium level (mg/kg): ")

    # Get current crop being grown
    crop_type = get_input("Enter crop type (e.g., wheat, rice): ")

    # Get real-time weather data
    location = get_location()  # e.g., latitude, longitude
    temperature = get_temperature(location)
    rainfall = get_rainfall(location)

    return [nitrogen, phosphorus, potassium, crop_type, temperature, rainfall]

# Recommend the appropriate fertilizer
function recommend_fertilizer():
    # Collect input data
    input_data = collect_fertilizer_input()

    # Convert the input data to a feature vector
    input_vector = preprocess_input(input_data)

    # Get fertilizer recommendation from the model
    fertilizer_recommendation = MODEL.predict(input_vector)
```

```
    # Extract NPK ratio and suggested quantity
    npk_ratio = fertilizer_recommendation['npk_ratio']
    fertilizer_quantity = fertilizer_recommendation['quantity']
    return "Recommended NPK Ratio: " + npk_ratio + ", Quantity: " + fertilizer_quantity +
      " kg/hectare"

# Main function for fertilizer recommendation
function fertilizer_recommendation_system():
    recommendation = recommend_fertilizer()
    return recommendation
```

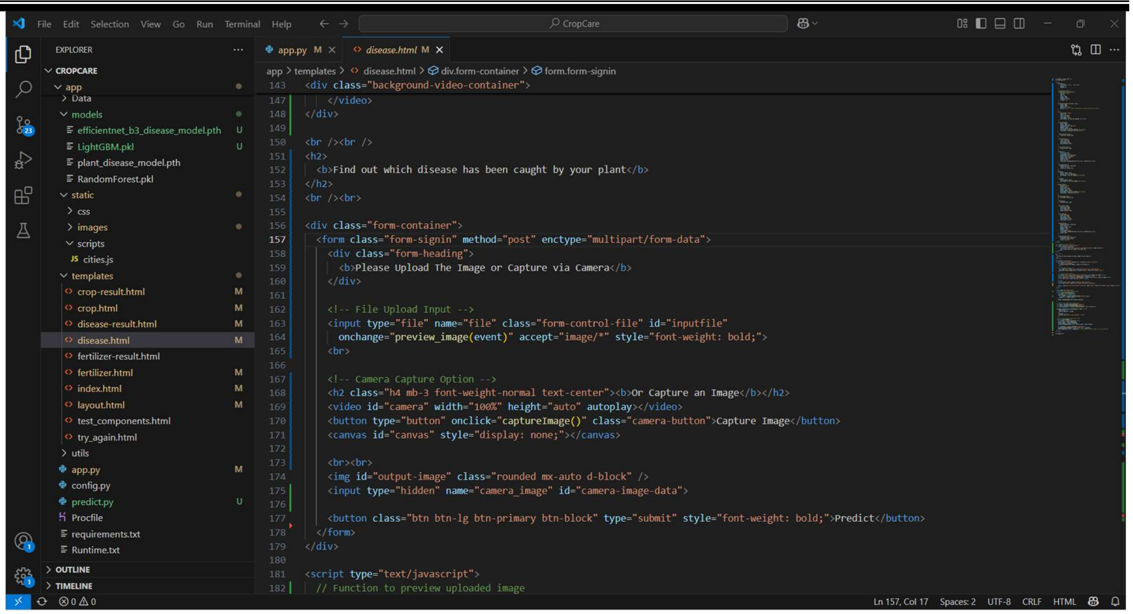
APPENDIX-B
SCREENSHOTS



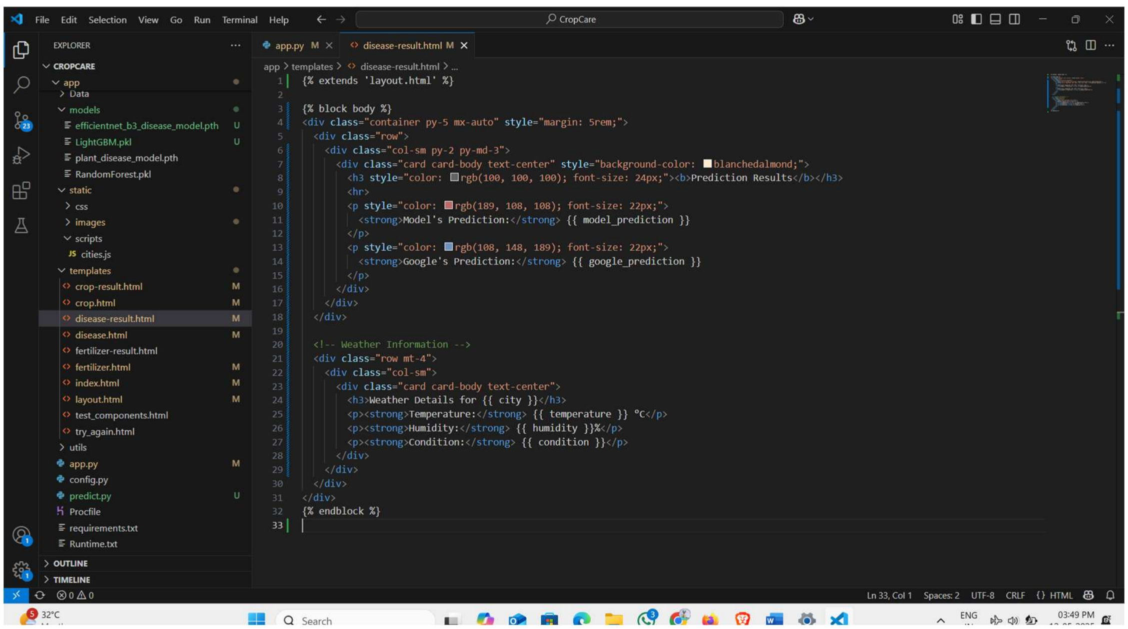
Screenshot 1: Workflow – Backend



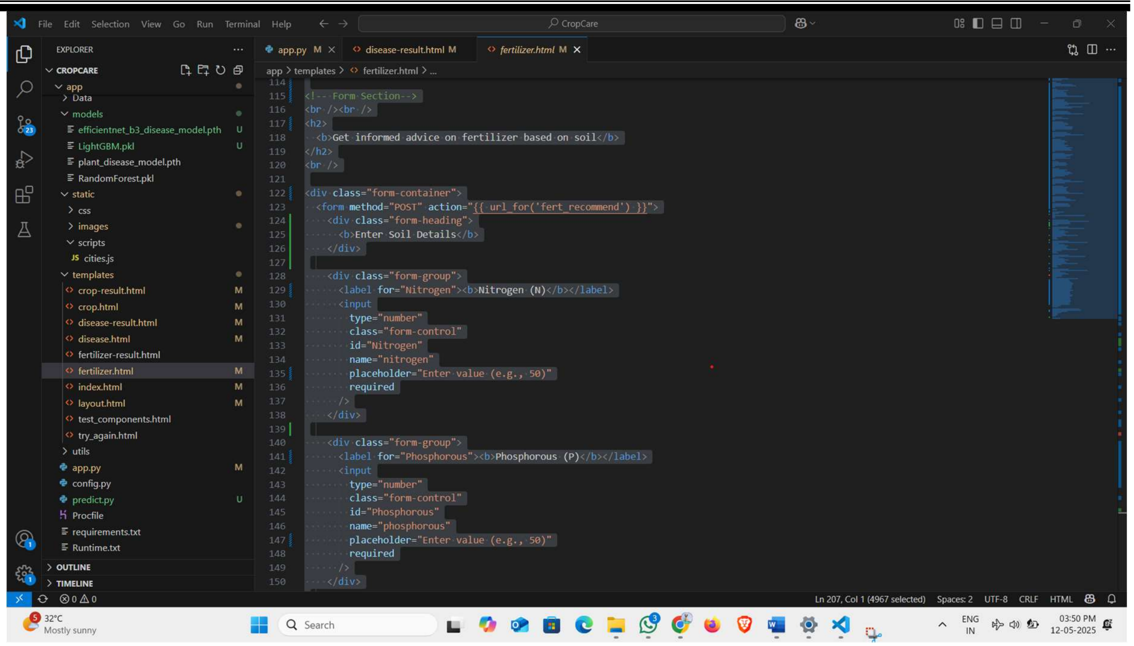
Screenshot 2: Workflow – Frontend



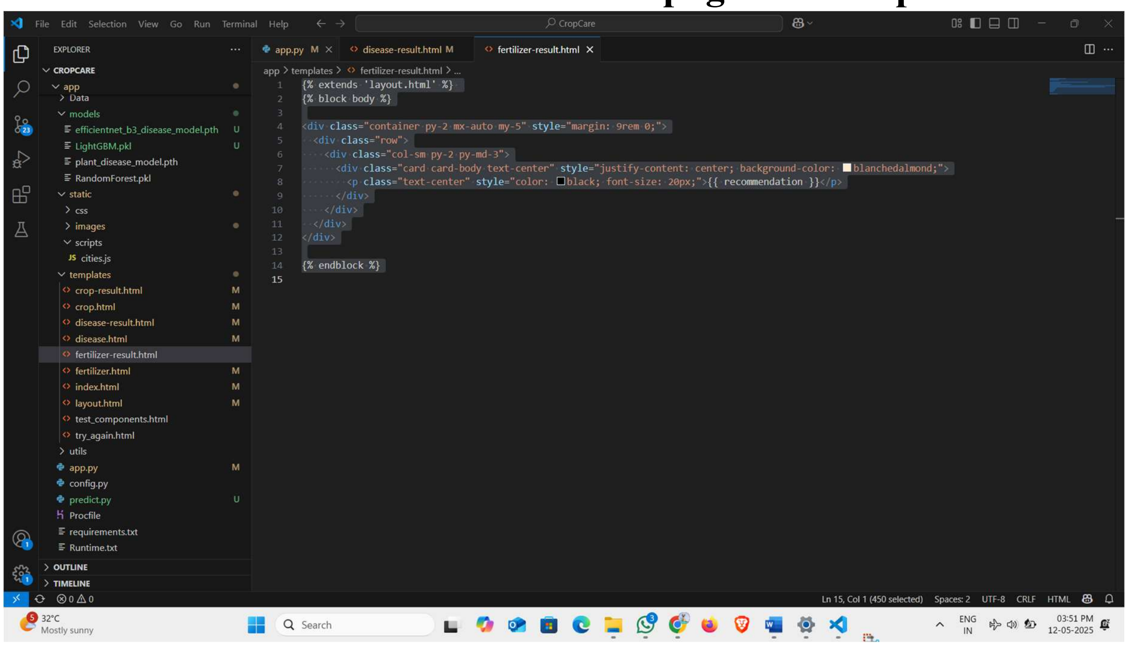
Screenshot 3 – Diseases FrontEnd



Screenshot 4 – Disease Output page



Screenshot 5 - Fertilizer Frontend pages User Input Code



Screenshot 6 – Fertilizer result Page Frontend Code

APPENDIX – C

ENCLOSURES

1. Journal Publication Paper Presented Certificates of all students.

5/12/25, 3:37 PM Mail - YARRAGUDI AKSHATH KUMAR REDDY - Outlook

Outlook

Re: 2nd INTERNATIONAL CONFERENCE ON NEW FRONTIERS IN COMMUNICATION, AUTOMATION, MANAGEMENT AND SECURITY 2025 : Submission (1181) has been created.

From Dr. Sudha P-Asso.prof -SCSE <sudha.p@presidencyuniversity.in>
Date Mon 4/21/2025 11:27 AM
To YARRAGUDI AKSHATH KUMAR REDDY <YARRAGUDI.20211CEI0152@presidencyuniversity.in>

Noted pa

From: YARRAGUDI AKSHATH KUMAR REDDY <YARRAGUDI.20211CEI0152@presidencyuniversity.in>
Sent: Monday, April 21, 2025 11:04 AM
To: Dr. Sudha P-Asso.prof -SCSE <sudha.p@presidencyuniversity.in>
Subject: Fw: 2nd INTERNATIONAL CONFERENCE ON NEW FRONTIERS IN COMMUNICATION, AUTOMATION, MANAGEMENT AND SECURITY 2025 : Submission (1181) has been created.

From: Microsoft CMT <noreply@msr-cmt.org>
Sent: Monday, April 21, 2025 11:03 AM
To: YARRAGUDI AKSHATH KUMAR REDDY <YARRAGUDI.20211CEI0152@presidencyuniversity.in>
Subject: 2nd INTERNATIONAL CONFERENCE ON NEW FRONTIERS IN COMMUNICATION, AUTOMATION, MANAGEMENT AND SECURITY 2025 : Submission (1181) has been created.

Hello,

The following submission has been created.

Track Name: ICCAMS2025

Paper ID: 1181

Paper Title: CropCare- AI-Integrated System for Smart Crop Protection and Disease Detection

Abstract:
Agriculture is the core of human existence since it supplies food to an increasing population. Yet, farmers encounter plant diseases, fertilizer abuse, and inappropriate crop choice, which result in low yields and economic losses. To address these issues, we suggest a web application that is AI-based and provides plant disease diagnosis, crop suggestion, and fertilizer suggestion. Our platform uses sophisticated machine learning to scan data and provide farmers and researchers with accurate, actionable data. It has an easy-to-use interface for easy navigation, allowing users to make farm decisions with ease. The plant disease detection module uses image processing to detect infections in their early stages, avoiding extensive crop

https://outlook.office.com/mail/inbox/id/AAQkADljYzY2ZGE5LTkzNTMtNDFkYS04NDhjLTFlZWJjZWQxMDg2ZAAQAJxMqy9G5oZJgh%2F3RPR7… 1/2

5/12/25, 3:37 PM Mail - YARRAGUDI AKSHATH KUMAR REDDY - Outlook

damage and loss. There is an in-built camera function, which enables farmers to take and post crop images for immediate disease diagnosis. The crop advisory module makes recommendations on appropriate crops as per environmental factors and soil type to enhance yield and sustainability. At the same time, the fertilizer advisory system offers evidence-based guidance on optimal use of fertilizer to prevent wastage and damage to the environment. The platform also offers a Google Search integration in which farmers can directly access related resources, best practices, and market trends. By improving decision-making and supporting sustainable agriculture, this web application based on AI enables farmers to achieve maximum productivity, minimize risks, and have sustainable long-term agricultural success.

Created on: Mon, 21 Apr 2025 05:33:25 GMT

Last Modified: Mon, 21 Apr 2025 05:33:25 GMT

Authors:
- Yarragudi.20211cei0152@presidencyuniversity.in (Primary)

Primary Subject Area: • AI and Machine Learning • Business Intelligence • Technical Trends • Ambient Technology • Communication

Secondary Subject Areas: Not Entered

Submission Files:
CropCare- AI-Integrated System for Smart Crop Protection and Disease Detection.pdf (314 Kb, Mon, 21 Apr 2025 05:32:32 GMT)

Submission Questions Response: Not Entered

Thanks,
CMT team.

https://outlook.office.com/mail/inbox/id/AAQkADljYzY2ZGE5LTkzNTMtNDFkYS04NDhjLTFlZWJjZWQxMDg2ZAAQAJxMqy9G5oZJgh%2F3RPR7... 2/2

2. Subject to above IEEE Conference take time to verify have Submitted to another journal here is the certificate of it:

International Journal of Scientific Research and Engineering Trends (IJSRET)

This is to certify that

Pasaluru Abhinay

has published a paper entitled

"CropCare – An AI-Integrated System For Smart Crop Protection And Disease Detection "

in International Journal of Scientific Research and Engineering Trends, in Volume 11, Issue 2, Mar-Apr-2025

Editor-in-Chief
IJSRET
www.ijsret.com
ISSN : 2395-566X

International Journal of Scientific Research and Engineering Trends (IJSRET)

This is to certify that

Dr. Sudha P

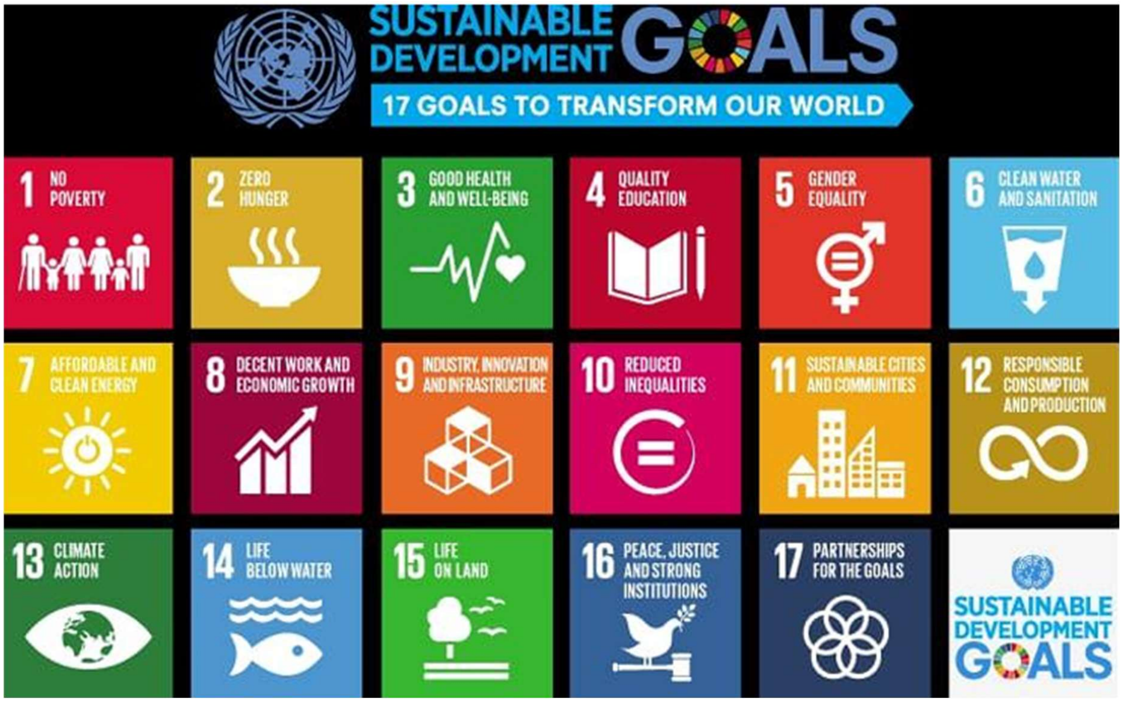
has published a paper entitled

"CropCare – An AI-Integrated System For Smart Crop Protection And Disease Detection"

in International Journal of Scientific Research and Engineering Trends, in Volume 11, Issue 2, Mar-Apr-2025

Editor-in-Chief
IJSRET
www.ijsret.com
ISSN : 2395-566X

3. Details of mapping the project with the Sustainable Development Goals (SDGs).



- **SDG 2: Zero Hunger**

AgroDoc contributes to ending hunger by improving crop yields through optimized farming practices, disease detection, and resource-efficient fertilizer use. It helps ensure food security by reducing crop losses and promoting sustainable agriculture.

- **SDG 12: Responsible Consumption and Production**

The app promotes efficient use of natural resources, such as water, soil, and fertilizers,

by offering data-driven recommendations. This reduces waste and minimizes the environmental impact of farming, supporting sustainable consumption and production practices.

- **SDG 13: Climate Action**

AgroDoc can assist farmers in adapting to climate change by integrating real-time weather data and offering guidance on how to respond to changing conditions. This enables farmers to mitigate climate-related risks.

- **SDG 9: Industry, Innovation, and Infrastructure**

By integrating deep learning and advanced technologies into agriculture, AgroDoc fosters innovation in farming techniques, contributing to the development of sustainable infrastructure in agriculture.

- **SDG 15: Life on Land**

AgroDoc helps protect ecosystems by promoting sustainable land management practices. By reducing overuse of fertilizers and improving crop health, the app supports the conservation of biodiversity.