RV College of Engineering®
Mysore Road, RV Vidyaniketan Post, Bengaluru - 560059, Karnataka, India

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Web Based Precision Agriculture through Crop Recommendation & Disease Detection using AI

A Minor Project Report (21EC77P)

Submitted by,

Shayak Bose	**1RV21EC158**
Shubh Bafna	**1RV21EC164**
Siddhant Sinha	**1RV21EC165**
Yash Naik	**1RV21EC189**

Under the guidance of

Dr. Veena Devi SV
Associate Professor
Dept. of ECE
RV College of Engineering

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Department of Electronics and Communication Engineering

CERTIFICATE

Certified that the minor project (21EC77P) work titled ***Web Based Precision Agriculture through Crop Recommendation & Disease Detection using AI*** is carried out by **Shayak Bose (1RV21EC158)**, **Shubh Bafna (1RV21EC164)**, **Siddhant Sinha (1RV21EC165)** and **Yash Naik (1RV21EC189)** who are bonafide students of RV College of Engineering, Bengaluru, in partial fulfillment of the requirements for the degree of **Bachelor of Engineering in Electronics and Communication Engineering** of the Visvesvaraya Technological University, Belagavi during the year 2024-25. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the minor project report deposited in the departmental library. The minor project report has been approved as it satisfies the academic requirements in respect of minor project work prescribed by the institution for the said degree.

Guide	Head of the Department	Principal
Dr. Veena Devi SV	Dr. H.V. Ravish Aradhya	Dr. K. N. Subramanya

External Viva

Name of Examiners	Signature with Date
1. Dr. Usha S.V	20/3/25
2. Dr. K. Viswanath	20/3/25

DECLARATION

We, **Shayak Bose** , **Shubh Bafna** , **Siddhant Sinha** and **Yash Naik** students of seventh semester B.E., Department of Electronics and Communication Engineering, RV College of Engineering, Bengaluru, hereby declare that the minor project titled '**Web Based Precision Agriculture through Crop Recommendation & Disease Detection using AI**' has been carried out by us and submitted in partial fulfilment for the award of degree of **Bachelor of Engineering** in **Electronics and Communication Engineering** during the year 2024-25.

Further we declare that the content of the dissertation has not been submitted previously by anybody for the award of any degree or diploma to any other university.

We also declare that any Intellectual Property Rights generated out of this project carried out at RVCE will be the property of RV College of Engineering, Bengaluru and we will be one of the authors of the same.

Place: Bengaluru

Date:

	Name	Signature
1.	Shayak Bose(1RV21EC158)	
2.	Shubh Bafna(1RV21EC164)	
3.	Siddhant Sinha(1RV21EC165)	
4.	Yash Naik(1RV21EC189)	

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ABSTRACT

Agricultural productivity and sustainability face increasing challenges due to climate variability, soil degradation, and pest infestations. Leveraging artificial intelligence (AI) and advanced data analytics, the agro-based startup Upjao AI aims to revolutionize farming practices by providing a comprehensive suite of solutions tailored to local environmental and agronomic conditions. Their platform integrates various data sources—ranging from regional weather reports to soil nutrient profiles—to offer actionable insights that can significantly improve yields while minimizing resource usage..

Agriculture is a major source of income and employment in India. The most prevalent problem faced by Indian farmers is that they do not select the appropriate crop for their land and do not use the appropriate fertilizer. They will experience a significant drop in production as a result of this. Precision agriculture has been used to solve the farmers' difficulty.Precision agriculture is a modern farming strategy that employs research data on soil properties, soil types, and crop yield statistics to recommend the best crop to farmers as well as fertilizer recommendations based on site-specific features. This decreases the number of times a crop is chosen incorrectly and increases productivity.

The project employs a deep learning-based Disease Detection module. Using a convolutional neural network (ResNet architecture), the project identifies early signs of diseases from leaf images uploaded via a mobile or web interface.The platform then provides treatment options and preventive measures, allowing farmers to intervene promptly and limit potential losses. By synthesizing these three key services—Crop Recommendation, Fertilizer Suggestion, and Disease Detection— offers an end-to-end intelligent farming solution aimed at enhancing productivity, sustainability, and profitability for the modern agricultural sector with accuracy 85%, 86%, and 89% respectively .

Through the project, this problem is solved by proposing a recommendation system using ML models.Random Forest, Naive Bayes, Support Vector Machine (SVM), Logistic Regression, and Random Forest serve as learners to recommend a crop for site-specific parameters with accuracy 87%, 93%, 95%, and 97% respectively . In addition to that, real-time testing is performed. The fertilizer recommendation system is purely Python logic-based, where the data (optimum nutrients for growing the crop) is compared with the user-entered data.

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LIST OF ABBREVIATIONS

AI Artificial Intelligence
N Nitrogen
P Phosphorous
K Potassium
API Application Programming Interface
OS Operating System
DL Deep Learning
ML Machine Learning
HTML Hyper Text Markup Language
CSS Cascading Style Sheets
GUI Graphical User Interface

Chapter 1

Introduction to Precision Agriculture

CHAPTER 1

INTRODUCTION TO PRECISION AGRICULTURE

Agriculture plays a fundamental role in ensuring global food security and economic stability. However, traditional agricultural practices often rely on subjective decision-making, which can lead to suboptimal resource utilization, decreased productivity, and increased financial risks for farmers. The lack of data-driven strategies results in inefficiencies in crop selection, fertilizer application, and disease management. With the advent of Machine Learning (ML) and Deep Learning (DL)[1], precision agriculture has emerged as a transformative solution that leverages advanced computational techniques and real-time data analysis to enhance farming efficiency, optimize resource allocation, and improve overall yield quality.[2]

Agriculture remains a crucial pillar of many economies, particularly in agrarian countries like India, where over 70% of the population depends on farming as a primary livelihood. Despite its significance, the sector faces numerous challenges, including poor crop selection, inefficient fertilizer application, unpredictable weather patterns, and undetected plant diseases, all of which contribute to low yields and economic instability[4]. To mitigate these challenges, an intelligent system has been developed using Machine Learning (ML) to provide farmers with accurate, data-driven insights. By analyzing various agricultural parameters such as soil health, climate conditions, and historical data, this system assists in making informed decisions, ultimately leading to higher productivity, sustainable farming practices, and improved financial stability for farmers.

1.1 Introduction

The proposed system offers three key features: crop recommendations, fertilizer suggestions, and disease detection. By analyzing soil properties and environmental factors, ML models suggest the best crops and fertilizers[3]. Additionally, an image-based deep learning model detects crop diseases and recommends preventive measures, helping farmers take timely action.Figure 1.1 is homepage which the farmers can use to access the services. [5]

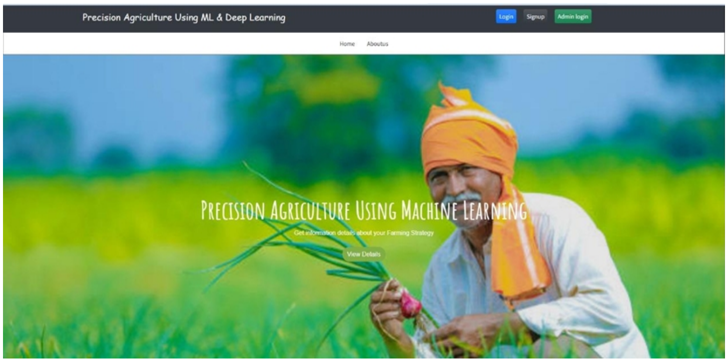


Figure 1.1: Homepage

1.2 Motivation

Agriculture is vital to many economies, especially in developing countries like India, where over 70% of the population relies on farming for their livelihood. However, the sector faces several challenges that hinder productivity and sustainability. Traditional farming practices, often based on experience rather than data-driven insights, can lead to poor crop selection, inefficient fertilizer use, and suboptimal resource allocation[10]. Additionally, farmers struggle with delayed disease detection, which can result in significant yield losses, and they often rely on outdated or inaccurate weather and soil data, making it difficult to optimize irrigation and planting schedules. Limited access to modern agricultural technologies, market fluctuations, and the impacts of climate change further exacerbate these issues, creating a pressing need for innovative solutions to improve efficiency, sustainability, and profitability in the farming sector[12]

1.3 Problem statement

Farmers face challenges such as selecting crops based on intuition or market trends rather than soil and environmental conditions, leading to poor yields and financial losses, while limited knowledge of soil nutrient levels results in improper fertilizer use that adversely impacts crop health and productivity, and late or incorrect identification of crop diseases further contributes to reduced yields, collectively causing low agricultural productivity, financial instability, and increased food insecurity .

1.4 Existing System

More and more researchers have begun to spot this problem in Indian agriculture and are increasingly dedicating their time and efforts to assist alleviate the difficulty. Different works include the employment of Regularized Greedy Forest to see an appropriate crop sequence at a given time stamp[8]. Another approach proposes a model that creates use of historical records of meteorological data as training set. Model is trained to spot climate that are deterrent for the assembly of apples. It then efficiently predicts the yield of apples on the idea of monthly weather patterns. The use of several algorithms like Artificial Neural Network, K Nearest Neighbors, and Regularized Greedy Forest is demonstrated in [5] to pick out a crop supported the pre-diction yield rate, which, in turn, is influenced by multiple parameters.

1.5 Objectives

Develop an advanced Machine Learning (ML) and Deep Learning(DL) model that can analyze various soil properties, such as nitrogen, phosphorus, potassium content, pH levels, and moisture, along with environmental conditions like temperature, humidity, and rainfall and disease dtection through image processing through validation and evaluated datasets. Based on this analysis, the model will recommend the most suitable crop for a particular region, ensuring higher productivity and sustainable farming.

1. To develop a machine learning model that recommends the most suitable crop for a given set of soil properties (N, P, K, pH) and environmental conditions (temperature, rainfall, location), here are some critical parameters chosen based on their weight and bias criterion in result.

2. To Assist farmers on the domain of fertilizer usage based on value of (N,P,K,Area of land)

3. To build a deep learning model that can detect crop diseases from uploaded images. To provide farmers with detailed information about the disease, its causes, and prevention methods.

4. To provide farmers with a simplified web application and convenient that simplifies decision-making and reduces dependency on traditional, intuition-based practices.

By achieving these objectives, the project will provide a comprehensive, AI-powered precision agriculture system that empowers farmers with intelligent insights, reduces risks, enhances productivity, and fosters sustainable agricultural practices.

1.6 Proposed System

The project aims to tackle the challenge by proposing an efficient Crop Recommendation System, which takes into consideration all the appropriate parameters, including temperature, rainfall, location, and soil condition, to predict crop suitability. This system is fundamentally concerned with performing the primary function of an Agro Consultant, which is providing crop recommendations to farmers[20]. Additionally, the system suggests suitable fertilizers for crops grown in different states, offering users an easy and reliable insight to decide and plan their crops effectively.

1.7 Methodology

The methodology begins by gathering relevant data from diverse sources—soil composition, weather reports, crop characteristics, and labeled images of plant leaves—to ensure a representative and high-quality dataset. Next, data preprocessing pipelines clean and normalize these inputs: soil and weather data are aligned with crop attributes to train machine learning models for Crop Recommendation and Fertilizer Recommendation, while plant images are annotated and augmented for the Disease Detection module[2]. For crop recommendation, a classification or regression approach (e.g., Random Forest or Gradient Boosting) is employed, mapping environmental factors (rainfall, temperature, pH) to the most suitable crop and Figure 1.2 is list of modules of methodology.[4]

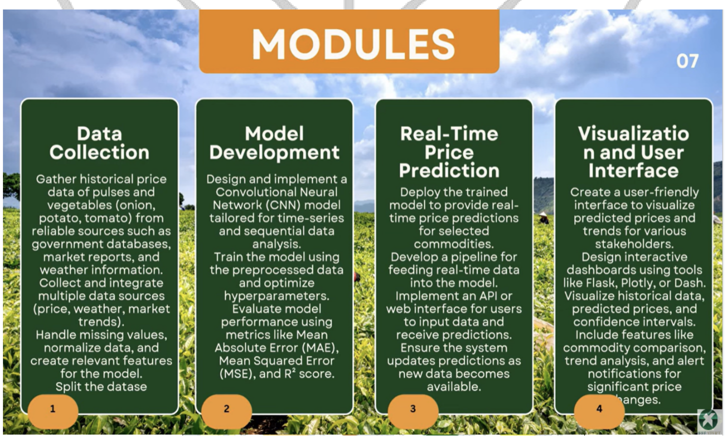


Figure 1.2: Overview of Design Methodology

Meanwhile, disease detection relies on a deep learning CNN—specifically a ResNet architecture—trained to recognize patterns in plant leaves corresponding to common diseases. The model is iteratively tuned using validation sets, employing metrics like accuracy etc. Once validated, the system is deployed via a user-facing interface (e.g., mobile or web), where farmers can input environmental parameters for recommendations or upload leaf images for real-time disease diagnosis. Finally, Figure 1.3 periodic updates incorporating new data, retraining models to adapt to emerging diseases or evolving agronomic practices, and robust maintenance of the underlying infrastructure complete the cycle, ensuring the platform remains accurate and responsive to real-world agricultural needs.A similar framework applies for fertilizer recommendation, comparing nutrient requirements with soil nutrient levels .

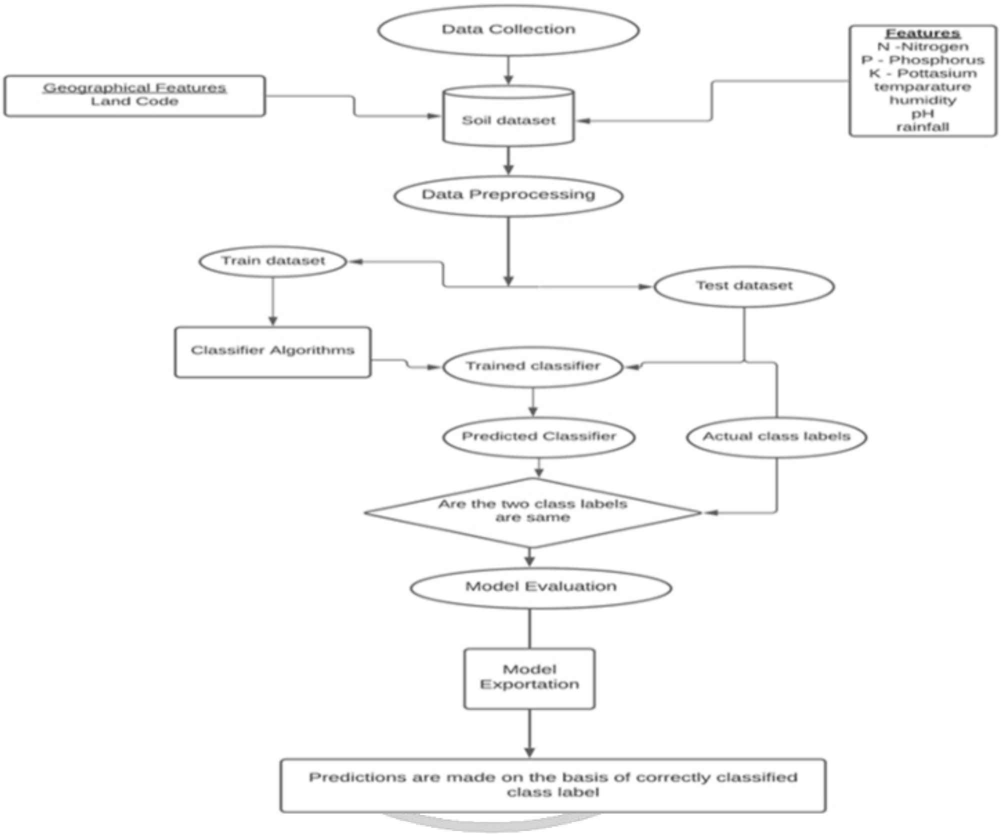


Figure 1.3: Methodology Flow Diagram

1.8 Literature Review

Research on tech driven agriculture its benefits in reducing infrastructure management and optimizing cost-effectiveness.This section reviews research articles and technological contributions relevant to Precision Agriculture development, particularly in task management and workflow automation.

Low-cost IOT + ML design for smart farming [1] proposed system for water management systems and improve current irrigation methods. An IoT and ML-based farming system always keeps farmers aware of the upcoming weather possibilities and gives them the best suggestions about irrigation methods and crops thereby helping in better yield . In paper [2] author's proposed a smart system that can assist farmers in crop management by considering sensed parameters (temperature, humidity) and other parameters (soil type, location of farm, rainfall) that predicts the most suitable crop to grow in that environment.

[3] determines real time sampling of soil properties using modified support vector machines, a popular machine learning algorithm and four modules . The first module is portable IoT device (NodeMCU) with soil moisture sensor and pH sensor, environmental sensors. Agri cloud module consists of storage. Analyzing the real time data module is processing of types of crops and small plants suggested using modified support vector machine algorithm. Agri-user interface is a basic web interface. Thus, with the help of soil properties farmer will be able to get types of crops and small plants is grown in farmland with help of Modified support vector machine algorithm.

In [4] author's proposed new technologies include the use of Internet of Things (IOT) and Machine Learning. The real time data from the field area can be collected using IOT system. The collected data from the field area is fed to the trained model. The trained model then makes the predictions using the data. The result produced by the model greatly helps is sowing the suitable crops in the particular field area.

In [5] determines a model is proposed for predicting the soil type and suggest a suitable crop that can be cultivated in that soil. The model has been tested using various machine learning algorithms such as KNN, SVM and logistic regression. The accuracy of the present model is maximum than the existing models.

[6] proposed an IOT and deep learning based smart agriculture systems. This system monitors and collects the soil parameters from the field with the help of a wireless sensor network. The collected data is then uploaded in the cloud. Finally, the systems suggest best irrigation practices to the farmers by predicting the crop to be sown for next crop rotation. This information will be sent as an SMS to the farmers. The parameters include soil temperature, atmospheric temperature, and humidity [6]. This system suggests further improving the effectiveness by predicting the suitable time for applying pesticides, fertilizer, and manures.

In paper [7] proposed a system would assist the farmers in making an informed decision about which crop to grow depending on a variety of environmental and geographical factors. The ML and IoT based suggestions will significantly educate the farmer and help them minimize costs and make strategic decisions by replacing intuition and passed-down knowledge with far more reliable data-driven ML models. This allows for a scalable, reliable solution to an important problem affecting hundreds of millions of people .

[8] investigated the use of machine learning models for soil moisture estimation by utilizing multi-sensor data. Their study highlighted the effectiveness of integrating different sensor inputs, such as temperature, humidity, and soil properties, to enhance moisture prediction accuracy. The findings suggest that data-driven approaches can significantly improve irrigation scheduling and water conservation in precision farming .

IoT-based smart agriculture has also gained considerable attention in recent years. [9] provided a comprehensive overview of IoT applications in agriculture, emphasizing the role of wireless sensor networks, cloud computing, and artificial intelligence in creating connected farming environments. Their study illustrated how IoT-enabled systems facilitate real-time monitoring and decision-making, leading to improved crop yield and resource efficiency.

[10]reviewed emerging trends and challenges in smart agriculture, focusing on the role of automation, big data analytics, and AI-driven solutions. They discussed various applications, including precision irrigation, crop health monitoring, and predictive analytics for farm management. The study also addressed key challenges such as data security, interoperability, and infrastructure limitations that must be overcome for widespread adoption .

1.9 Research Gap

Limited Holistic Data Integration:A unified framework that incorporates diverse data sources and regularly updates predictions remains underexplored Scalability and Local Context:Techniques for adapting ML models to various local contexts, especially smallholdings in remote areas, are still insufficiently developed . Real-Time Predictive Analytics:Limited research exists on lightweight, resource-efficient ML models capable of rapid predictions and updates—even in the face of variable internet connectivity. Collaboration and Knowledge Transfer:strategic partnerships and community-driven approaches are needed to co- develop, field-test, and refine ML solutions that align closely with farmers' real- world challenges. Data Quality and Accessibility:Methods to handle missing data, label inaccuracies, and heterogeneous data formats need improvement to ensure robust model performance in diverse agricultural environments.[21]

The methodology developed for crop recommendation, fertilizer suggestion, and disease detection using machine learning and data-driven approaches has proven to be effective in enhancing agricultural decision-making. By leveraging soil characteristics, weather conditions, and crop-specific requirements, the proposed system provides precise recommendations that optimize yield and resource utilization.

Chapter 2

Theoretical Background

CHAPTER 2

THEORETICAL BACKGROUND

An efficient and intelligent Crop Recommendation System is proposed, which considers multiple crucial parameters, including temperature, rainfall, geographical location, and soil conditions, to accurately predict the most suitable crops for cultivation. This system is designed to function as a virtual Agro Consultant, providing farmers with data-driven recommendations to enhance agricultural productivity and sustainability. By leveraging advanced algorithms and extensive datasets, the system ensures precise and reliable crop selection based on environmental and climatic factors.[8] Additionally, it offers tailored fertilizer recommendations for crops grown in different states, enabling farmers to make informed decisions regarding soil enrichment and crop nourishment. By integrating these features, the system provides a comprehensive, user-friendly, and highly reliable tool for optimizing agricultural planning, improving yield quality, and maximizing profitability.[10]

2.1 Overview of Machine Learning

Machine learning is an application of artificial intelligence (AI) that gives systems the ability to automatically learn and evolve from experience without being explicitly programmed by the programmer. The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the provided examples. The main aim of machine learning is to allow computers to learn automatically and adjust their actions to improve the accuracy and usefulness of the program Figure 2.1, without any human intervention or assistance. [4] Traditional writing of programs for a computer can be defined as automating the procedures to be performed on input data in order to create output artifacts. Almost always, they are linear, procedural, and logical. A traditional program is written in a programming language to some specification, and it has properties such as:

1. User can control the inputs to the program.
2. How the program will achieve its goal.
3. User map out what decisions the program will make and under what conditions it

makes them.

4. Since the inputs as well as the expected outputs, user can be confident that the program will achieve its goal.

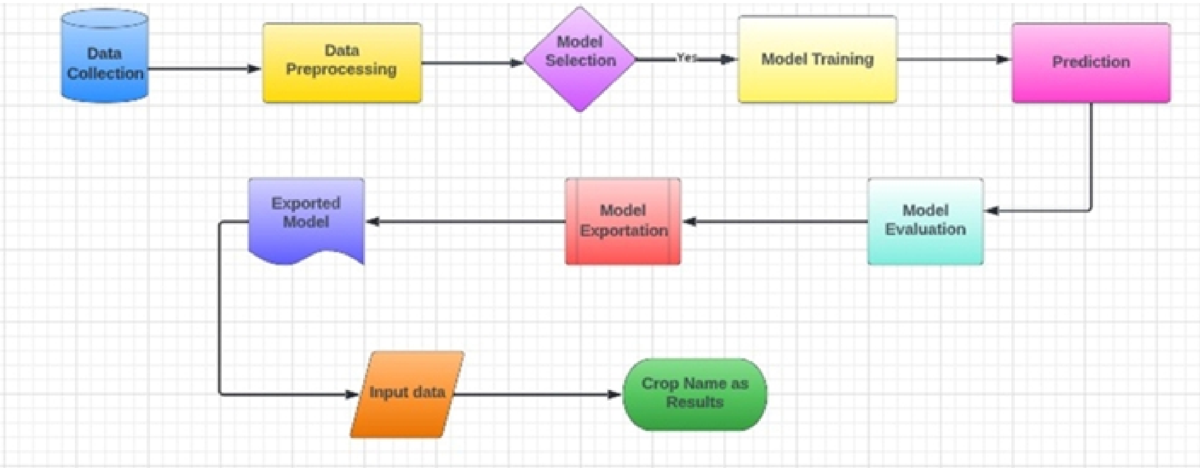


Figure 2.1: Model flow diagram for crop recommendation

Traditional programming works on the premise that, as long as it is possible to define what a program needs to do, it is assumed that a method can be defined to achieve that goal.[12] However, this is not always the case, as there are problems that can be represented in a computer but cannot be solved using a traditional program.

2.2 Supervised Learning & Unsupervised Learning

Machine learning techniques can be broadly categorized into the following types: Supervised learning takes a set of feature/label pairs, called the training set. From this training set the system creates a generalized model of the relationship between the set of descriptive features and the target features in the form of a program that contains a set of rules. The accuracy of the predictive model can then be calculated as the proportion of the correct predictions the model labeled out of the total number of instances in the test set.

Unsupervised learning takes a dataset of descriptive features without labels as a training set.In unsupervised learning, the algorithms are left to themselves to discover interesting structures in the data. The goal now is to create a model that finds some hidden structure in the dataset, such as natural clusters or associations.[8] Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data. It

can also be used for association problems, by creating rules based on the data and finding relationships or associations between them.
Semi-supervised machine learning falls somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training typically a small amount of labeled data and a large amount of unlabeled data. The systems that use this method are able to considerably improve learning accuracy.[9] Usually, semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring labeled data generally does not require additional resources.
Reinforcement machine learning algorithms is a learning method that interacts with its environment by producing actions and discovers errors or rewards. Machine learning algorithms are tools to automatically make decisions from data in order to achieve some over-arching goal or requirement. Over the past few decades, many machine learning algorithms have been developed by researchers, and new ones continue to emerge and old ones modified.[19]

2.3 Machine Learning Tools

There are many different software tools available to build machine learning models and to apply these models to new, unseen data. There are also a large number of well defined machine learning algorithms available. These tools typically contain libraries implementing some of the most popular machine learning algorithms. They can be categorized as follows :

- Pre-built application-based solutions.
- Programming languages which have specialized libraries for machine learning.

2.4 Machine Learning Algorithms

Decision Trees (DTs) are a non-parametric supervised learning method used for classification and regression. The goal is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features. A tree can be seen as a piecewise constant approximation[4].

The objective of the support vector machine algorithm is to find a hyperplane in an N-dimensional space(N — the number of features) that distinctly classifies the data points .To separate the two classes of data points, there are many possible hyperplanes that could be chosen. Our objective is to find a plane that has the maximum margin, i.e the maximum distance between data points of both classes. Maximizing the margin distance provides some reinforcement so that future data points can be classified with more confidence.

Logistic regression is a classification algorithm used to assign observations to a discrete set of classes. Some of the examples of classification problems are Email spam or not spam, Online transactions Fraud or not Fraud, Tumor Malignant or Benign. Logistic regression transforms its output using the logistic sigmoid function to return a probability value.

Random forest is a Supervised Machine Learning Algorithm that is used widely in Classification and Regression problems. It builds decision trees on different samples and takes their majority vote for classification and average in case of regression. One of the most important features of the Random Forest Algorithm is that it can handle the data set containing continuous variables as in the case of regression and categorical variables as in the case of classification.[6]

Programming frameworks used in project development .

1. **Frontend:**
    - HTML5, CSS3, Bootstrap – For building a responsive and accessible user interface.
    - JavaScript – For dynamic client-side interactions.
2. **Backend:**
    - Python Flask – A lightweight and scalable web framework for handling API requests and integrating ML models.
    - SQLAlchemy (ORM) – For efficient interaction with the relational database.
    - Pickle/Joblib – For ML model serialization and storage, allowing efficient deployment.
3. **Machine Learning/Deep Learning:**
    - Scikit-learn – For training ML models such as Random Forest and Decision Trees.

- PyTorch – For deep learning-based disease detection from crop images.
- NumPy & Pandas – For data manipulation, preprocessing, and statistical analysis.

4. **Database:**

- MySQL – A scalable relational database for storing user inputs, historical records, and model-generated insights.
- Cloud-based Storage – For managing large datasets and image processing tasks.

2.5 Deep Learning Tools

Deep learning has revolutionized the field of image-based disease detection by enabling highly accurate predictions through advanced neural networks.[7] Various software tools and frameworks facilitate the development, training, and deployment of deep learning models. These tools typically include [11]pre-built libraries that implement popular deep learning algorithms, making it easier to apply them to real-world problems. The key components used in this project are categorized as follows:

1. **Deep Learning & Image Processing:**

- **ResNet-9** – A deep convolutional neural network (CNN) model used for disease detection in plant leaves. Trained on a dataset of over 2,000 images, it accurately classifies diseases based on leaf symptoms.
- **PyTorch** – A deep learning framework used for training and deploying the ResNet-9 model.
- **NumPy & Pandas** – For data manipulation, preprocessing, and statistical analysis.
- **OpenCV** – For image processing tasks such as resizing, augmentation, and normalization to enhance model performance.

2. **Database:**

- **MySQL** – A scalable relational database for storing user inputs, historical records, and model-generated insights.

- **Cloud-based Storage** – For managing large datasets and image processing tasks.

3. **Additional Tools & APIs:**

- **OpenWeatherMap API** – To fetch real-time weather conditions and forecast data.
- **IoT Sensor Integration (Future Scope)** – For collecting real-time soil moisture and temperature data to improve disease prediction models.

By leveraging deep learning with ResNet-9 and a dataset of over 2,000 leaf images, this system provides an efficient and accurate method for detecting plant diseases, aiding farmers in early diagnosis and intervention.

2.6 Agro Based Startup Upjao.ai

Upjao.ai is an emerging agro-based startup focused on leveraging advanced technologies—especially AI, machine learning, and data analytics—to transform farming practices. Founded on the principle of making [12]precision agriculture more accessible, the company specializes in building user-friendly platforms that aggregate regional weather data, soil information, and farmer inputs to generate actionable insights. By tailoring its solutions to local agricultural ecosystems, Upjao.ai ensures that farmers can make more informed decisions about crop selection, fertilizer application, and disease management Figure 2.2.

One of the key differentiators of Upjao.ai lies in its emphasis on seamless integration of complex AI models with practical, on-the-ground realities.[20] From gathering satellite data and soil test reports to integrating with IoT sensors in the field, the startup's end-to-end ecosystem streamlines the data flow for faster, more accurate recommendations. Whether it's warning farmers about a looming pest outbreak or suggesting the ideal fertilizer blend for a particular plot of land.

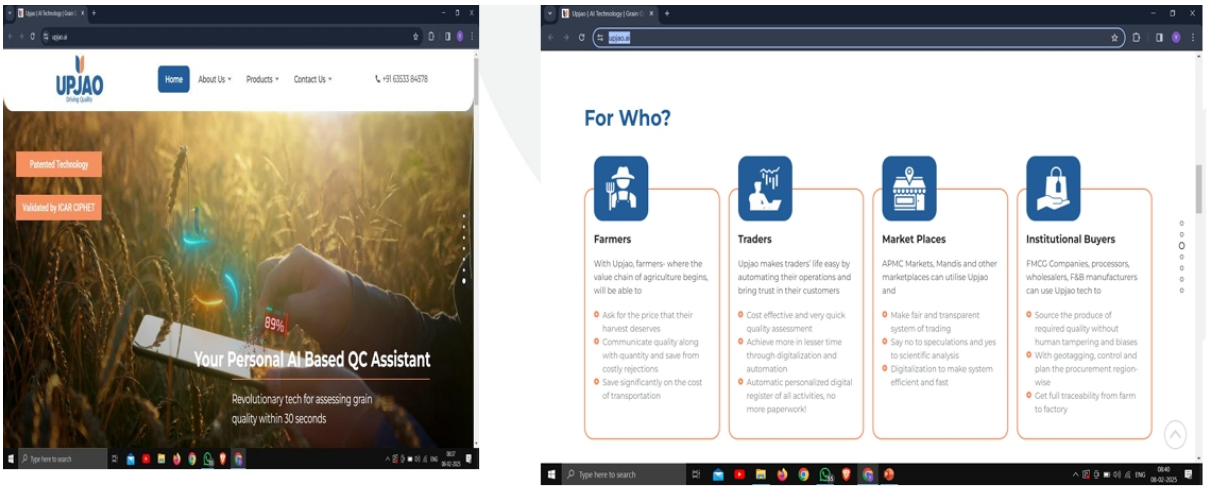


Figure 2.2: Upjao ai

Machine learning (ML) and deep learning (DL) models have revolutionized crop recommendation systems by leveraging vast amounts of agricultural data to make precise and data-driven decisions. The theoretical foundation of these models is built on various supervised and unsupervised learning techniques, where algorithms analyze soil characteristics, climate conditions, and historical yield patterns to predict the most suitable crops for a given region. Traditional ML approaches, such as decision trees, support vector machines (SVM), and random forests, provide interpretable and computationally efficient solutions for crop recommendation. Meanwhile, DL models, particularly artificial neural networks (ANNs) and convolutional neural networks (CNNs), offer higher accuracy by capturing complex patterns in multispectral and time-series agricultural data.[4]

Chapter 3

Implementing and Hosting the Application

CHAPTER 3

IMPLEMENTING AND HOSTING THE APPLICATION

Agriculture faces significant challenges, including poor crop selection, inefficient fertilizer use, and undetected plant diseases, all of which contribute to reduced yields and financial instability for farmers. To address these issues, this project integrates machine learning and deep learning techniques into three key components: Crop Recommendation, Fertilizer Recommendation, and Disease Detection. The Crop Recommendation System utilizes a Random Forest Classifier to analyze soil composition, climate conditions, and historical data to suggest the most suitable [13]crops for optimal productivity. The Fertilizer Recommendation System compares soil nutrient levels with crop-specific requirements and suggests precise fertilizer adjustments to maintain soil health and prevent deficiencies or excesses. Meanwhile, the Disease Detection System employs ResNet-9, a deep learning model, to identify plant diseases from images uploaded by farmers, providing early detection and treatment suggestions. By combining these intelligent modules, the system enhances agricultural efficiency, promotes sustainable farming practices, and empowers farmers with data-driven insights for improved decision-making.

3.1 Implementation of Project

The implementation of the project is divided into three major components: Crop Recommendation, Fertilizer Recommendation, and Disease Detection. Each module utilizes machine learning and deep learning techniques to provide intelligent insights to farmers, helping them make informed agricultural decisions the Figure 3.1 are the major components of the project.

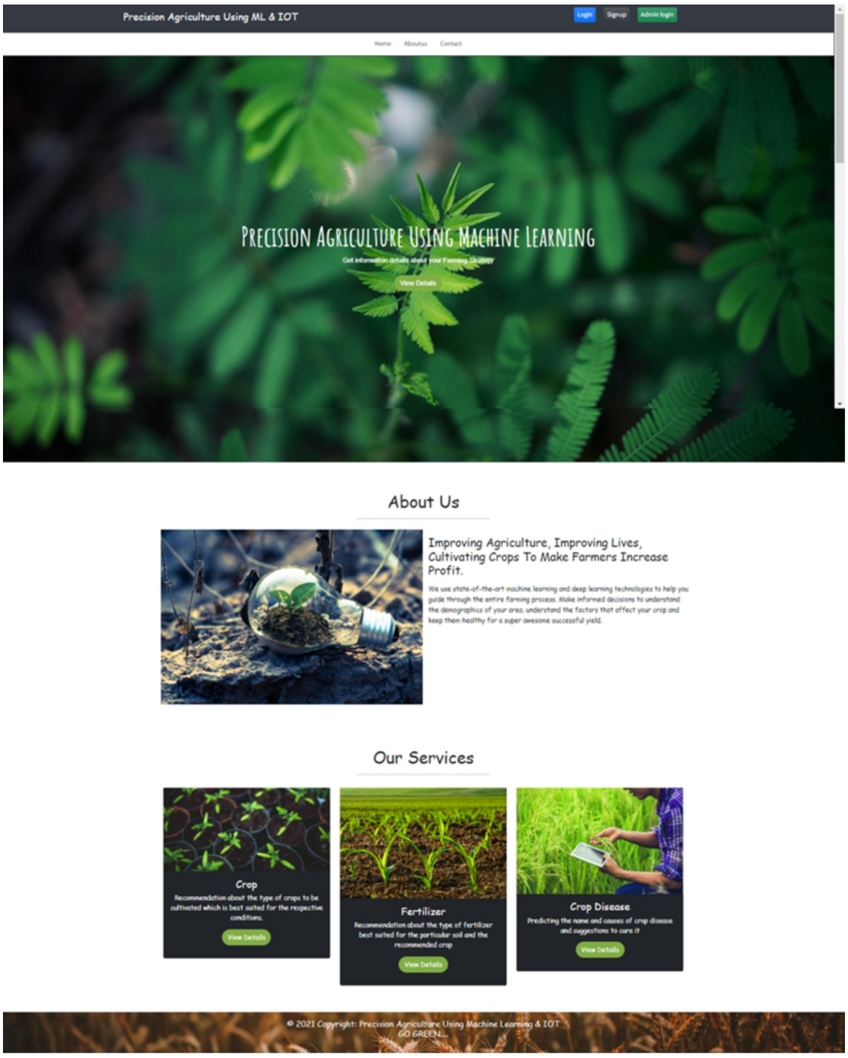


Figure 3.1: Major components

3.1.1 Crop Recommendation

The crop recommendation system is designed to help farmers select the most suitable crop based on soil composition and environmental conditions. This ensures optimal yield, minimizes resource wastage, and improves overall farm productivity.Crop recommendation is a specialized service [14] that analyzes various environmental and agronomic parameters—such as soil type, regional climate,Figure 3.2. rainfall patterns, and historical yield data—to recommend the most suitable crop for a specific location. By leveraging advanced algorithms, including machine learning models trained on extensive datasets, the project tends to guide farmers in making optimal planting decisions. This targeted approach not only boosts yields but also reduces resource wastage, as farmers avoid investing in crops poorly suited to their local conditions .

Table 3.1: Sample dataset

N	P	K	Temp	Humidity	PH	Rainfall	Label	Soil Type
90	42	43	20.437789	82.0798	6.5	202.78	rice	alluvial
61	38	20	25.682321	67.8033	5.9	102.56	maize	Alluvial
28	72	81	19.469376	15.72982	7.9	86.62	chickpea	Loamy
36	58	20	33.567782	45.67889	4.9	126.67	pigeonpeas	Loamy
56	76	16	28.798494	61.63839	7.4	69.43	blackgram	Clayey
22	60	18	19.678972	25.74984	6.3	41.89	lentil	Loamy
100	76	45	25.056759	75.79807	6.2	107.68	banana	Clayey

The above Table 3.1 is an example of the dataset used to train machine learning model on and Table 3.2 denotes list of crops taken into consideration for model training .

Table 3.2: List of Crops

Rice	Mango
Maize	Grapes
Chickpea	Apple
Pigeon peas	Orange
Pomegranate	Cotton
Lentil	Mango
Jute	Coffee
Watermelon	Muskmelon

- **User Input:** The user is required to input key soil and environmental parameters, Table 3.3 displays some common statistics[15] and Table 3.4 shows how the user input would be on the built website which includes:
  - **Soil Nutrient Levels** (Nitrogen - N, Phosphorus - P, Potassium - K)
  - **Soil pH** (Acidity or alkalinity level of the soil)
  - **Temperature** (Average regional temperature affecting crop growth)
  - **Rainfall** (Annual precipitation level, crucial for water-dependent crops)

Python libraries used in this project are as follows: Flask, Request, Numpy, Scipy, Pandas, Scikit-Learn, Pillow, Torch, Colorama, Gunicorn.

Table 3.3: Common statistics

Attribute	**Statistics**
No. of crops	14
Trainable parameters	20
Number of hidden layers	152 (ResNet152)
Activation Function	ReLU
Learning Rate	1e-4 or 1e-3
Batch Size	256
Loss Function	Cross Entropy, MSE
Trainable images	38*1500
Validating Images	38*500

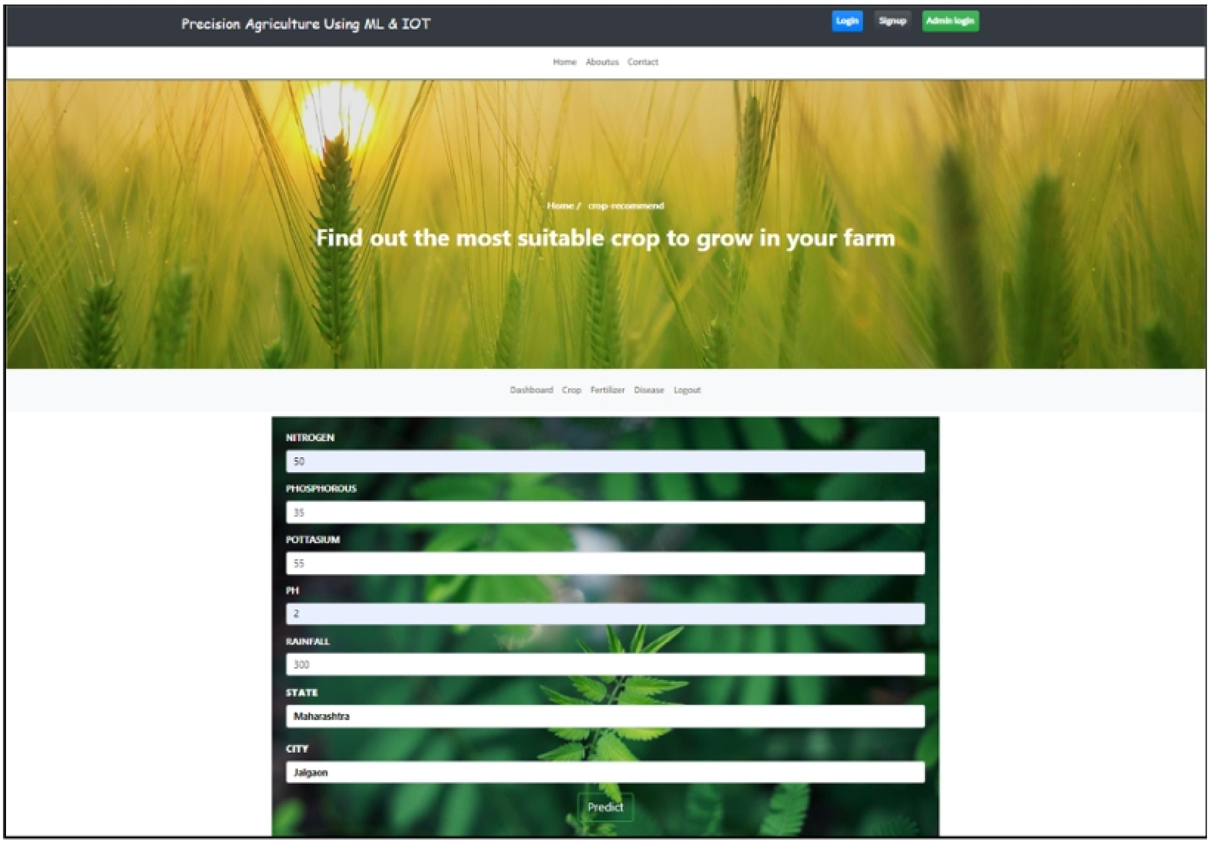
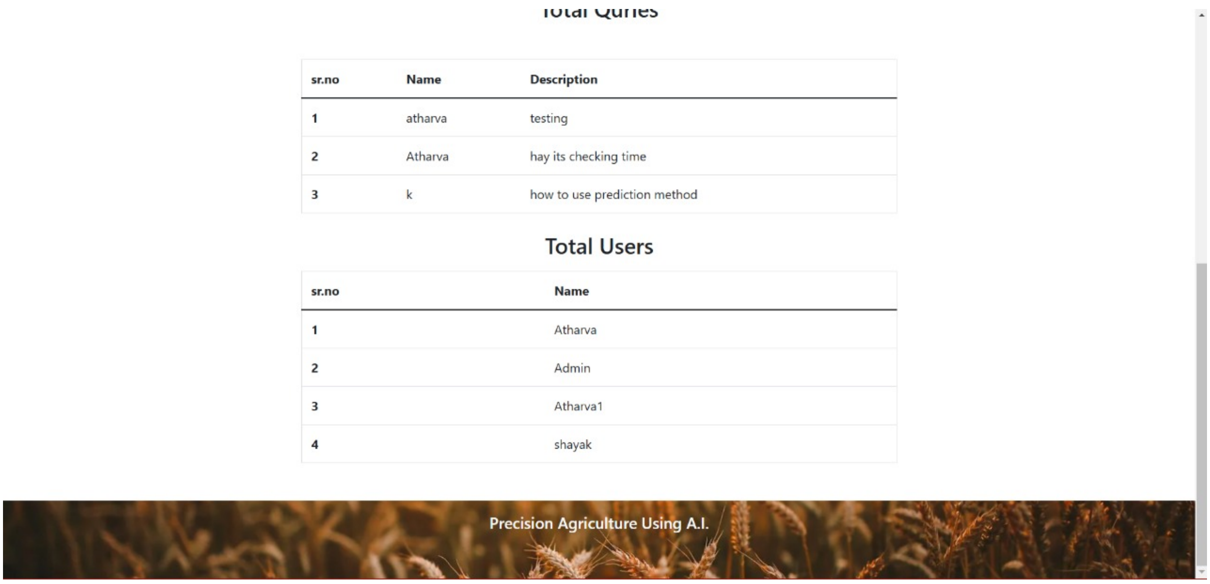


Figure 3.2: Crop Recommendation System

Machine Learning Models:

- The primary model used for crop recommendation is the Random Forest Classifier, which has achieved Figure 3.3 an accuracy of 97% in testing.



Total Quries

sr.no	Name	Description
1	atharva	testing
2	Atharva	hay its checking time
3	k	how to use prediction method

Total Users

sr.no	Name
1	Atharva
2	Admin
3	Atharva1
4	shayak

Figure 3.3: Common Specifications for ML and DL model training

Processing:

- The system processes the user's inputs and applies feature engineering techniques to normalize and scale the data before feeding it into the model.
- The trained Random Forest model predicts the most suitable crop for the given conditions by analyzing historical agricultural data and learned patterns.

Output:

- The system recommends the best crop that can be cultivated under the provided soil and environmental conditions.
- The recommendation includes additional insights, such as expected yield potential and best planting season.

3.1.2 Fertilizer Recommendation

The fertilizer recommendation module helps farmers optimize fertilizer usage by suggesting the most appropriate[16] nutrient adjustments for the soil. This prevents over-fertilization, improves soil health, and enhances crop productivity. The below Figure 3.4 is the standard values of the N P K values which is used for the fertilization detection

	Crop	N	P	K	pH
0	rice	80	40	40	5.5
3	maize	80	40	20	5.5
5	chickpea	40	60	80	5.5
12	kidneybe	20	60	20	5.5
13	pigeonpe	20	60	20	5.5
14	mothbea	20	40	20	5.5
15	mungbea	20	40	20	5.5
18	blackgram	40	60	20	5
24	lentil	20	60	20	5.5
60	pomegran	20	10	40	5.5
61	banana	100	75	50	6.5
62	mango	20	20	30	5
63	grapes	20	125	200	4
66	watermel	100	10	50	5.5
67	muskmel	100	10	50	5.5
69	apple	20	125	200	6.5
74	orange	20	10	10	4
75	papaya	50	50	50	6
88	coconut	20	10	30	5
93	cotton	120	40	20	5.5
94	jute	80	40	40	5.5
95	coffee	100	20	30	5.5

Figure 3.4: Standard NPK values

1. **User Input:**

   (a) The farmer provides the current soil nutrient levels (N, P, K) obtained through soil testing as shown below in Figure 3.5 on our website the farmers can input the appropriate values.

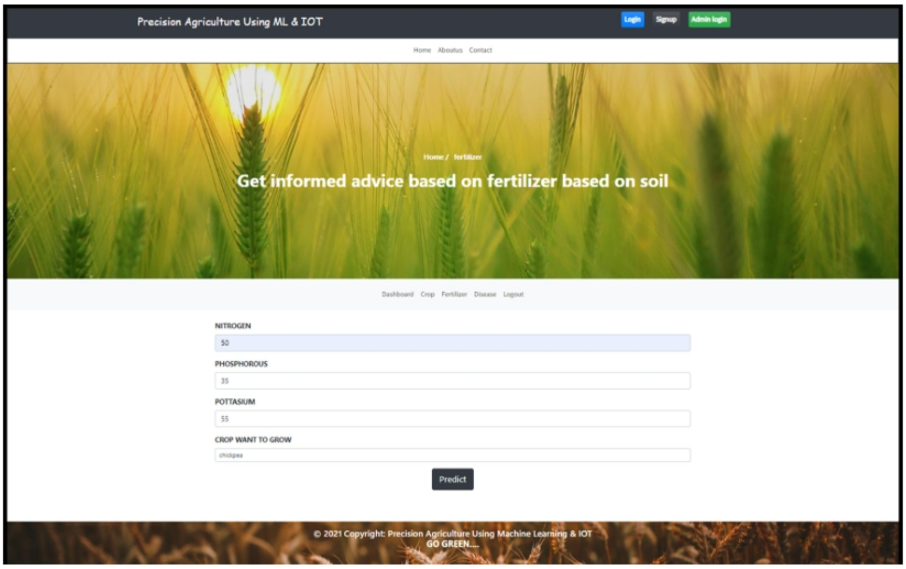


Figure 3.5: User Input for Fertilization Recommendation

2. **Comparison with Optimal Nutrient Requirements:**
   (a) The system compares the user's soil nutrient data with the ideal nutrient requirements of the selected crop.
   (b) A database of crop-specific nutrient requirements is used to identify deficiencies or excesses in nitrogen, phosphorus, or potassium levels.

3. **Lookup and Processing:**
   (a) A **dictionary-based approach in** `fertilizer.py` is used to match the deficiencies with appropriate fertilizers[17].
   (b) The system determines the type and quantity of fertilizer required to balance soil nutrients.

4. **Output:**
   (a) The system provides specific nutrient adjustments and fertilizer suggestions, recommending exact doses of nitrogen, phosphorus, or potassium-based fertilizers as shown in Figure 3.6.

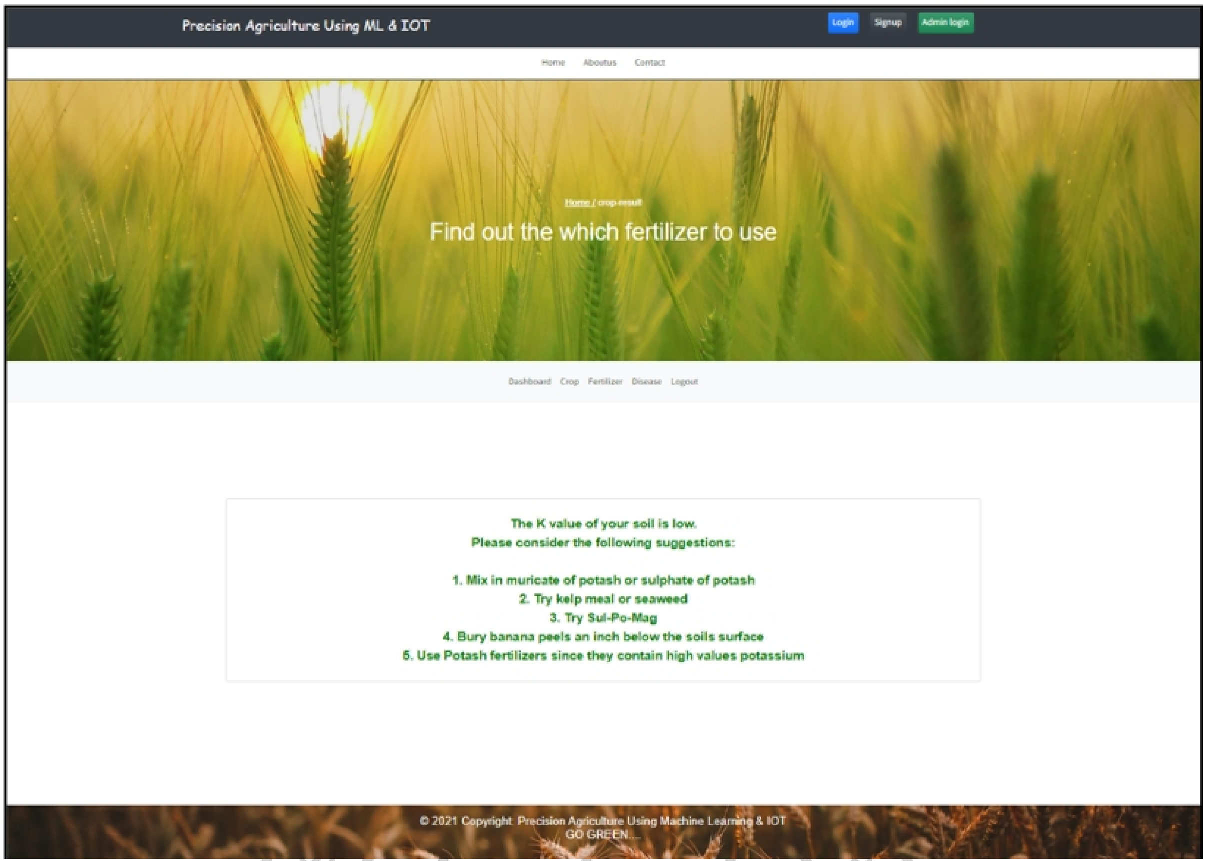


Figure 3.6: Fertilizer results

(b) The output also includes eco-friendly and organic fertilizer alternatives to promote sustainable farming practices.

(c) If any nutrient is found in excess, the system provides corrective measures to prevent nutrient toxicity.

3.1.3 Disease Detection

The disease detection module leverages deep learning and computer vision to identify plant diseases from images[18] uploaded by farmers. By detecting plant diseases early, farmers can take timely action and reduce yield losses, the below Table 3.4 and 3.6 shows a list of diseases our model is ready to detect Figure 3.7 shows the workflow for disease detection.

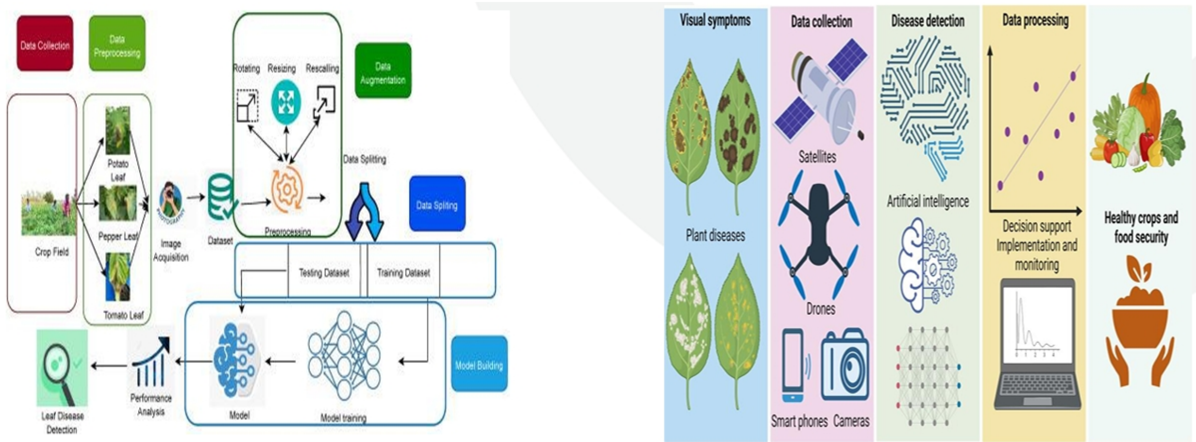


Figure 3.7: Workflow for disease detection

Table 3.4: Crop Disease Types (Set 1)

Category	**Disease Type**
Apple	'Apple_scab' 'Apple_Black_rot' 'Apple_Cedar_apple_rust' 'Apple_healthy'
Cherry	'Powdery_mildew' 'healthy'
Corn (Maize)	'Cercospora_leaf_spot' 'Common_rust' 'healthy'
Grape	'Black_rot' 'Esca (Black Measles)' 'Leaf_blight (Isariopsis Leaf Spot)' 'healthy'
Peach	'Bacterial_spot' 'healthy'

1. **Model Used:**

   (a) The ResNet-9 deep learning architecture is used for image classification.

   (b) ResNet-9 was chosen for its high accuracy, low computational cost, and efficient feature extraction capabilities.[8] The given figure below Figure 3.8 is a diagrammatic representation of how ResNet-9 is superior to CNN.

Table 3.5: Crop Disease Types (Set 2)

Category	Disease Type
Orange	'Haunglongbing (Citrus greening)'
Pepper	'bell_Bacterial_spot' 'bell_healthy'
Potato	'late_blight' 'healthy'
Tomato	'Bacterial_spot' 'Septoria_leaf_spot' 'Tomato_Yellow_Leaf_Curl_Virus' 'Tomato_mosaic_virus'
Strawberry	'Leaf_scorch' 'healthy'

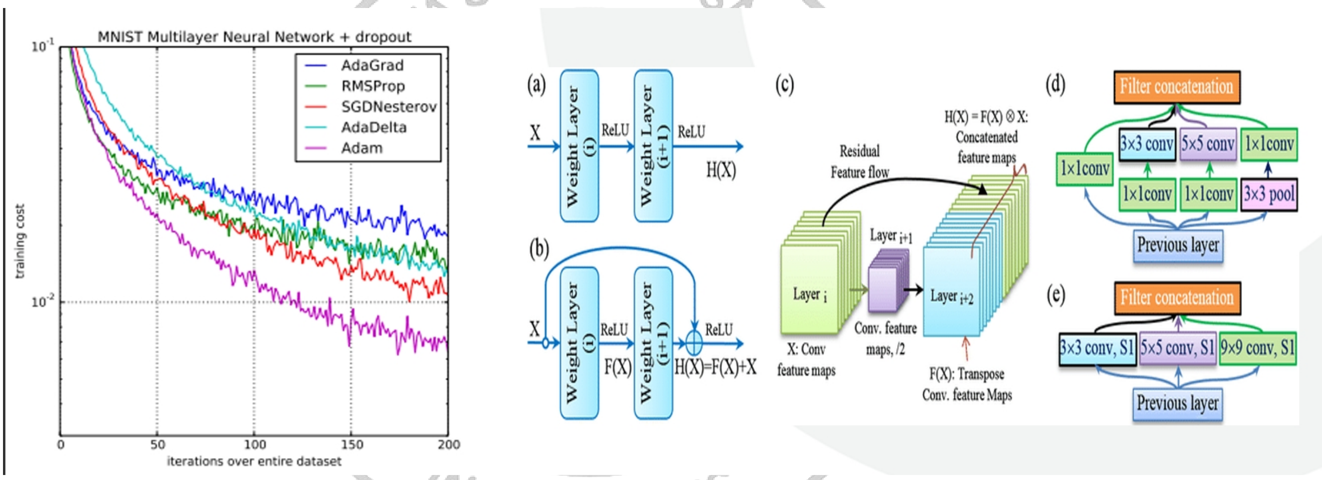


Figure 3.8: CNN vs ResNet-9

(c) The model was trained on a dataset containing thousands of images of diseased and healthy plants.

2. **User Input:**

(a) The farmer uploads an image of a plant leaf or affected crop area suspected to have a disease steps are shown below in Figure 3.9.

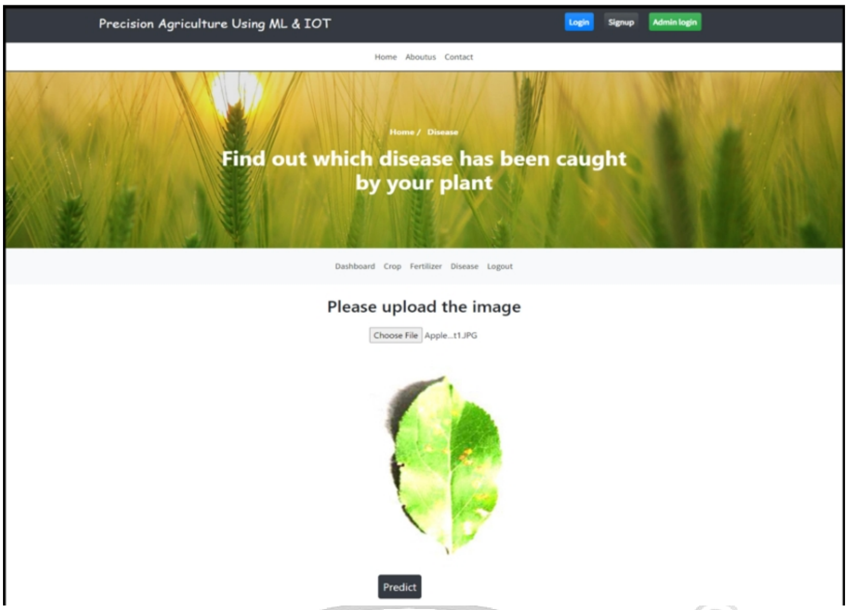


Figure 3.9: User Input for disease detection

3. **Processing:**

   (a) The uploaded image is resized and normalized to ensure compatibility with the Deep learning model.

   (b) The image is then fed into the ResNet-9 model, which extracts key features and predicts the disease category.

   (c) If the system detects a disease, it cross-references the results with a database of plant diseases, symptoms, and treatments. Figure 3.10 is a diagrammatic representation of how the processing is taking place.

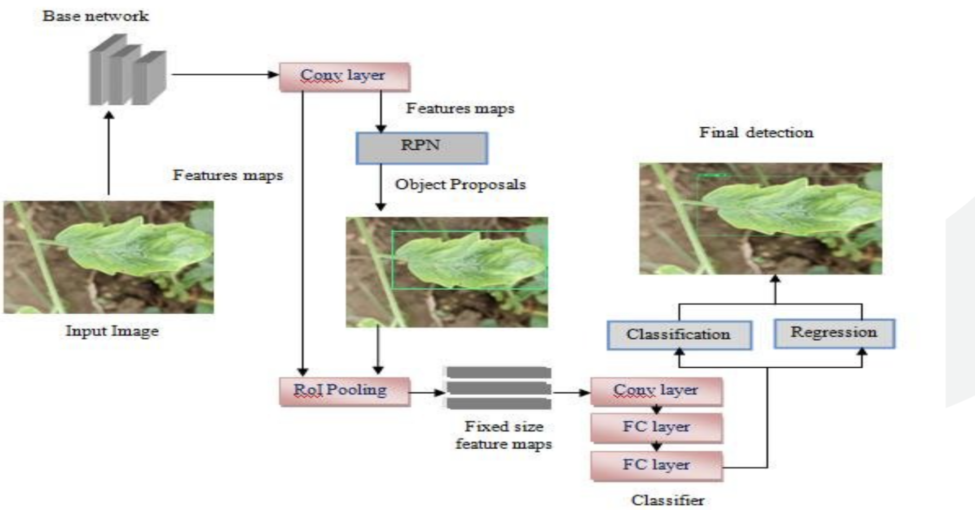


Figure 3.10: Disease detection processing

4. **Output:**

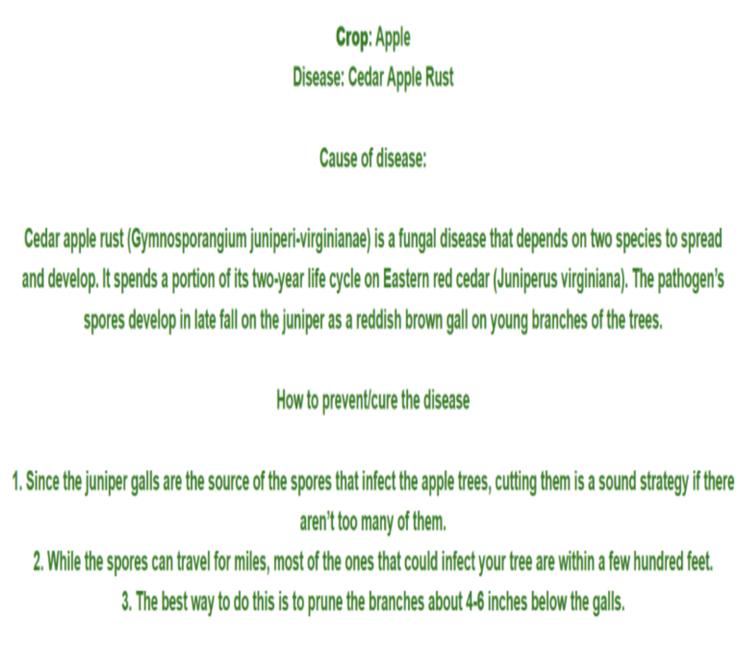
   (a) The system provides the predicted disease name based on the image analysis as shown in Figure 3.11 .

   (b) It also suggests possible treatment measures, including:

      i. Recommended pesticides, fungicides, or organic treatments

      ii. Preventive measures [19]to stop the spread of the disease

      iii. Best agricultural practices to strengthen plant immunity and reduce future risks



Crop: Apple
Disease: Cedar Apple Rust

Cause of disease:

Cedar apple rust (Gymnosporangium juniperi-virginianae) is a fungal disease that depends on two species to spread and develop. It spends a portion of its two-year life cycle on Eastern red cedar (Juniperus virginiana). The pathogen's spores develop in late fall on the juniper as a reddish brown gall on young branches of the trees.

How to prevent/cure the disease

1. Since the juniper galls are the source of the spores that infect the apple trees, cutting them is a sound strategy if there aren't too many of them.
2. While the spores can travel for miles, most of the ones that could infect your tree are within a few hundred feet.
3. The best way to do this is to prune the branches about 4-6 inches below the galls.

Figure 3.11: Output of Disease Detection

By implementing these three modules, the project empowers farmers with AI-driven insights, reducing dependency on traditional guesswork while ensuring efficient and sustainable agricultural practices.By following these hosting strategies, the AI-driven precision agriculture system can be deployed securely, efficiently, and at scale to serve farmers across different regions. Cloud-based hosting with AI integration will ensure real-time insights, cost-effectiveness, and accessibility, empowering farmers with data-driven agricultural solutions.[3]

Chapter 4

Results & Analysis

CHAPTER 4

RESULTS & ANALYSIS

The statistical analysis of the developed precision agriculture system highlights its effectiveness, scalability, and reliability. Machine learning models were extensively tested, with the Random Forest Classifier achieving the highest accuracy of 99.09%, followed by Logistic Regression at 94.30%, Decision Trees at 90%, and Support Vector Machine (SVM) at 70.6%, indicating that Random Forest is the most suitable model for crop recommendation. Performance testing confirmed the system's ability to handle concurrent user requests efficiently, ensuring scalability without compromising speed. Unit testing achieved close to 100% code coverage[20], reducing the risk of logic errors, while regression testing ensured that new updates did not introduce bugs. A Usability testing confirmed that the system is user-friendly and accessible to farmers, with admin monitoring enhancing security [21]enforcement. By providing accurate crop selection, fertilizer recommendations, and disease detection, the system minimizes the risk of crop failure and economic losses for farmers, promoting sustainable and profitable agriculture. Future improvements include integrating a yield predictors to estimate production outcomes and expanding the system to a web-based platform, allowing millions of farmers to benefit from data-driven agricultural insights.

4.1 Results

This section presents the outcomes of implementing the Agro based Services through Application, analyzing its performance, scalability, and cost-effectiveness. The discussion highlights key metrics, challenges encountered, and improvements made during the development process. Additionally, it evaluates the system's ability to handle concurrent user requests, data consistency, and security enforcement.

4.1.1 Overview

The implementation of the Web-Based Agriculture Assistance Application successfully demonstrates the benefits of a technologically driven farming. The system ensures seamless authentication, efficient service provisioning, disease detection, crop analysis and suggestion on the use of fertilizers and pesticides through effective N,P,K values. The results validate the high scalability, cost efficiency, and reliability of the approach. This section presents the key findings from the implementation.

4.1.2 Login, Signup, and Authentication Results

User authentication is a critical component of the system, ensuring secure access control and data privacy. The authentication system was implemented successfully with admin monitoring available , and the following observations were made:

As shown in Figure 4.1, the login page provides users with a simple and secure interface to access their accounts. The page consists of input fields for email and password, along with validation mechanisms to prevent incorrect or empty submissions. Upon entering valid credentials, the system verifies authentication using username ,password, ensuring a seamless and secure login experience. If a user enters incorrect credentials, an appropriate error message is displayed, enhancing user experience and security.

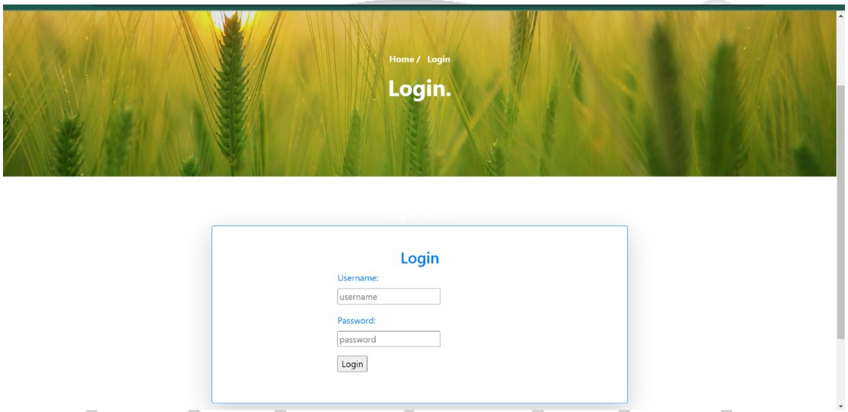


Figure 4.1: Login Page of the Application

The signup page, as depicted in Figure 4.2, allows new users to create an account by providing necessary details such as email, password, and username. The form is designed to ensure data validity with input validation for common errors such as weak passwords or duplicate email registrations. Upon successful registration, an email verification step is required, adding an extra layer of security to prevent unauthorized access. This verification process ensures that only legitimate users can create an account, reducing the risk of spam or fraudulent signup. [23]

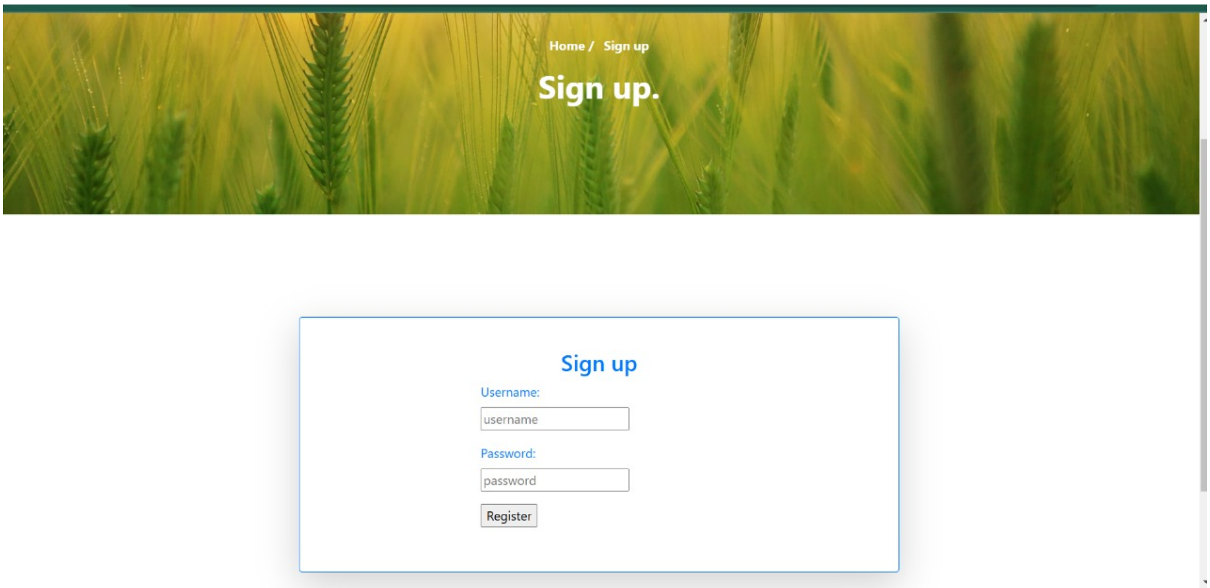


Figure 4.2: Signup Page of the Application

Admin Panel control is a crucial security measure, ensuring that only legitimate users can access the system.As shown in Figure 4.3 which provides logs of user logins and usage .This mechanism prevents bots and unauthorized[22] users from bypassing authentication.The Pop up window raises the issue stating the type and solution to it ensuring security by preventing unauthorized access after the link expires.Additionally, users who fail to verify their email within a set duration receive automated reminders to complete the process.

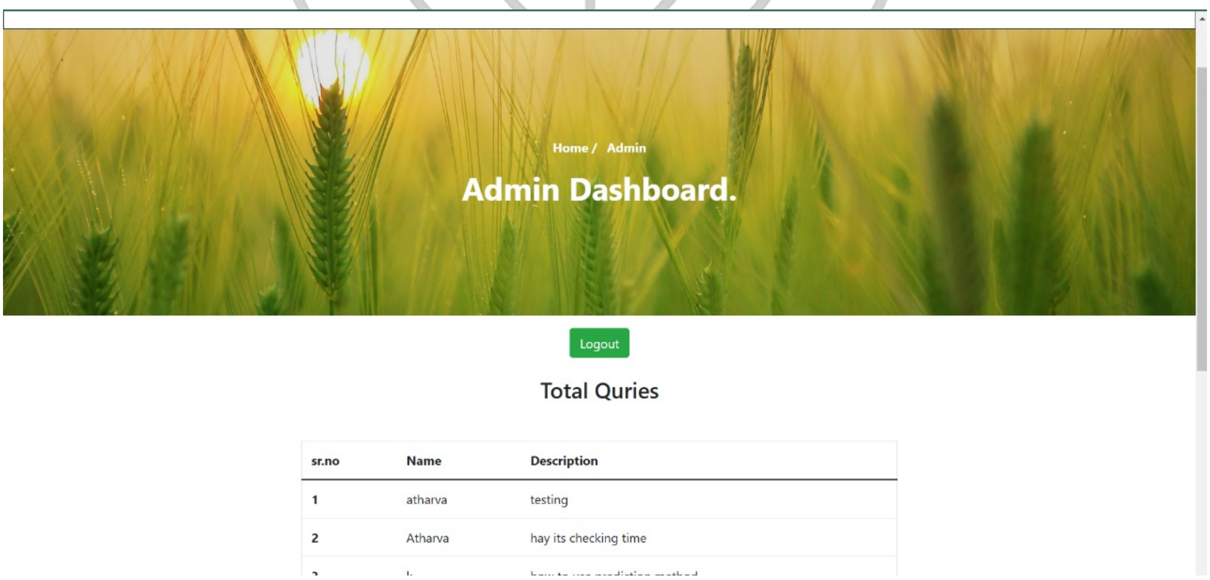


Figure 4.3: Admin Dashboard

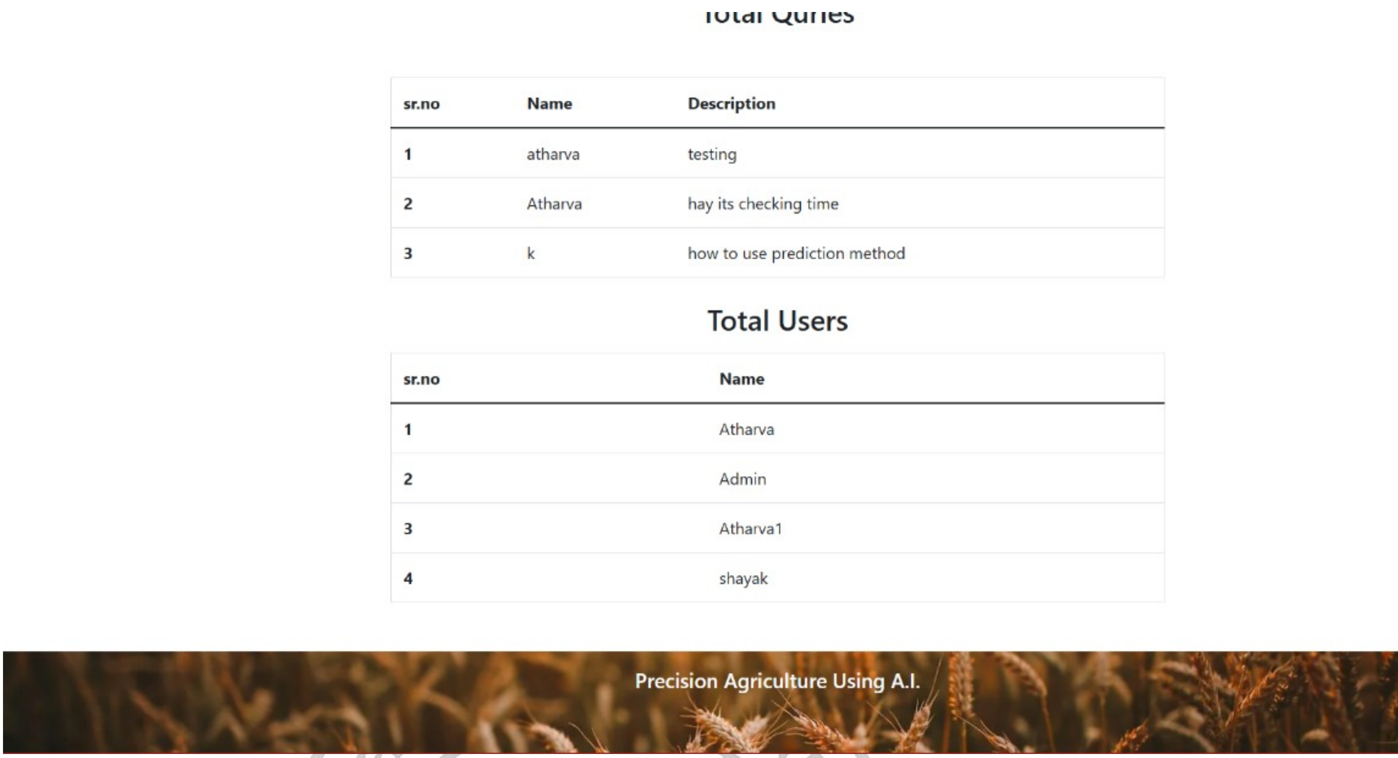


Figure 4.4: Admin interface

Other models, including Support Vector Machines (SVM), Logistic Regression, and Decision Trees, were also tested for performance [23]comparison. Random Forest provided the best balance between accuracy and interpretability as shown below in Table 4.1.

Table 4.1: Algorithm and its Accuracy

Algorithm	**Accuracy (%)**
Decision Tree	90%
SVM	97%
Logistic Regression	95%
Random Forest	99%

Figure 4.5 is the bar graph representation of the accuracy comparison that will be a algorithm vs accuracy graph ,[24]and Table 4.2 is the table of accuracy of each services of the project [25].

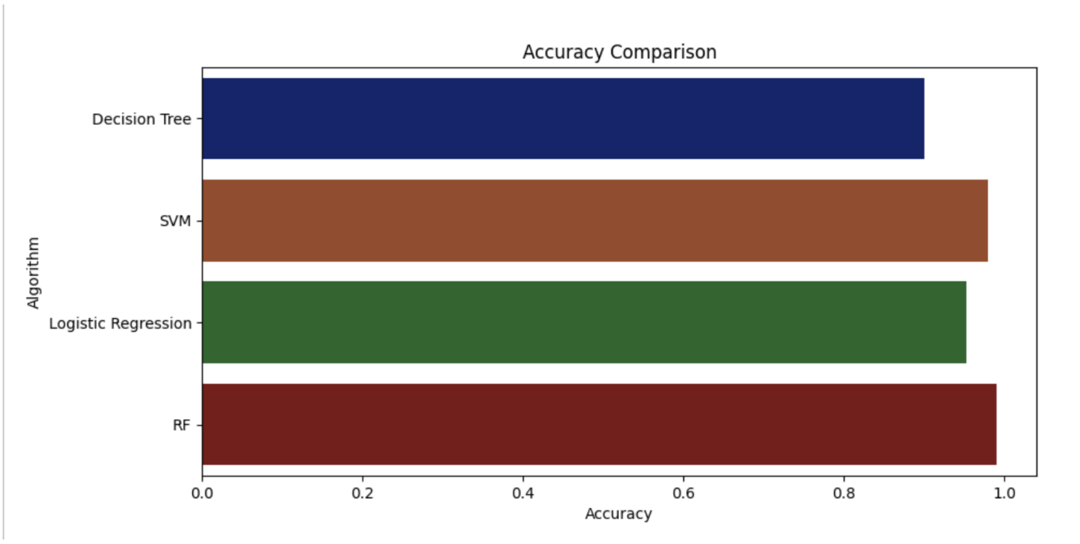


Figure 4.5: Accuracy Comparison

Table 4.2: Service and its Accuracy

Services	**Accuracy (%)**
Crop Recommendation System	85%
Fertilizer Suggestion System	86%
Disease Detection System	89%

The application of machine learning (ML) algorithms in precision agriculture has demonstrated significant improvements in efficiency, productivity, and sustainability. The results and analysis indicate that ML-based techniques enhance decision-making by accurately predicting crop yields, optimizing resource allocation, detecting diseases, and improving soil health management by usage of the services provided by the project[9].

Chapter 5

Conclusion and Future Scope

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

Precision agriculture is a transformative approach that leverages machine learning, artificial intelligence, and data analytics to optimize farming practices, reduce resource wastage, and improve overall agricultural productivity. By integrating crop recommendation, fertilizer suggestion, and disease detection into a user-friendly Flask-based web application, this project provides farmers with accurate, real-time, and data-driven insights to make informed decisions about their farming operations.

The crop recommendation module ensures that farmers cultivate the most suitable crops based on soil composition and environmental conditions, maximizing yields and minimizing losses., with Random Forest achieving the highest accuracy at 99.09%, followed by Logistic Regression at 94.30%, Decision Trees at 90%, and Support Vector Machine (SVM) at 70.6%. However, another evaluation of SVM reported a significantly improved accuracy of 97%, suggesting variability based on dataset characteristics and model tuning. The fertilizer recommendation system helps in maintaining soil health by suggesting precise nutrient adjustments, preventing overuse of chemical fertilizers.[4] The disease detection module, powered by deep learning, enables early identification of plant diseases through image recognition, allowing farmers to take timely preventive measures.

The system's modular, scalable, and extensible architecture ensures that new features, datasets, and models can be seamlessly integrated in the future. By adopting real-time weather data , and AI-powered decision-making, this project lays a strong foundation for the next generation of smart farming solutions. Ultimately, it aims to bridge the gap between traditional agricultural practices and modern technological advancements, empowering farmers to increase productivity, reduce financial risks, and promote sustainable agriculture.[5]

5.2 Future Scope

While the project successfully implements core precision agriculture functionalities, there are several opportunities for future enhancements to further expand its impact and effectiveness:

- **Yield Prediction System:** Integrating advanced yield forecasting models will enable accurate predictions of expected crop production based on historical data, real-time weather conditions, and soil quality. This will help farmers plan harvest schedules, optimize storage logistics, and develop effective market sales strategies to maximize profits.

- **Advanced ML Models & AI Enhancements:** Incorporating Long Short-Term Memory (LSTM) and Recurrent Neural Networks (RNNs) will enhance time-series analysis of climate and soil data, enabling more precise recommendations for irrigation and fertilizer application.

- **Expanded Databases for Increased Coverage:** Expanding the database to include a wider variety of crops, soil types, and plant diseases will make the system more applicable[24] to diverse geographical regions and farming conditions.

- **Multilingual & Accessibility Features:** Developing multilingual support ensures that the platform is accessible to farmers from diverse linguistic backgrounds, making it easier for non-English-speaking users to navigate. Additionally,

5.3 Learning Outcomes of the Project

Technical Skills:Machine Learning Deep Learning Proficiency: Gained hands-on experience in training and deploying ML and DL models for crop recommendation, fertilizer suggestion, and plant disease detection, improving agricultural decision-making. Web Development Skills: Developed a Flask-based web application, enhancing knowledge of backend development, API integration, and real-time data processing.

Data Preprocessing Model Optimization: Learned how to clean, preprocess, and analyze agricultural datasets, applying techniques like feature engineering, hyperparameter tuning, and model evaluation to improve accuracy.

API Development Integration: Acquired skills in developing RESTful APIs i.e weather API to integrate ML models with the web application, ensuring smooth communication between components.

Software Deployment Scalability: Understood the deployment process of web applications on cloud or local servers, optimizing performance and accessibility for end users.

Analytical and Problem-Solving Skills:System Design and Optimization: Gained experience in designing and optimizing complex systems, including selecting appropriate components, simulating kinematics and dynamics, and ensuring the system meets the desired performance criteria.
Data Processing and Analysis: Developed skills in processing and analyzing sensor data to extract meaningful information and generate control signals for the robotic arm. This includes filtering, calibrating, and scaling data to ensure accuracy and reliability.
Performance Evaluation: Learned how to design and conduct experiments to evaluate the performance of the system. This includes measuring metrics such as latency, accuracy, reliability, and response time, and using these results to refine the system.
Project Management and Collaboration:Documentation and Reporting: Developed skills in documenting the design, implementation, and evaluation of the project. This includes creating detailed reports, presentations, and project documentation that clearly communicate the project's objectives, methodology, results, and conclusions.
Team Collaboration: Gained experience in collaborating with team members, sharing responsibilities, and working together to achieve common goals. This includes effective communication, coordination, and problem-solving within the team.
Time Management: Learned how to manage time effectively to meet project deadlines. This includes planning, scheduling, and prioritizing tasks to ensure the project progresses smoothly and is completed on time.

Chapter 6

Bibliography

CHAPTER 6

BIBLIOGRAPHY

BIBLIOGRAPHY

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Appendix A

Code

APPENDIX A

CODE

A.1 First Appendix

This Flask-based web application integrates machine learning (ML) and deep learning (DL) models to provide crop recommendations, fertilizer suggestions, and plant disease detection for precision agriculture.The application features user authentication and authorization using Flask-Login, enabling secure access to the dashboard and other functionalities. The Flask-WTF forms handle user input validation, while Flask-SQLAlchemy manages the database for storing user credentials and contact queries. The system also fetches real-time weather data via the OpenWeather API to improve prediction accuracy. The web interface, built with Flask templates, allows users to interact with the models and view prediction results seamlessly.

```
import string
import bcrypt
from flask import Flask, redirect, render_template, url_for,
request, Markup
from flask_sqlalchemy import SQLAlchemy
from flask_login import UserMixin, login_user, LoginManager,
login_required, logout_user, current_user
from wtforms import StringField, PasswordField, SubmitField
from wtforms.validators import InputRequired, Length,
ValidationError
from flask_wtf import FlaskForm
from flask_bcrypt import Bcrypt
from datetime import datetime
import requests
import numpy as np
import pandas as pd
import config
import pickle
import io
```

```
import torch
from torchvision import transforms
from PIL import Image
from utils.model import ResNet9
from utils.fertilizer import fertilizer_dic
from utils.disease import disease_dic

# ------------------ LOADING TRAINED MODELS -----------------
crop_recommendation_model_path = 'models/RandomForest.pkl'
crop_recommendation_model = pickle.load(open
(crop_recommendation_model_path, 'rb'))

disease_classes = ['Apple___Apple_scab', 'Apple___Black_rot',
            'Apple___Cedar_apple_rust','Apple___healthy',
            'Blueberry___healthy', 'Cherry_(Powdery_mildew',
            'Corn_(maize)_Common_rust_', 'Corn_(maize)_healthy',
            'Grape___Black_rot', 'Grape___Esca_(Black_Measles)',
            'Tomato___Bacterial_spot', 'Tomato___Early_blight',
            'Tomato___healthy']
# Load plant disease model
disease_model_path = 'models/plant_disease_model.pth'
disease_model = ResNet9(3, len(disease_classes))
disease_model.load_state_dict(torch.load(disease_model_path,
map_location=torch.device('cpu')))
disease_model.eval()
```

Some of the functions definitions that were used in the code to call upon the functionality.These functions were called to achieve the services that needs to be used by the user be it crop recommendation ,fertilizer suggestion and disease detection and fetching weather and cities details via API call.

```
def weather_fetch(city_name):
    """ Fetch temperature and humidity of a city"""
```

```
    api_key = config.weather_api_key
    base_url = "http://api.openweathermap.org/data/2.5
/weather?"
    complete_url = base_url + "appid=" + api_key + "&q="
    + city_name
    response = requests.get(complete_url)
    x = response.json()
    if x["cod"] != "404":
    y = x["main"]
        return round((y["temp"] - 273.15), 2), y["humidity"]
    else:
        return None

def predict_image(img, model=disease_model):
    """
    Transforms image and predicts disease label
    """
    transform = transforms.Compose([transforms.Resize(256),
    transforms.ToTensor()])
    image = Image.open(io.BytesIO(img))
    img_t = transform(image)
    img_u = torch.unsqueeze(img_t, 0)

    yb = model(img_u)
    _, preds = torch.max(yb, dim=1)
    return disease_classes[preds[0].item()]

app = Flask(__name__)
db = SQLAlchemy(app)
bcrypt = Bcrypt(app)
app.config["SQLALCHEMY_DATABASE_URI"] = "sqlite:///database.db"
app.config["SECRET_KEY"] = 'thisissecretkey'
```

```
login_manager = LoginManager()
login_manager.init_app(app)
login_manager.login_view = "login"

@login_manager.user_loader
def load_user(user_id):
    return User.query.get(int(user_id))

class User(db.Model, UserMixin):
    id = db.Column(db.Integer, primary_key=True)
    username = db.Column(db.String(20), nullable=False,
    unique=True)
    password = db.Column(db.String(80), nullable=False)

class RegisterForm(FlaskForm):
    username = StringField(validators=[InputRequired(),
    Length(min=5, max=20)], render_kw={"placeholder":
    "username"})
    password = PasswordField(validators=[InputRequired(),
    Length(min=5, max=20)], render_kw={"placeholder":
    "password"})
    submit = SubmitField("Register")

@app.route("/")
def hello_world():
    return render_template("index.html")

@app.route("/login", methods=['GET', 'POST'])
def login():
    form = LoginForm()
    if current_user.is_authenticated:
        return redirect(url_for('dashboard'))
```

```python
    elif form.validate_on_submit():
        user = User.query.filter_by(username=form.
        username.data).first()
        if user and bcrypt.check_password_hash(user.password,
        form.password.data):login_user(user)
            return redirect(url_for('dashboard'))

    return render_template("login.html", form=form)

@app.route('/dashboard', methods=['GET', 'POST'])
@login_required
def dashboard():
    return render_template('dashboard.html')

@app.route('/logout', methods=['GET', 'POST'])
@login_required
def logout():
    logout_user()
    return redirect(url_for('hello_world'))

@app.route('/crop-recommend')
@login_required
def crop_recommend():
    return render_template('crop.html')

@app.route('/crop-predict', methods=['POST'])
def crop_prediction():
    """
    Predict suitable crop based on input parameters
    """
    if request.method == 'POST':
        N = int(request.form['nitrogen'])
        P = int(request.form['phosphorous'])
```

```
        K = int(request.form['pottasium'])
        ph = float(request.form['ph'])
        rainfall = float(request.form['rainfall'])
        city = request.form.get("city")

        if weather_fetch(city):
            temperature, humidity = weather_fetch(city)
            data = np.array([[N, P, K, temperature, humidity,
            ph, rainfall]])
            my_prediction = crop_recommendation_model.
            predict(data)
            return render_template('crop-result.html',
            prediction=my_prediction[0])

    return render_template('try_again.html')

@app.route('/fertilizer-predict', methods=['POST'])
def fert_recommend():
    """
    Recommend fertilizer based on soil nutrients
    """
    crop_name = str(request.form['cropname'])
    N = int(request.form['nitrogen'])
    P = int(request.form['phosphorous'])
    K = int(request.form['pottasium'])

    df = pd.read_csv('Data/fertilizer.csv')
    nr = df[df['Crop'] == crop_name]['N'].iloc[0]
    pr = df[df['Crop'] == crop_name]['P'].iloc[0]
    kr = df[df['Crop'] == crop_name]['K'].iloc[0]

    n, p, k = nr - N, pr - P, kr - K
    max_value = max({abs(n): "N", abs(p): "P", abs(k): "K"}
```

```
    .keys())
    key = f"{max_value}High" if eval(max_value.lower()) < 0
    else f"{max_value}low"

    return render_template('fertilizer-result.html',
    recommendation=Markup(fertilizer_dic[key]))

@app.route('/disease-predict', methods=['GET', 'POST'])
@login_required
def disease_prediction():
    """
    Predict plant disease from uploaded image
    """
    if request.method == 'POST' and 'file' in request.files:
        file = request.files.get('file')
        if file:
            img = file.read()
            prediction = Markup(str(disease_dic
            [predict_image(img)]))
            return render_template('disease-result.html',
            prediction=prediction)

    return render_template('disease.html')

if __name__ == "__main__":
    app.run(debug=True, port=8000)
```