Abstract

- Develop an AI-driven decision-support system for sustainable farming.
- Nutrient Prediction: Uses Random Forest Regression to determine optimal soil nutrient levels.
- Fertilizer Recommendation: Provides precise fertilizer application guidance to prevent overuse and environmental harm.
- Crop Recommendation: Decision Tree model suggests the best crops based on soil and climate conditions.
- Disease Detection: Utilizes RaceNet for early and accurate crop disease classification.
- Weather Forecasting: Integrates a 7-day weather forecast API to aid in farming decisions.

Introduction

- Agriculture plays a vital role in ensuring food security and sustaining economic development, particularly in countries where farming is a primary occupation.
- Challenges like plant diseases and improper nutrient management affect crop yields and harm the environment.
- "Nutrient Prediction: Uses Random Forest Regression to predict optimal nitrogen (N), phosphorus (P), and potassium (K) levels."
- "Crop Selection Optimization: Machine learning models recommend the best crops based on soil and climate conditions."

Introduction

- "Fertilizer Application Efficiency: AI-driven insights help in reducing overuse and improving sustainability."
- "Disease Detection: CNN-based deep learning model identifies crop diseases through image analysis."
- "Real-time Weather API Integration: Uses real-time data to enhance decision-making in sowing, irrigation, and harvesting."
- An integrated system combining plant disease detection and NPK estimation using machine learning.
- Aims to provide a comprehensive approach to crop health management.

Problem Statement

- Traditional fertilizer use often leads to nutrient imbalances, reduced crop yields, and envirmental harm.
- Inefficient Farming Practices Excessive fertilizer use leads to soil degradation and environmental pollution.
- Climate Variability Challenges Unpredictable weather patterns affect traditional farming decisions.
- Additionally, the lack of early disease detection further reduces crop health.
- "This project aims to develop an intelligent system using machine learning to optimize fertilizer usage based on real-time weather data and detect plant diseases throug image analysis, improving crop yields, reducing environmental impact, and promoting sustainable farming."

Literature Survey

Paper Title	Author	Observations
Random forest versus logistic regression a large-scale benchmark experiment	BMC informatics Date of Publishing : 17 July 2018	The Random Forest (RF) algorithm for regression and classification has considerably gained popularity since its introduction in 2001. Meanwhile,it has grown to a standard classification approach competing with logistic regression in many innovation-friendly scientific fields. RF performed better than LR according to the considered accuracy measured in approximately 69per of the datasets..

Literature Survey

Paper Title	Author	Observations
Effect of Climate Changes on Soil Properties and Crop Nutrition.	V. R. RAMAKRISHNA PARAMA Date of Publishing : 1 November 2017	Defining soil properties in relation to climate change should consider the impacts of a range of predicted global climate change such as rising atmospheric carbon dioxide (CO2) levels, elevated temperature, altered precipitation (rainfall) and atmospheric nitrogen (N2) deposition on soil chemical,physical and biological functions.,This paper describes the impact of climate change on different soil properties,

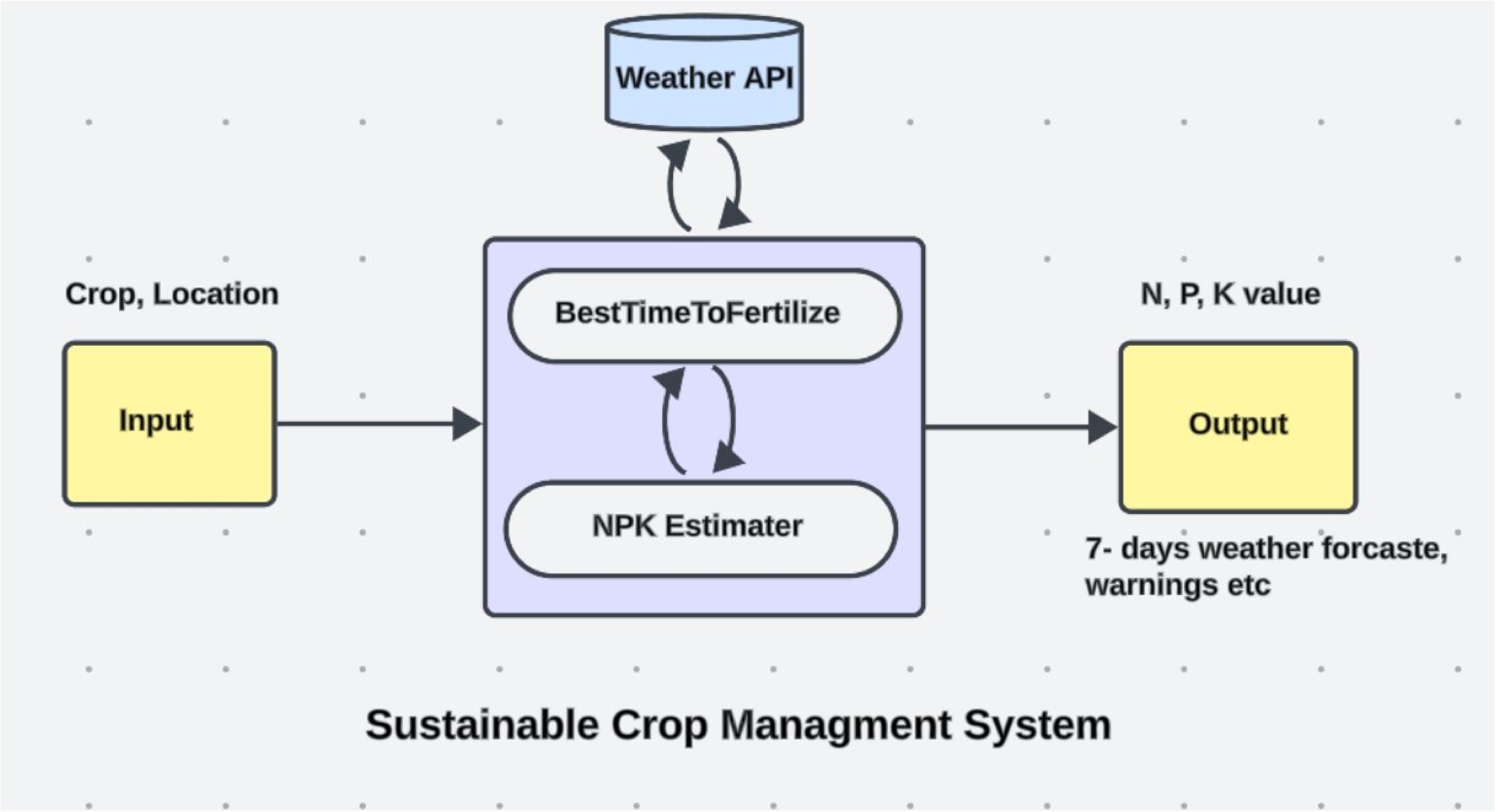
Literature Survey

Paper Title	Author	Observations
Smart farming using Machine Learning and Deep Learning techniques.	Senthil Kumar Swami Durai, Mary Divya Shamili b Date of Publishing : 2 April 2022	Farmers till date had adopted conventional farming techniques.These techniques were not precise thus reduced productivity and consumed a lot of time.Precise farming helps to increase productivity by precisely determining the steps that need to be practised due season. analysing the soil, determining the amount of fertilisers,Data Mining, Data Analytics, Machine Learning to collect the data, train the systems and predict the results.

Research Objectives

- “Develop an integrated system that combines plant disease detection with NPK estimation using machine learning techniques.”
- “To prevent environmental degradation by minimizing leaching and Utilize leaf pattern analysis to identify common plant diseases accurately.”
- ”Integrate real-time weather data for better predictions..”
- “To design a user-friendly web platform accessible to farmers.”
- ”Develop an AI-based decision-support system to Optimize nutrient management and fertilizer application.”

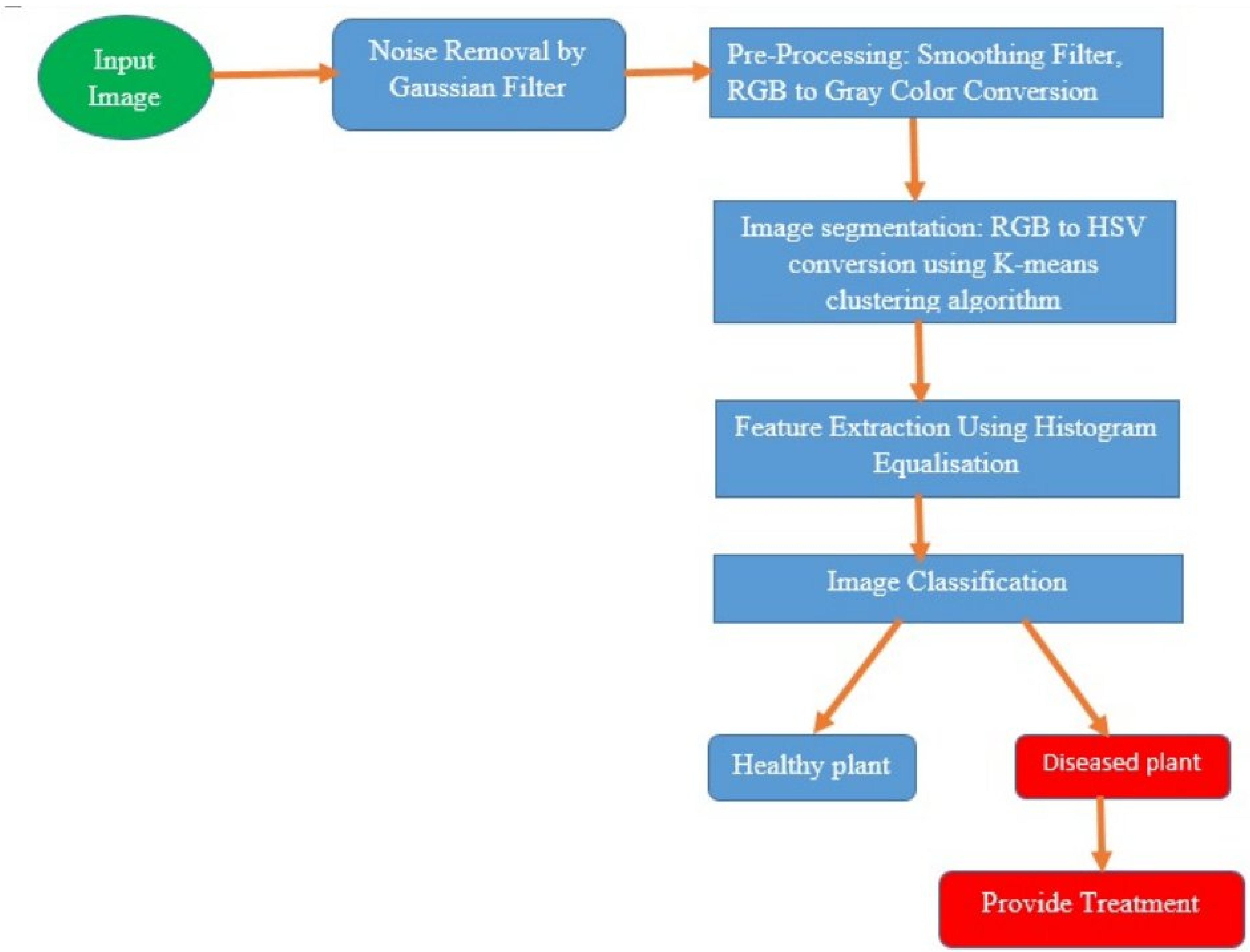
System Design



System Design

- Key Components:
  - Frontend: HTML, CSS, JavaScript.
  - Backend: Flask framework, machine learning (Random Forest Regression).
  - Weather API: For real-time data integration.
  - Database: Stores user data, crop information, and historical recommendations, managed through CSV files.
  - Machine Learning: Python libraries such as Scikit-learn for model implementation.

System Design



System Design

- Input Data Collection– Gather crop type, location, weather parameters(temperature, humidity, rainfall), and plant images for disease detection.
- Preprocessing Feature Extraction– Normalize soil and weather data; apply image processing techniques for plant disease analysis.
- Machine Learning Models– Implement Random Forest Regression for NPK prediction and CNN-based image classification for plant disease detection.
- Prediction Analysis– Generate fertilizer recommendations and disease diagnoses, offering actionable insights to farmers.
- Web-Based User Interface– Develop an intuitive platform for farmers to input data, receive predictions, and access recommendations

Methodology

Using Random Forest Regresion

- Input Data:Features provided by the user:
  Crop type: e.g., Wheat
  Location: e.g., Zone C
  Weather data: e.g., temperature = 28°C, rainfall = 250 mm, humidity = 70
- Model Processing:
  The input data is passed through each decision tree in the Random Forest.
  Each tree independently predicts the N, P, and K values based on its learned rules.
- Aggregation of Predictions:
  The Random Forest collects predictions from all the decision trees.
  The final prediction is the average of all tree outputs for each nutrient (N, P, and K).

Methodology

- Example:
  - Tree 1 predicts: N = 65, P = 35, K = 45
    Tree 2 predicts: N = 60, P = 30, K = 40
    Tree 3 predicts: N = 70, P = 40, K = 50
    Final predictions:
    N = (65 + 60 + 70) / 3 = 65 kg
    P = (35 + 30 + 40) / 3 = 35 kg
    K = (45 + 40 + 50) / 3 = 45 kg

Methodology

Using Convolutional Neural Networks (CNN)

- Input Data
  Plant images captured/uploaded by the user.
  Preprocessing: Resize images to (128,128,3), normalize pixel values, and apply data augmentation (flip, zoom, rotate)
- Model Processing:
  The image is passed through multiple convolutional layers to extract features. MaxPooling layers reduce dimensionality while retaining key patterns.Fully connected layers classify the image into disease categories
- Prediction Diagnosis:
  The trained CNN model assigns a probability score to each disease class. The final output is the most probable disease along with recommended actions for treatment

Data Collection and Features

- Sources:"Interviews with agricultural experts. Historical weather and soil nutrient data. Online research papers and agricultural databases.
- Key Features:
  Crop Type: e.g., Wheat, Rice, Maize
  Location: e.g., Maharashtra, Punjab.
  Temperature: Measured in °C. Humidity: Relative humidity in
  Rainfall: Recorded in mm.
  Leaf Images: For plant disease detection using CNN.

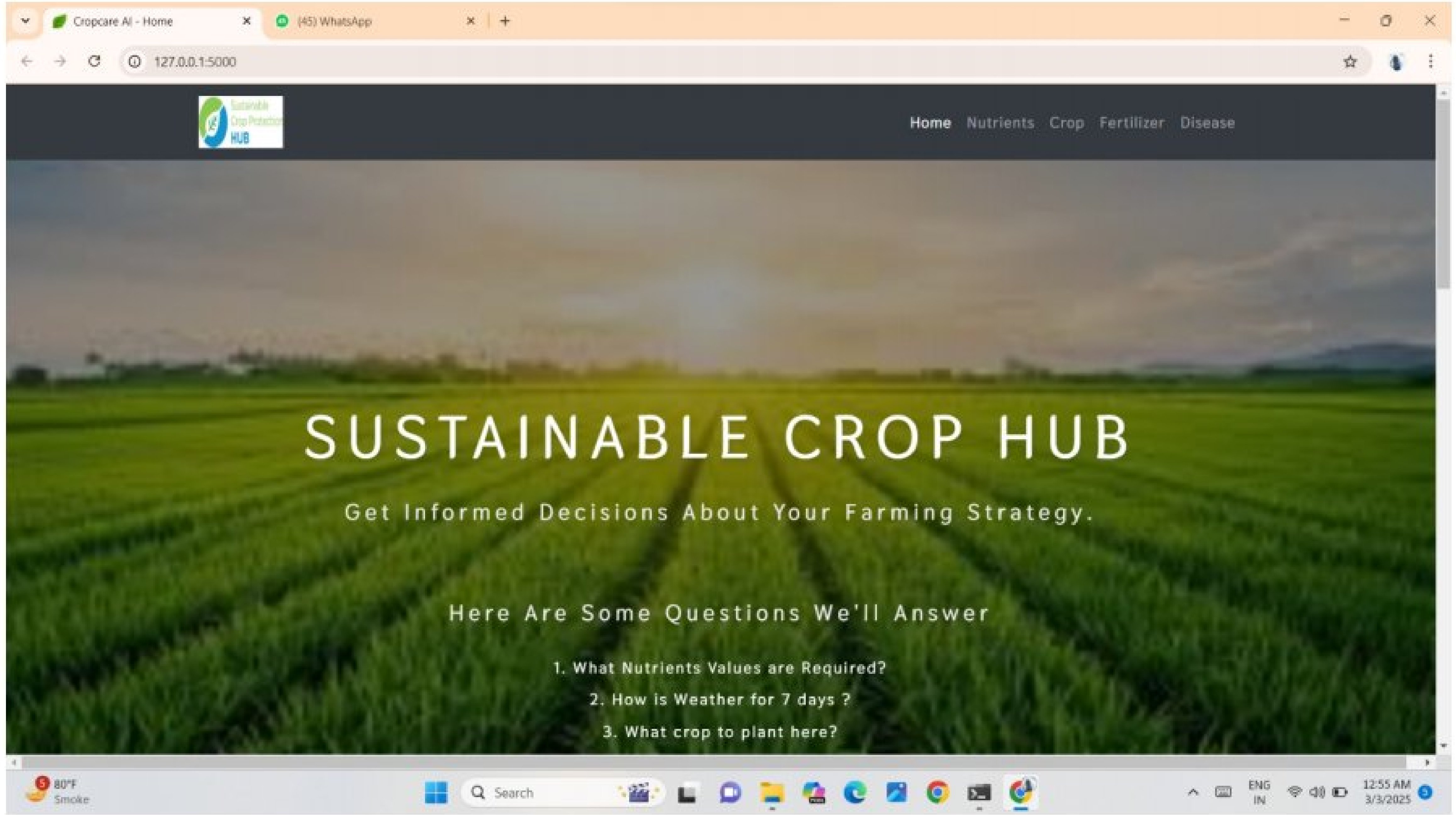
Implementation

- Step 1: Data Collection
- Step 2: Data Pre- processing
- Step 3: Model Development
- Step 4: System Design
- Designing core modules for NPK estimation and disease detection.
- Step 5: Web Application Development
- Step 6: Testing and Validation

Results

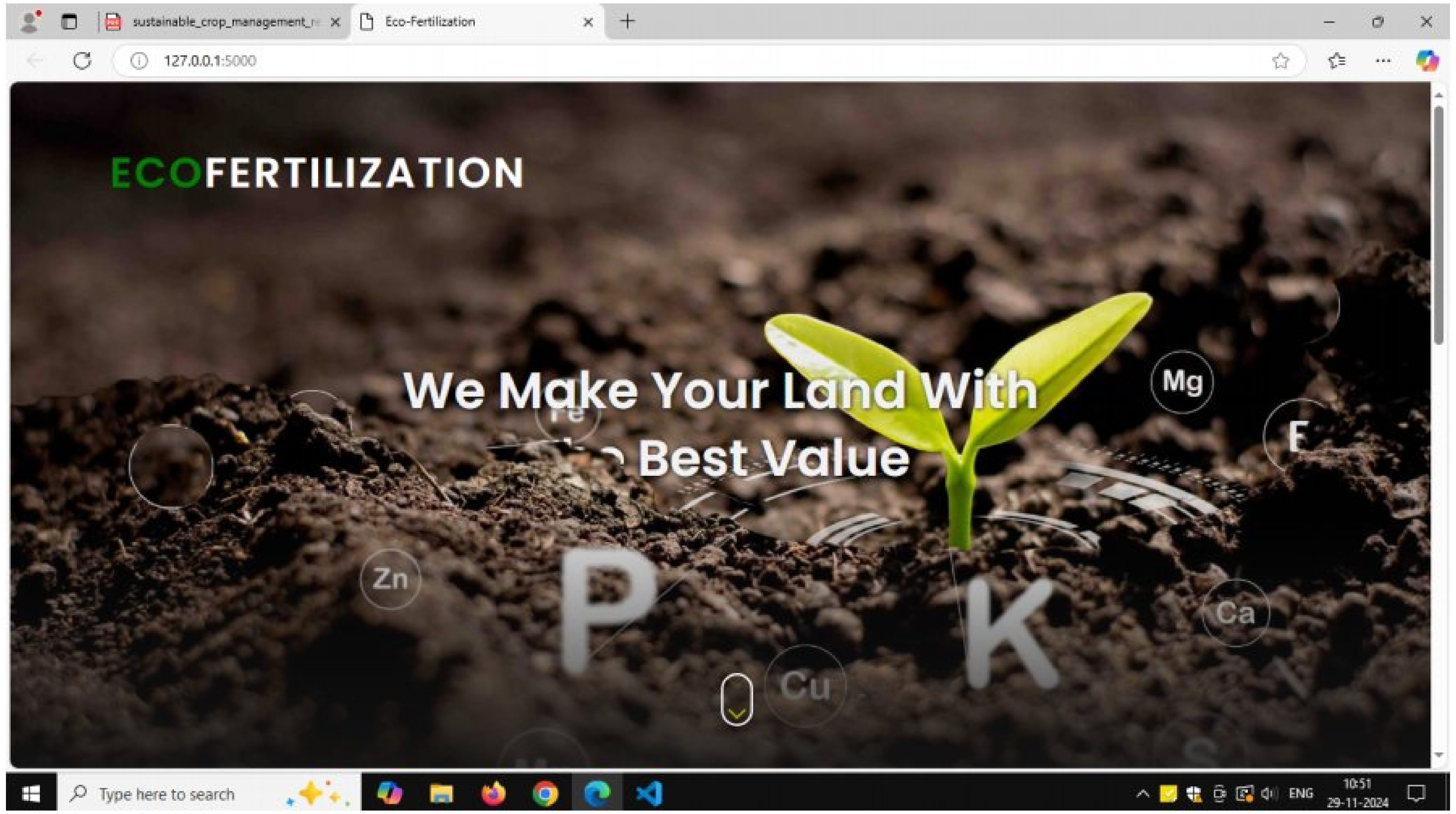
- Random Forest Regression achieved 92% accuracy in nutrient predictions.
- Crop Recommendation model: The Decision Tree based recommendation system achieved 91% accuracy .
- Disease Detection Model: The CNN-based model achieved an 87% accuracy in plant disease classification.
- The real-time weather data improved the model's accuracy by 12% as demonstrated in a line graph prediction before and after API integration.
- Improved Resource Utilization: Reduces fertilizer wastage and promotes sustainability.

Result



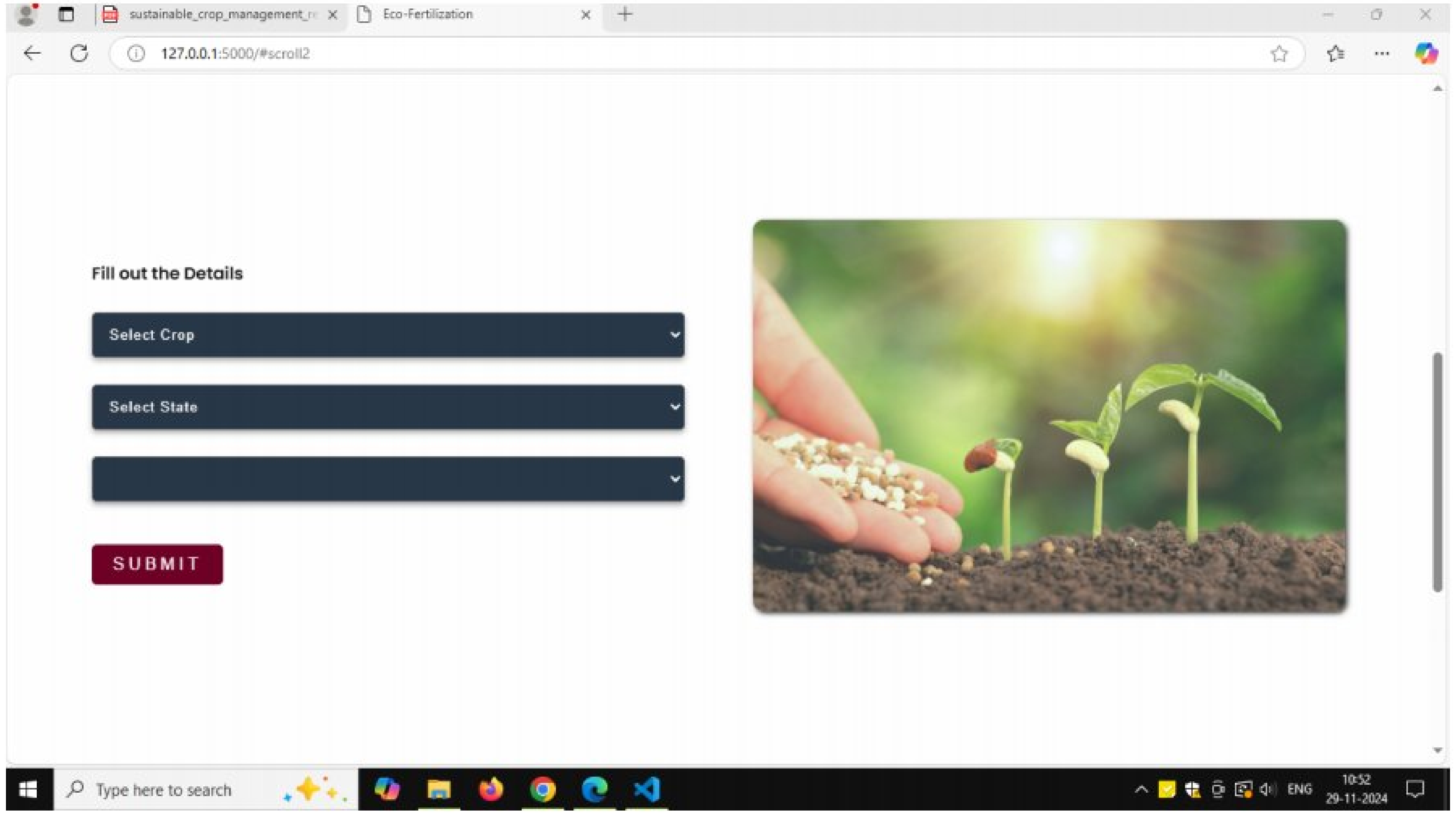
Home Page

Result



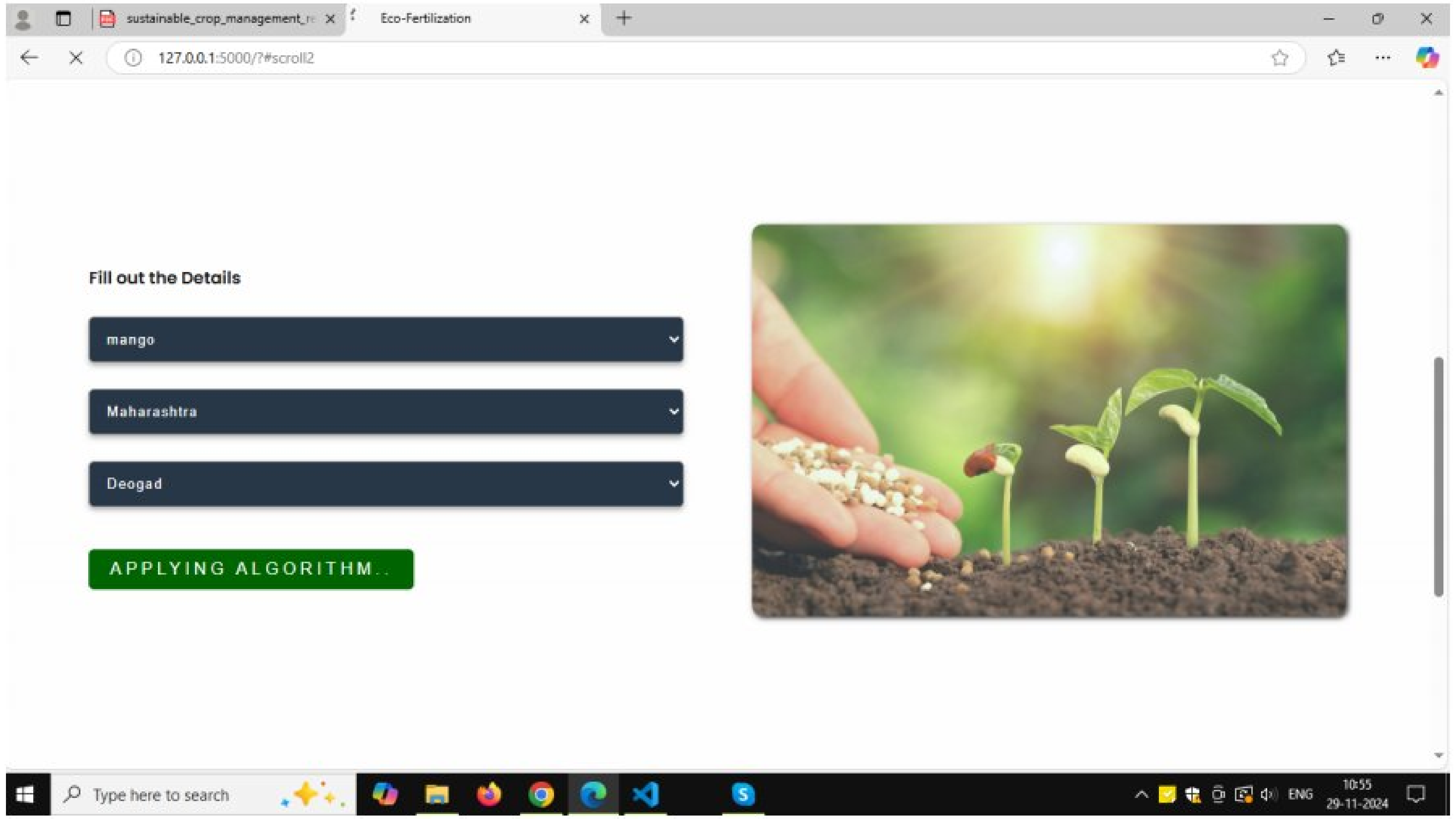
Home Page

Result



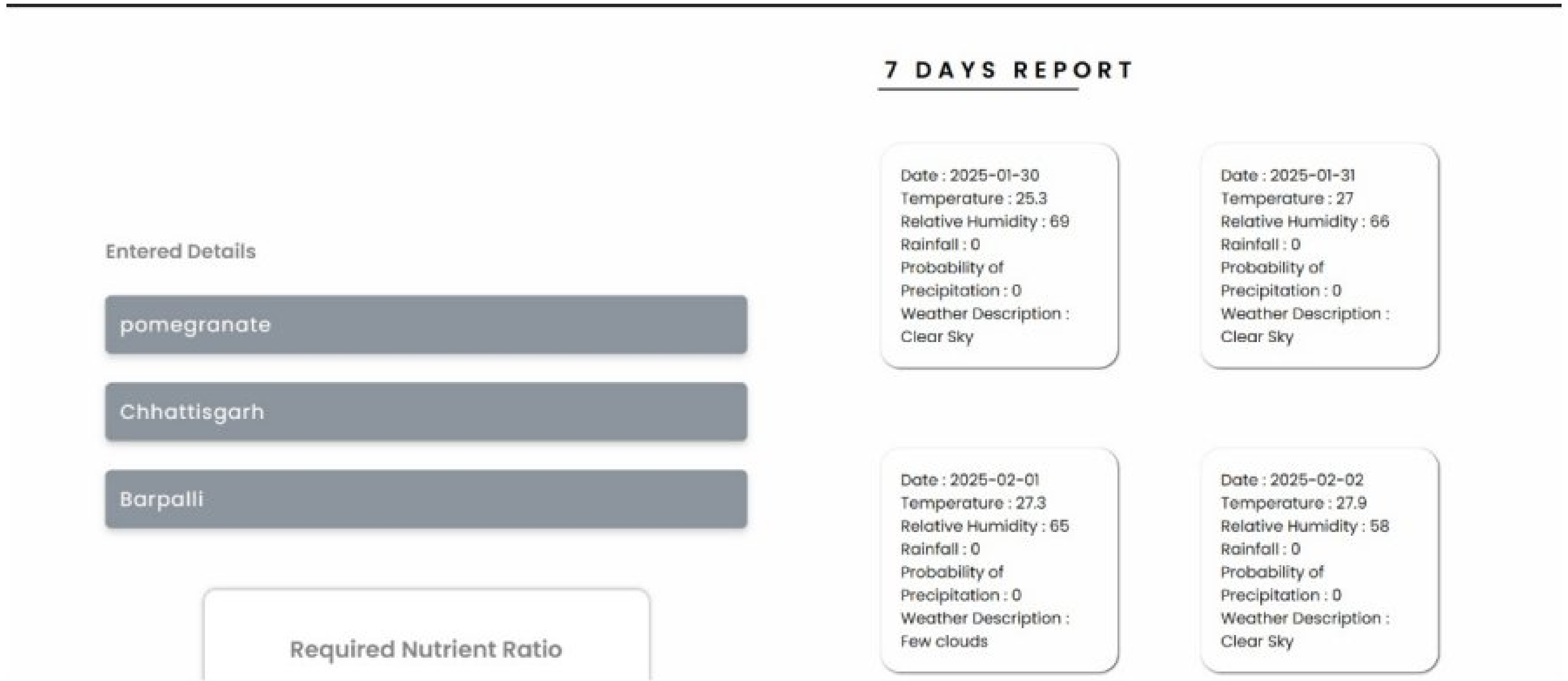
Input Page 1

Result



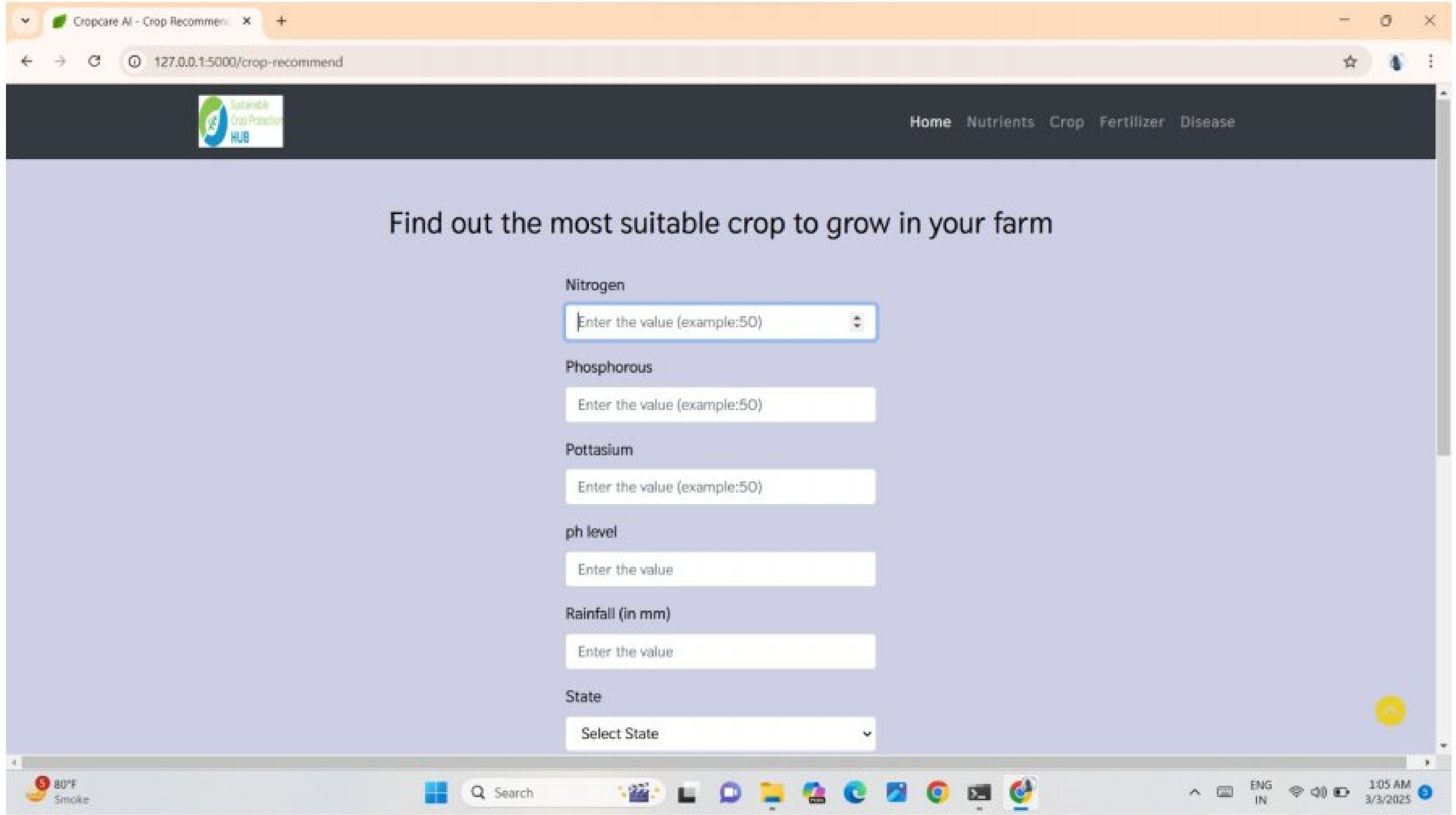
Input Page 2

Result



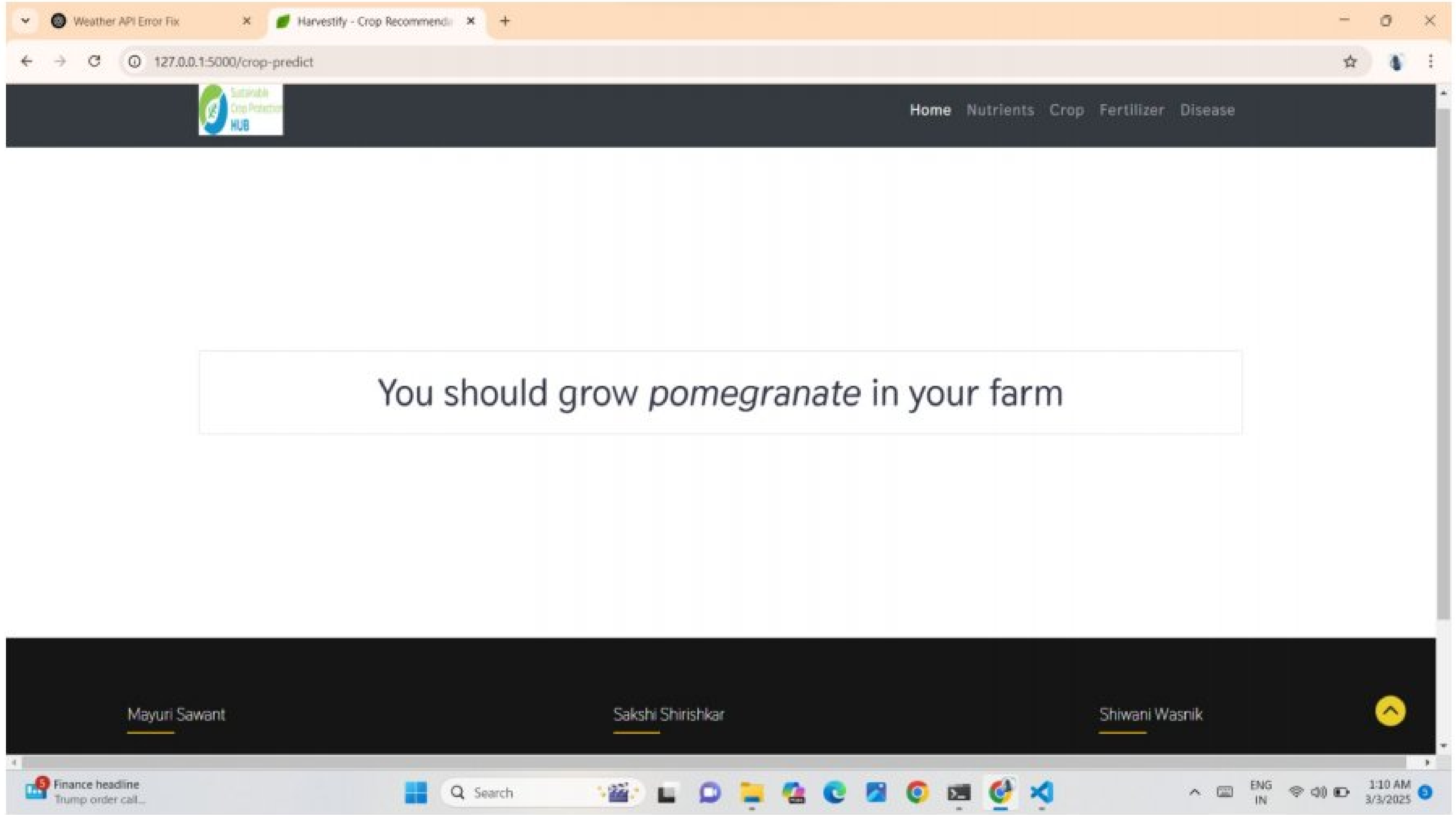
Output Page

Result



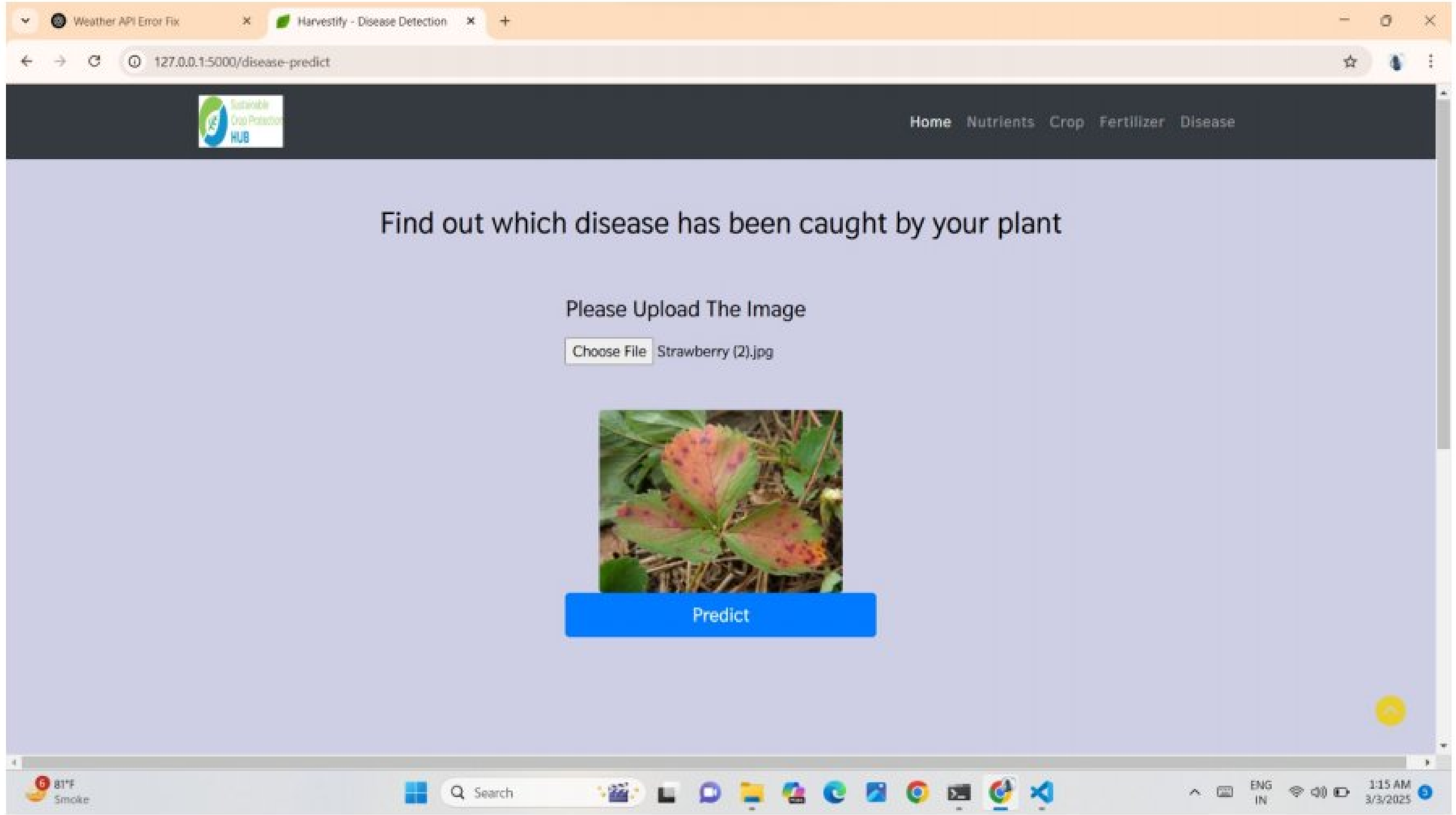
Input Page

Result



Output Page

Result



Disease Detection Page

Feasibility Study

- Technical Feasibility: "Flask, Python, and Scikit-learn libraries provide robustness."
- Random Forest Regression: Nutrient optimization.
- Economic Feasibility: "Use of open-source tools minimizes costs."
- Convolutional Neural Network (CNN): Disease detection through image-based analysis.
- Weather API Integration: Real-time weather impact assessment.
- Environmental Feasibility: "Precision recommendations reduce over-fertilization and soil degradation, and pollution."

Conclusion and Future Scope

- "The NPK prediction and plant disease detection system offers an innovative solution to modern agricultural challenges,combining machine learning,weather data integration, and disease detection for optimized crop health and productivity."
- Future Scope:
  - "Integrate native language support and speech recognition for accessibility."
  - "Expand the system for more crops and regions."
  - "Integration with IoT sensors for real-time soil health monitoring."

Thank You!