Agricultural Crop Recommendation System using Machine Learning: Recommending based on the Environmental Aspects of a Specific land

A PROJECT REPORT

submitted by

THRILOKE N **2116210701291**

VAISHNAV KUMAR G **2116210701311**

NANDHA KRISHNA R **2116210701518**

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BONAFIDE CERTIFICATE

Certified that this Project report titled **"AGRICULTURAL CROP RECOMMENDATION SYSTEM USING MACHINE LEARNING: RECOMMENDING BASED ON THE ENVIRONMENTAL ASPECTS OF A SPECIFIC LAND"** is the bonafide work of **"THRILOKE N -2116210701291, VAISHNAV KUMAR G -2116210701297,NANDHA KRISHNA R – 2116210701312"** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE

Dr.P.SHANMUGAM,**M.Tech.,Ph.D**,

PROJECT COORDINATOR

Associate Professor

Department of Computer Science and Engineering

Rajalakshmi Engineering College

Chennai - 602 105

Submitted to Project Viva-Voce Examination held on _____

Internal Examiner **External Examiner**

ABSTRACT

Agriculture is an important field worldwide, where there are many challenges in solving problems in conditionally estimating crops. Many solutions have been proposed regarding this problem using IOT-based services and mechanical technology to reduce manual work. These methods are mainly useful in the case of minimizing manual labor but not in the prediction process. It is necessary to be able to predict the optimal crop to plant based on the soil condition to minimize losses, harm and maximize profits. We build machine learning models to recommend optimal crops to growers based on many parameters and help them make informed decisions before farming. Dataset prepared with values of nitrogen, phosphorus, potassium and soil pH, temperature and rainfall required for a particular crop. In this system, we will provide records approximately the specific traits of the soil and the temperature, humidity, autumn conditions of the region, primarily based totally on which we can make appropriate crop prediction.

ACKNOWLEDGMENT

We thank the almighty god for the successful completion of the project. Our sincere thanks to our chairman **Mr. S. MEGANATHAN,B.E., F.I.E.,** for his sincere endeavor in educating us in his premier institution. We would like to express our deep gratitude and sincere thanks to our beloved Chairperson **Dr.(Mrs).THANGAM MEGANATHAN,Ph.D.,**for her enthusiastic motivation which inspired us a lot in completing this project and we extend our gratitude to our Vice Chairman **Mr.ABHAY SHANKAR MEGANATHAN,B.E., M.S.,** for providing us with the requisite infrastructure.

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THRILOKE N

VAISHNAV KUMAR G

NANDHA KRISHAN R

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CHAPTER 1

INTRODUCTION

Agriculture is the basic source of food supply of all the countries of the world—whether underdeveloped, developing or even developed. The world population is estimated to be about 9.7 billion by 2025. This added with unpredictable weather conditions makes it difficult to ensure food sustainability. Fortunately there is a solution for this problem as for many others. Crop Recommendation System takes the N-P-K (Nitrogen, Phosphorous and Potassium) and pH values along with the temperature, humidity values as input and recommends the optimal crop to the farmer, hence ensuring that the farmer takes an informed decision before cultivation. In this system , we train the model using Random Forest , Decision Tree and KNN neighbor . We compare the accuracy of this models and choose the best out of it and store that specific model using pickle module and deploy the machine learning model using Flask. A user can input the various parameters like Nitrogen , Phosphorous , potassium , PH value , Rainfall and Location by interacting with user interface to predict the appropriate crop.

1.1 PROBLEM STATEMENT

We aim to create a system that can accurately tell the farmer the suitable crop to be grown based on the input features of the soil and the temperature conditions of the region. In this system, the models will be trained on a textual data set which will be engineered carefully after performing the feature engineering. The user can interact with the model through a website which takes the necessary inputs and loads the trained model. Based on the input data, the model makes a prediction on the optimum crop to be cultivated. The result is then displayed to the user. Instead of directly taking the temperature and humidity values from the user, the website asks the user for their location. By using a weather API, the system automatically retrieves the temperature and humidity values for specific region.

1.2 SCOPE OF THE WORK

In the proposed model, scope of the work includes addresses food security challenges by developing a Crop Recommendation System for farmers. The system addresses the increasing global population and unpredictable weather patterns that threaten food sustainability. It analyzes soil conditions (N-P-K, pH) alongside temperature, humidity, and rainfall data to recommend optimal crops for specific locations. Machine learning models are trained and evaluated to choose the most accurate model. The chosen model is then deployed using Flask to create a user-friendly interface. Farmers can input their land's data points to receive crop recommendations, promoting informed decision-making and potentially improving agricultural output.

1.3 AIM AND OBJECTIVES OF THE PROJECT

The aim of the proposed of this Crop Recommendation System aims to empower farmers with data-driven crop selection, enhancing food security for a growing global population (9.7 billion by 2025) facing unpredictable weather patterns. To achieve this, the system will leverage powerful computing resources like GPUs for efficient machine learning. Core development relies on Python for machine learning models, potentially including like using Random Forest , Decision Tree and KNN neighbor . By effectively utilizing these resources, this system aims to improve agricultural decision-making and potentially lead to a more sustainable food supply.

The main objectives of our proposed system are Designing and implementing system addresses this challenge by aiming to provide farmers with the optimal crop selection for their specific land. To achieve this, the system will analyze various factors that influence crop yield, including soil nutrients (N-P-K, pH), temperature, humidity, and rainfall data. Machine learning algorithms like Random Forest, Decision Tree, and K-Nearest Neighbors will be trained on historical data to identify patterns and relationships between these factors and successful crop choices. The project will then objectively evaluate the accuracy of each model and select the one that delivers the most accurate crop recommendations. Finally, the chosen model will be deployed using Flask to create a user-friendly interface.

1.4 RESOURCES

The resources required for the proposed system includes high-performance computing infrastructure capable of running Machine Learning algorithms efficiently, including KNN's, Random Forest and Decision Tree. We compare the accuracy of this models and choose the best out of it and store that specific model using pickle module and deploy the machine learning model using Flask. A user can input the various parameters like Nitrogen , Phosphorous , potassium , PH value , Rainfall and Location by interacting with user interface to predict the appropriate crop.

1.5 MOTIVATION

The Crop Recommendation System using Machine Learning project is motivated by The world's growing population and unpredictable weather threaten our ability to produce enough food. Traditionally, farmers have relied on experience to choose crops. However, machine learning offers a powerful solution. By considering factors like soil nutrients, weather data, and location, machine learning models can recommend the optimal crop for a specific field. This allows farmers to make data-driven decisions that can improve yields and ensure food security.

CHAPTER 2

2.1 LITERATURE SURVEY

[1] **"An Acquisition Based Optimised Crop Recommendation System with Machine Learning Algorithm"** by **Choudhury, S. S., Pandharbale, P. B., Mohanty, S. N., & Jagadev, A. K.,2024,** The agricultural sector makes a significant economic impact in India. It contributes 19.9% to the national GDP. The prosperity of the country's economy greatly affects the country's progress and the quality of life for Indian citizens. The vast majority of farms still use antiquated methods rather than adopting a data-driven strategy to increase output and earnings. It is considered a cornerstone of India's financial structure. Since achieving independence, increasing output through the implementation of cutting-edge technologies has been a top priority.

[2] **“Intelligent Crop Recommender System for Yield Prediction Using Machine Learning Strategy.,2024”** by **Maheswary, A., Nagendram, S., Kiran, K. U., Ahammad, S. H., Priya, P. P., Hossain, M. A., & Rashed, A. N. Z.,** For most developed nations, agriculture is a significant economic force. The realm of contemporary agriculture is consistently growing with evolving farming techniques and agricultural innovations. Farmers face challenges in keeping pace with the evolving demands of the planet and meeting the requirements of profitable initiatives, characters, and various other stakeholders.

[3] “**Red fox optimization with ensemble recurrent neural network for crop recommendation and yield prediction model.,"** by **Gopi, P. S. S., and M. Karthikeyan,2024;** Precision agriculture concentrates on monitoring (sensing technologies), management information system, variable rate technologies, and responses to inter- and intravariability in cropping systems. The advantages of precision agriculture involve improving crop productivity and crop quality with minimum environmental impact. Crop yield prediction (CYP) is one of the challenging tasks in agriculture, which mainly depends upon soil, meteorological, environmental, and crop-related variables.

[4] **“Ensemble machine learning-based recommendation system for effective prediction of suitable agricultural crop cultivation.,2023”,**by **Hasan, M., Marjan, M. A., Uddin, M. P., Afjal, M. I., Kardy, S., Ma, S., & Nam, Y**. the authors Agriculture is the most critical sector for food supply on the earth, and it is also responsible for supplying raw materials for other industrial productions. Currently, the growth in agricultural production is not sufficient to keep up with the growing population, which may result in a food shortfall for the world’s inhabitants. As a result, increasing food production is crucial for developing nations with limited land and resources. It is essential to select a suitable crop for a specific region to increase its production rate. Effective crop production forecasting in that area based on historical data, including environmental and cultivation areas, and crop production amount, is required.

[5] **"Data-Driven Analysis and Machine Learning-Based Crop and Fertilizer Recommendation System for Revolutionizing Farming Practices,2023"** by **Musanase, C., Vodacek, A., Hanyurwimfura, D., Uwitonze, A., & Kabandana,** Agriculture plays a key role in global food security. Agriculture is critical to global food security and economic development. Precision farming using machine learning (ML) and the Internet of Things (IoT) is a promising approach to increasing crop productivity and optimizing resource use. This paper presents an integrated crop and fertilizer recommendation system aimed at optimizing agricultural practices in Rwanda. The system is built on two predictive models: a machine learning model for crop recommendations and a rule-based fertilization recommendation model.

[6] **"IoT-enabled soil nutrient analysis and crop recommendation model for precision agriculture,2023**," by **Senapaty, M. K., Ray, A., & Padhy, N**. Healthy and sufficient crop and food production are very much essential for everyone as the population is increasing globally. The production of crops affects the economy of a country to a great extent. In agriculture, observing the soil, weather, and water availability and, based on these factors, selecting an appropriate crop, finding the availability of seeds, analysing crop demand in the market, and having knowledge of crop cultivation are important. At present, many advancements have been made in recent times, starting from crop selection to crop cutting. Mainly, the roles of the Internet of Things, cloud computing, and machine learning tools help a Farmers.

[7] "Contrastive learning for sequential recommendation,2022," by Xie, X., Sun, F., Liu, Z., Wu, S., Gao, J., Zhang, J., ... & Cui, B. Sequential recommendation methods play a crucial role in modern recommender systems because of their ability to capture a user's dynamic interest from her/his historical inter-actions. Despite their success, we argue that these approaches usually rely on the sequential prediction task to optimize the huge amounts of parameters. They usually suffer from the data sparsity problem, which makes it difficult for them to learn high-quality user representations**.**

[8] "**IoT framework for measurement and precision agriculture: predicting the crop using machine learning algorithms,2022" by Bakthavatchalam, K., Karthik, B., Thiruvengadam, V., Muthal, S., Jose, D., Kotecha, K., & Varadarajan, V.** IoT architectures facilitate us to generate data for large and remote agriculture areas and the same can be utilized for Crop predictions using this machine learning algorithm. Recommendations are based on the following N, P, K, pH, Temperature, Humidity, and Rainfall these attributes decide the crop to be recommended. The data set has 2200 instances and 8 attributes. Nearly 22 different crops are recommended for a different combination of 8 attributes. At present, many advancements have been made in recent times, starting from crop selection to crop cutting.

[9] " **An intelligent system for crop identification and classification from UAV images using conjugated dense convolutional neural network, 2022" Pandey, A., & Jain, K.** Crop identification and classification is an important aspect for modern agricultural sector. With development of unmanned aerial vehicle (UAV) systems, crop identification from RGB images is experiencing a paradigm shift from conventional image processing techniques to deep learning strategies because of successful breakthrough in convolutional neural networks (CNNs). UAV images are quite trustworthy to identify different crops due to its higher spatial resolution. For precision agriculture crop identification is the primal criteria.

[10] "**Iris Features Extraction and Recognition Based on the Scale Invariant Feature Transform (SIFT),2022" M.A. Taha, H.M. Ahmed, and S.O. Husain** undertake a detailed exploration of utilizing the Scale Invariant Feature Transform (SIFT) algorithm for iris feature extraction and recognition.Initially, it may delve into existing methodologies and technologies utilized for iris recognition, ranging from traditional techniques like template matching to more recent advancements in computer vision and machine learning.By situating ELM within the broader landscape of machine learning techniques, the review underscores its potential for efficient and scalable solutions in complex real-world problems.

[11] "**Artificial neural networks based integrated crop recommendation system using soil and climatic parameters,2021**" by **Madhuri, J., & Indiramma, M** the To develop crop recommendation system depending on locationspecific soil and climatic conditions. Method: The study introduces a novelrecommendation system which uses Artificial Neural Networks (ANN) forrecommending the suitable crop. The crops are recommended based on (a) Soilproperties (b) Crop characteristics (c) Climate parameters. The crops namelymaize, Finger millet, Rice and sugarcane is considered for the study. Dependingon degree of relationship and limitations of the factors considered, followingsuitability classes are established: (a) Highly suitable: S1 (b) Moderately suitable:S2 (c) Marginally suitable: S3 (d) not suitable.

[12] **"Impact of machine learning techniques in precision agriculture. In 2020 3rd International Conference on Emerging Technologies in Computer Engineering, 2020"** by **Katarya, R., Raturi, A., Mehndiratta, A., & Thapper, A.,** Agriculture and its accessories contribute to approximately 17% of India's GDP and it is still the most popular occupation amongst 70% of India's population. The agriculture sector provides different outputs used by diverse segments which include, but not limited to, use as raw materials by different industries, sources of nutrition and businesses, etc. However, the different methods used for growing crops are still mostly traditional and even borderline outdated.

[13] "A fuzzy logic-based crop recommendation system. In Proceedings of International Conference on Frontiers in Computing and Systems" by Banerjee, G., Sarkar, U., & Ghosh, I. in 2021, Soil, geographical and meteorological parameters have major impacts on sustained crop production. Most of the rural farmers have no adequate knowledge about the effects of these parameters on crop production. The rural farmers generally rely on their traditional knowledge to select a crop which often leads to huge economic loss. A scientific system considering these site-specific parameters along with the traditional knowledge of the farmers may be an effective solution. This paper suggests a fuzzy logic-based crop recommendation system to assist rural farmers.

[14] "**A state-of-the-art survey on recommendation system and prospective extensions. Computers and Electronics in Agriculture " by Maibam Maikel Singh and Thounaojam Rupachandra Singh,in June 2020**, With the new era of the Internet, we have a large amount of data available in the form of ratings, reviews, graphs, images, etc. However, still, people face difficulty in finding useful information or knowledge from those data. To address these challenges, recommendation systems come into the picture by providing useful content to the user based on users' history and similarity among users.

2.2 PROPOSED SYSTEM

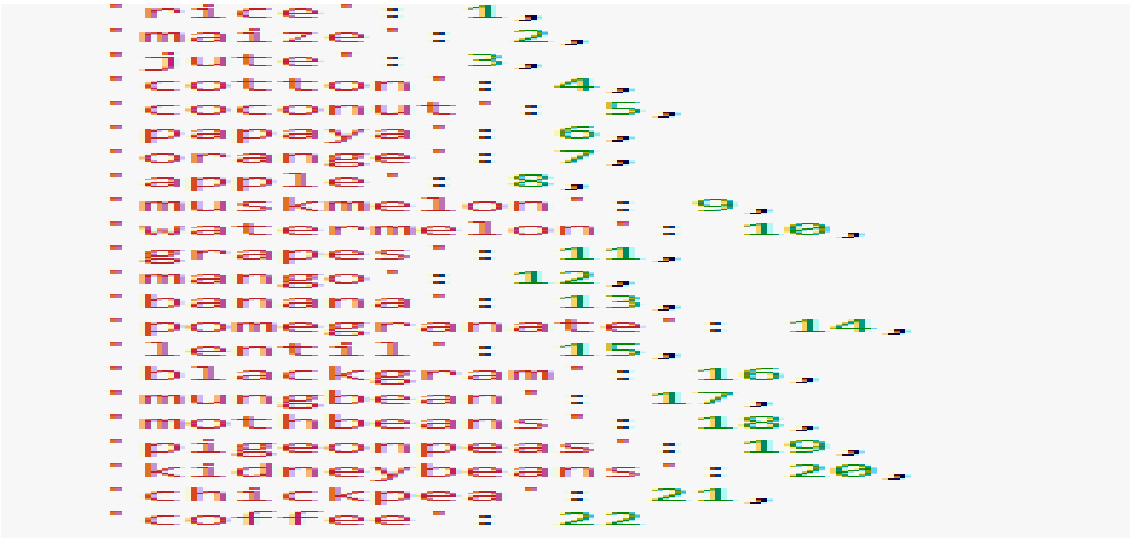
In this project, we have proposed a model that addresses the existing issues. The novelty of the proposed system is to guide the farmers to maximize the crop yield as well as suggest the most profitable crop for the specific region.

Our system tackles crop selection for farmers. It analyzes environmental factors to recommend high-yielding, profitable crops. Unlike existing solutions, ours goes beyond yield to consider profit potential. By predicting yield based on user-provided data like nitrogen, phosphorus, potassium, temperature, humidity, PH value and rainfall in mm system empowers farmers to maximize production and income, ensuring food security.

DATASET:

The main data used in the data set are initialized with the number to use in the algorithm it is like initializing all the details. In this metadata, we are going to initialize all the crop names with the numbers. This data makes us use the data easily in the algorithm. Hear the metadata of all the crops is given with a particular number. This number is not duplicated that is one number is given to one crop; the same number is not given to the other crop. This metadata consists of more than a hundred crops that grown all over India. The described version of dataset is where it contains attributes like N - ratio of Nitrogen content in soil, P - ratio of Phosphorous content in soil, P - ratio of Potassium content in soil, temperature - temperature in degree Celsius,

humidity - relative humidity in %, ph - ph value of the soil, rainfall - rainfall in mm. Based on this the crops 22 unique crops which is cultivated in India, are recommended, the crops are shown below figure.



TRAINING AND TESTING:

In order to solve the classification problem, we must split the data into training and testing datasets. The training data set is the data on which our models will be trained on, and the testing set is the data in which we evaluate the performance of our model using various metrics. We use the sklearn module,. This will be useful in order to evaluate our model later on. import classification report, confusion matrix In the above step split the data is split such that 20% of the dataset is testing data and the remaining 80% of the data is training data. As the split is done in a random order, we set the random state to 2.

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CHAPTER 3

SYSTEM DESIGN

3.1 GENERAL

In this section, we would like to show how the general outline of how all the components end up working when organized and arranged together. It is further represented in the form of a flow chart below.

3.2 SYSTEM ARCHITECTURE DIAGRAM

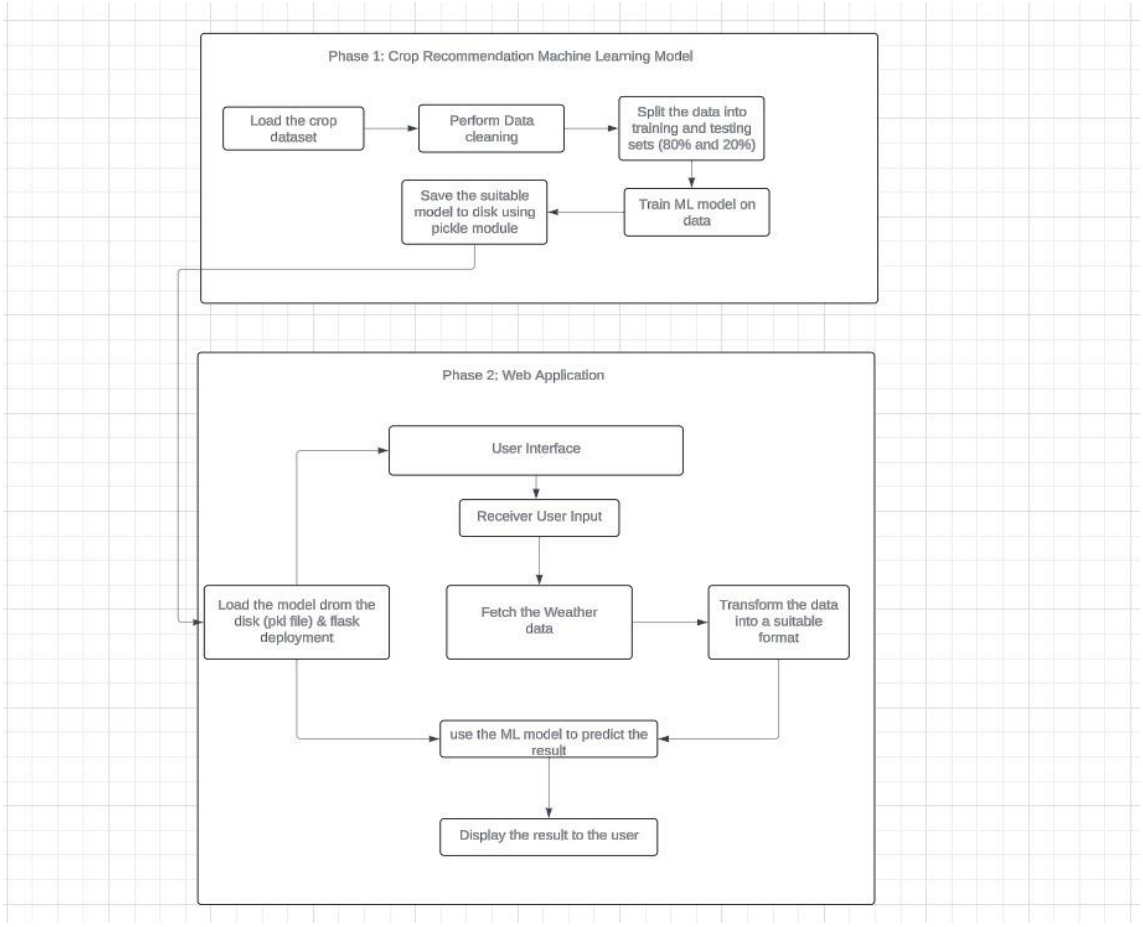

Fig 3.2.1: System Architecture

3.3 DEVELOPMENTAL ENVIRONMENT

3.3.1 HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the system's implementation. It should therefore be a complete and consistent specification of the entire system. It is generally used by software engineers as the starting point for the system design.

Table 3.3.1 Hardware Requirements

COMPONENTS	SPECIFICATION
PROCESSOR	Intel Core i5
RAM	8 GB RAM
GPU	NVIDIA GeForce GTX 1650
MONITOR	15" COLOR
HARD DISK	512 GB
PROCESSOR SPEED	MINIMUM 1.1 GHz

3.3.2 SOFTWARE REQUIREMENTS

The software requirements document is the specifications of the system. It should include both a definition and a specification of requirements. It is a set of what the system should rather be doing than focus on how it should be done. The software requirements provide a basis for creating the software requirements specification.The software requirements are description of features and functionalities of the target system. Requirements convey the expectations of users from the software product.

Table 3.3.2 Software Requirements

S.NO	REQUIREMENT
1	Jupyter Notebook
2	PyCharm
3	Flask
4	Chrome browser
5	Python

3.4 DESIGN OF THE ENTIRE SYSTEM:

3.4.1 SEQUENCE DIAGRAM:

A sequence diagram simply depicts the interaction between the objects in a sequential order. An sequence diagram is used to show the interactive behavior of a system. The sequence diagram for Agricultural Crop Recommendation System is attached in the below figure 3.4.1.

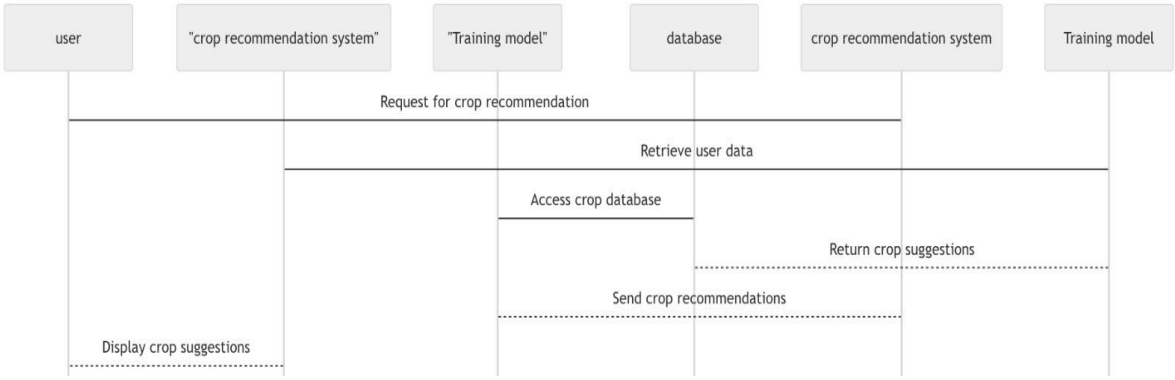

Fig 3.4.1: Sequence Diagram

CHAPTER 4

PROJECT DESCRIPTION

4.1 METHODOLODGY

There are numerous critical elements in the methodology for recommending crop based on the environmental aspects of the specific area, this added with unpredictable weather conditions makes it difficult to ensure food sustainability. Fortunately there is a solution for this problem as for many others. Crop Recommendation System takes the N-P-K (Nitrogen, Phosphorous and Potassium) and pH values along with the temperature, humidity values as input and recommends the optimal crop to the farmer, hence ensuring that the farmer takes an informed decision before cultivation. In this system , we train the model using Random Forest , Decision Tree and KNN neighbor . We compare the accuracy of this models and choose the best out of it and store that specific model using pickle module and deploy the machine learning model using Flask. A user can input the various parameters like Nitrogen , Phosphorous , potassium , PH value , Rainfall and Location by interacting with user interface to predict the appropriate crop.

4.2 MODULE DESCRIPTION

The Crop Recommendation System using Machine Learning is divided into three major sections. First, the Data Collection and Preprocessing Module collects a broad dataset of takes the N-P-K (Nitrogen, Phosphorous and Potassium) and pH values along with the temperature, humidity values as input and recommends the optimal crop to the farmer, hence ensuring that the farmer takes an informed decision before cultivation.

The Machine learning Model training , we train the model using Random Forest , Decision Tree and KNN neighbor . We compare the accuracy of this models and choose the best out of it and store that specific model using pickle module and deploy the machine learning model using Flask. A user can input the various parameters like Nitrogen , Phosphorous , potassium , PH value , Rainfall and Location by interacting with user interface to predict the appropriate crop.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 OUTPUT

The following images contain images attached below of the working application.

Crop Recommendation System Webpage

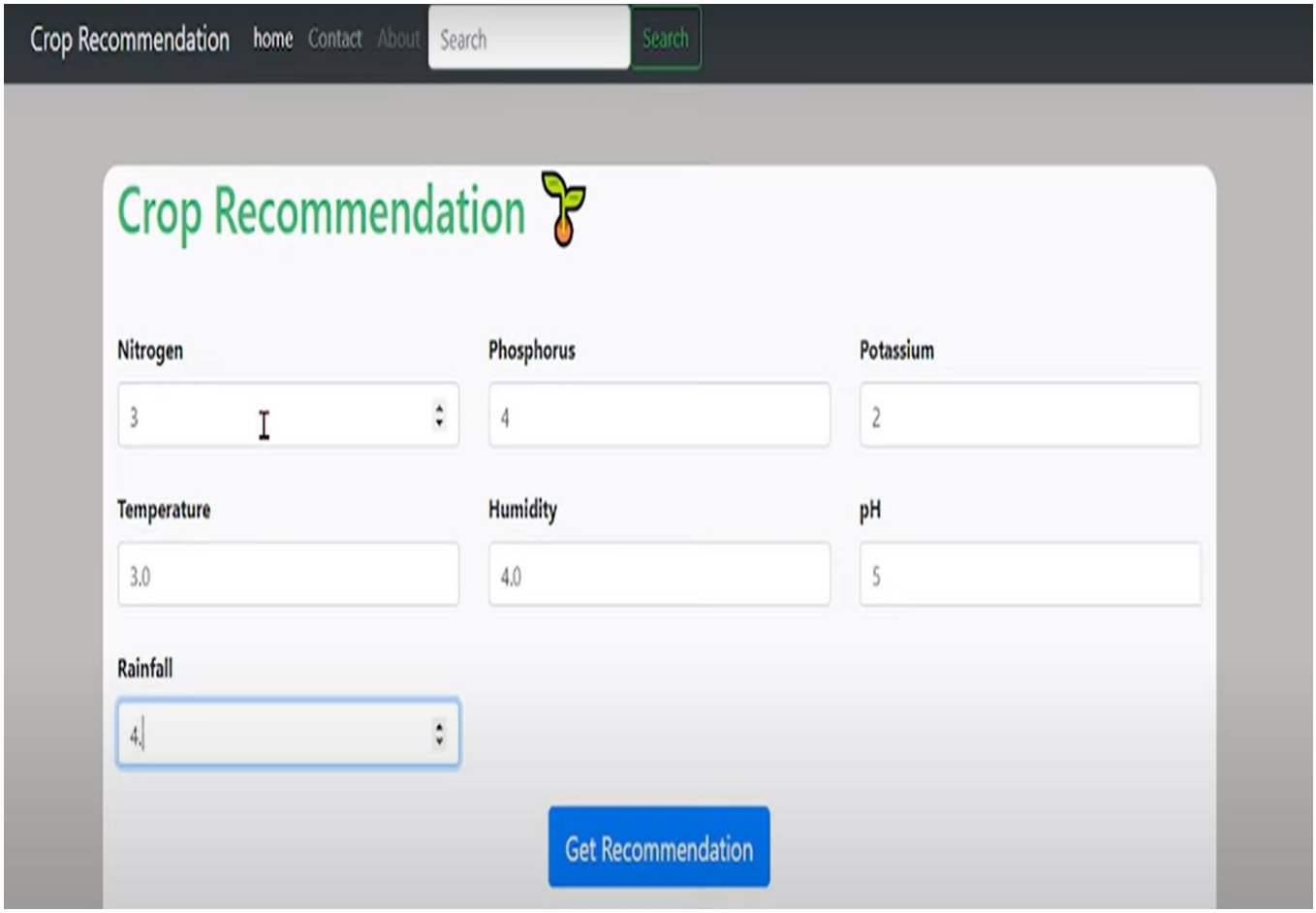

Fig 5.1.1: Crop Recommendation website

Output for the user input:

Where the crop is recommended for the user input data by training the model and the output is predicted.

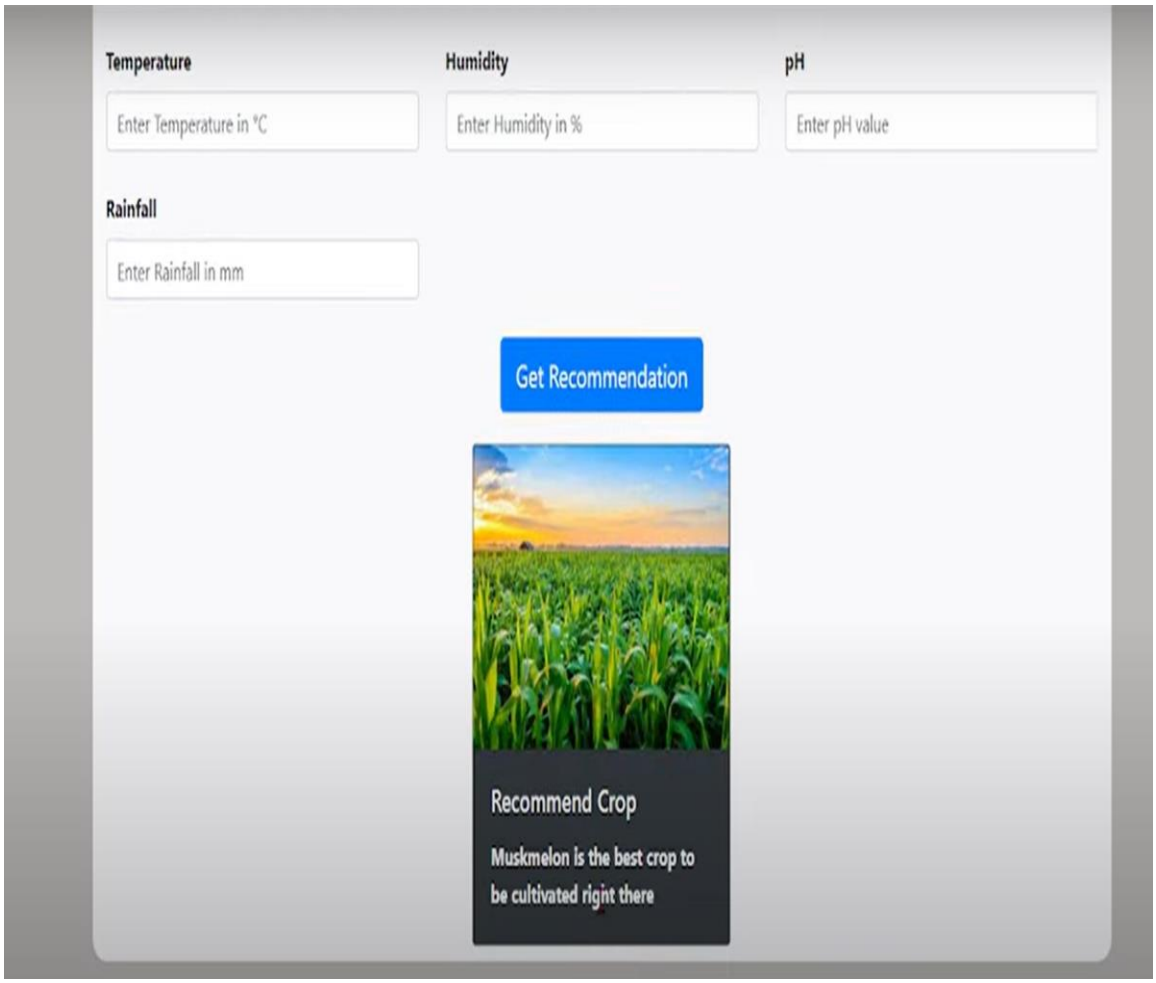

Fig 5.1.2: Output of predicted plant

Confusion Matrix :

The proposed model is evaluated and the confusion matrix for the trained model is attached in below Figure 5.1.3

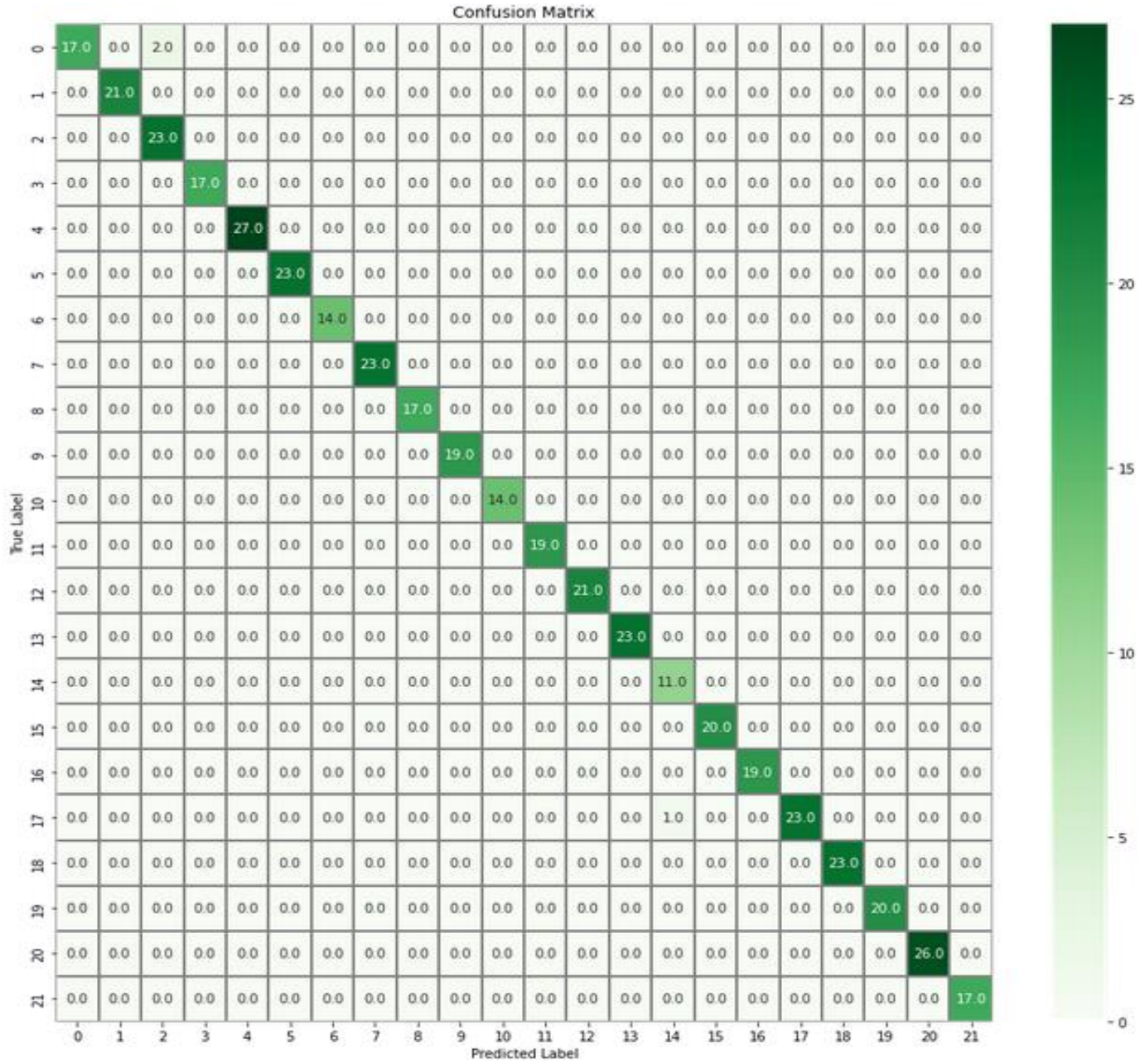

Fig 5.1.3: Confusion matrix

Training and testing Accuracy graph:

The proposed model is evaluated and the testing and training accuracy graph is obtained. The training and testing accuracy of the model is attached in the format of line graph with epochs in x-axis and accuracy in the y-axis, where one blue line indicates Testing accuracy, Green line indicates Training below figure 5.1.4

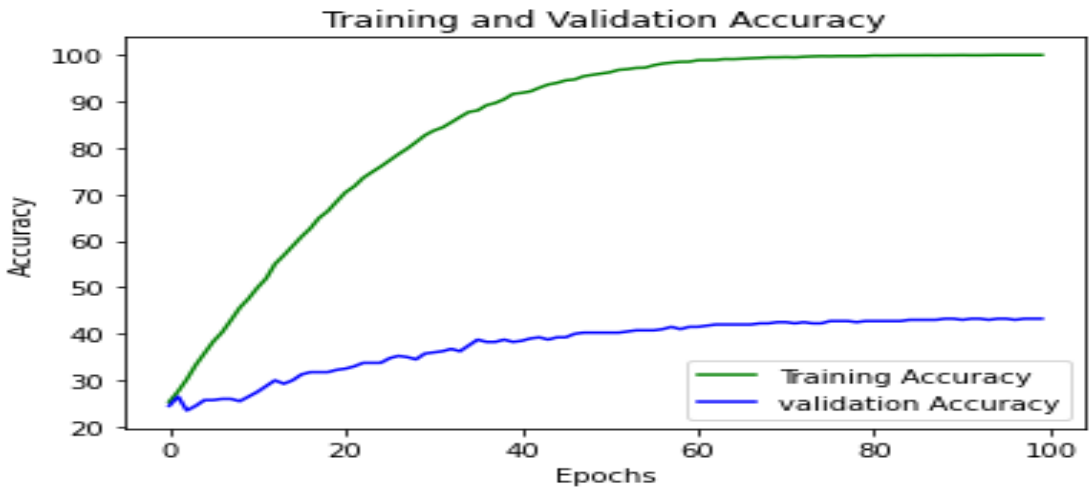

Fig 5.1.4: Training and Testing Accuracy Graph

5.2 RESULT

The crop recommendation system website was made using HTML, CSS and JavaScript in the frontend and Flask framework in the backend. The website front end was made using the Materialize CSS framework. We have used HTML forms to capture the input data from the user. The ‘Recommend Crop’ button is a submit button that uses the HTTP POST method which sends the data to the python Flask. It takes humidity and temperature values from the user as input, then the model predicts the crop for production then, the model recommends the crop for farming to get the maximum yield , which alternatively gets maximum profit.

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

The Crop Recommendation System is mainly used to recommend the optimal crop to the Farmer. With many industries going digital, it is important that the agricultural sector also take advantage of the various technologies by using them to solve problems faced by the farmers. Using the approach that we discussed, farmers can expect greater yields. This system can be integrated with other smart agricultural systems that already exist. It is cost efficient and helps the farmers make an informed decision.

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6.2 FUTURE ENHANCEMENT

Enhancing the system with the market-demand products: Connect the recommendation system to database where the market-demand products and seasonal fruits to get the max profit from the yield of the recommended crop for the production, my future work is aimed at an improved data set with large number of attributes and also implements yield prediction.

Enhanced User Experience: Develop a mobile app for easy field access and data collection, Integrate a crop management system to provide guidance on planting, irrigation, and pest control based on the chosen crop, create a farmer community forum for knowledge sharing and peer-to-peer support.

APPENDIX

app.py:

```
from flask import Flask,request,render_template
import numpy as np
import pandas
import sklearn
import pickle

# importing model
model = pickle.load(open('model.pkl','rb'))
sc = pickle.load(open('standscaler.pkl','rb'))
ms = pickle.load(open('minmaxscaler.pkl','rb'))

# creating flask app
app = Flask(__name__)

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

@app.route("/predict",methods=['POST'])
def predict():
    N = request.form['Nitrogen']
    P = request.form['Phosporus']
    K = request.form['Potassium']
    temp = request.form['Temperature']
    humidity = request.form['Humidity']
    ph = request.form['Ph']
    rainfall = request.form['Rainfall']

    feature_list = [N, P, K, temp, humidity, ph, rainfall]
    single_pred = np.array(feature_list).reshape(1, -1)

    scaled_features = ms.transform(single_pred)
    final_features = sc.transform(scaled_features)
    prediction = model.predict(final_features)

    crop_dict = {1: "Rice", 2: "Maize", 3: "Jute", 4: "Cotton", 5: "Coconut", 6: "Papaya", 7:
"Orange",
                 8: "Apple", 9: "Muskmelon", 10: "Watermelon", 11: "Grapes", 12: "Mango", 13:
"Banana",
                 14: "Pomegranate", 15: "Lentil", 16: "Blackgram", 17: "Mungbean", 18:
```

```
"Mothbeans",
            19: "Pigeonpeas", 20: "Kidneybeans", 21: "Chickpea", 22: "Coffee"}

    if prediction[0] in crop_dict:
        crop = crop_dict[prediction[0]]
        result = "{} is the best crop to be cultivated right there".format(crop)
    else:
        result = "Sorry, we could not determine the best crop to be cultivated with the provided
data."
    return render_template('index.html',result = result)




# python main
if __name__ == "__main__":
    app.run(debug=True)
```

index.html:

```
<!doctype html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <title>Bootstrap demo</title>
    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0-alpha3/dist/css/bootstrap.min.css" rel="stylesheet"
integrity="sha384-KK94CHFLLe+nY2dmCWGMq91rCGa5gtU4mk92HdvYe+M/SXH301p5ILy+dN9+nJOZ"
crossorigin="anonymous">
  </head>
  <style>
                h1 {
                        color: mediumseagreen;
                        text-align: center;
                }

                .warning {
                        color: red;
                        font-weight: bold;
                        text-align: center;
                }
                .card{
                margin-left:410px;
                margin-top: 20px;
                color: white;
                }
```

```
                .container{
                background:#edf2f7;
                font-weight: bold;
                padding-bottom:10px;
                border-radius: 15px;
                }
        </style>



  <body style="background:#BCBBB8">
  <!--======================navbar================================================--
>
<nav class="navbar navbar-expand-lg navbar-dark bg-dark">
  <div class="container-fluid">
    <a class="navbar-brand" href="/">Crop Recommendation</a>
    <button class="navbar-toggler" type="button" data-bs-toggle="collapse" data-bs-target="#navbarSupportedContent"
aria-controls="navbarSupportedContent" aria-expanded="false" aria-label="Toggle navigation">
      <span class="navbar-toggler-icon"></span>
    </button>
    <div class="collapse navbar-collapse" id="navbarSupportedContent">
      <ul class="navbar-nav me-auto mb-2 mb-lg-0">
        <li class="nav-item">
          <a class="nav-link active" aria-current="page" href="#">home</a>
        </li>
        <li class="nav-item">
          <a class="nav-link" href="#">Contact</a>
        </li>
        <li class="nav-item">
          <a class="nav-link disabled">About</a>
        </li>
      </ul>
      <form class="d-flex" role="search">
        <input class="form-control me-2" type="search" placeholder="Search" aria-label="Search">
        <button class="btn btn-outline-success" type="submit">Search</button>
      </form>
    </div>
  </div>
</nav>

<!--
=============================================================================================
====-->
  <div class="container my-3 mt-3">
      <h1 class="text-success">Crop Recommendation System <span class="text-success">🌱</span></h1>

<!--      adding form-->
      <form action="/predict" method="POST">
          <div class="row">
              <div class="col-md-4">
                                          <label for="Nitrogen">Nitrogen</label>
                                          <input type="number" id="Nitrogen" name="Nitrogen" placeholder="Enter
Nitrogen" class="form-control" required step="0">
```

```
                                </div>
            <div class="col-md-4">
                                        <label for="Phosporus">Phosphorus</label>
                                        <input type="number" id="Phosporus" name="Phosporus" placeholder="Enter
Phosphorus" class="form-control" required step="00">
                                </div>
                                <div class="col-md-4">
                                        <label for="Potassium">Potassium</label>
                                        <input type="number" id="Potassium" name="Potassium" placeholder="Enter
Potassium" class="form-control" required step="0">
                                </div>
        </div>

        <div class="row mt-4">
                                <div class="col-md-4">
                                        <label for="Temperature">Temperature</label>
                                        <input type="number" step="0.01" id="Temperature" name="Temperature"
placeholder="Enter Temperature in °C" class="form-control" required step="0">
                                </div>
                                <div class="col-md-4">
                                        <label for="Humidity">Humidity</label>
                                        <input type="number" step="0.01" id="Humidity" name="Humidity"
placeholder="Enter Humidity in %" class="form-control" required step="0">
                                </div>
                                <div class="col-md-4">
                                        <label for="pH">pH</label>
                                        <input type="number" step="0.01" id="Ph" name="Ph" placeholder="Enter pH
value" class="form-control" required step="0">
                                </div>
                        </div>

        <div class="row mt-4">
                                <div class="col-md-4">
                                        <label for="Rainfall">Rainfall</label>
                                        <input type="number" step="0.01" id="Rainfall" name="Rainfall"
placeholder="Enter Rainfall in mm" class="form-control" required>
                                </div>
                        </div>



         <div class="row mt-4">

        <div class="col-md-12 text-center">
                                <button type="submit" class="btn btn-primary btn-lg">Get Recommendation</button>
                        </div>
                        </div>
    </form>



     {% if result %}
                <div class="card bg-dark" style="width: 18rem;">
                  <img src="{{url_for('static', filename='img.jpg')}}" class="card-img-top" alt="...">
```

```
                    <div class="card-body">
                            <h5 class="card-title">Recommend Crop for cultivation is:</h5>
                            <p class="card-text">{{ result }}</p>
                    </div>
                   </div>
            {% endif %}
  </div>

    <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0-alpha3/dist/js/bootstrap.bundle.min.js" integrity="sha384-
ENjdO4Dr2bkBIFxQpeoTz1HIcje39Wm4jDKdf19U8gI4ddQ3GYNS7NTKfAdVQSZe"
crossorigin="anonymous"></script>
  </body>
</html>
```

REFERENCES

[1] Bakthavatchalam, K., Karthik, B., Thiruvengadam, V., Muthal, S., Jose, D., Kotecha, K., & Varadarajan, V. (2022).**" IoT framework for measurement and precision agriculture: predicting the crop using machine learning algorithms"**. Technologies, 10(1), 13.

[2] Pandey, A., & Jain, K. (2022). **"An intelligent system for crop identification and classification from UAV images using conjugated dense convolutional neural network"**. Computers and Electronics in Agriculture, 192, 106543.

[3] Banerjee, G., Sarkar, U., & Ghosh, I. (2021).**" A fuzzy logic-based crop recommendation system. In Proceedings of International Conference on Frontiers in Computing and Systems"**: COMSYS 2020 (pp. 57-69). Springer Singapore.

[4] Madhuri, J., & Indiramma, M. (2021). "**Artificial neural networks based integrated crop recommendation system using soil and climatic parameters"**. Indian Journal of Science and Technology, 14(19), 1587-1597.

[5] Patel, K., & Patel, H. B. (2020). **"A state-of-the-art survey on recommendation system and prospective extensions"**. Computers and Electronics in Agriculture, 178, 105779.

[6] Katarya, R., Raturi, A., Mehndiratta, A., & Thapper, A. (2020, February). **"Impact of machine learning techniques in precision agriculture"**. In 2020 3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things (ICETCE) (pp. 1-6). IEEE.

[7] Fayyaz, Z., Ebrahimian, M., Nawara, D., Ibrahim, A., & Kashef, R. (2020). **"Recommendation systems: Algorithms, challenges, metrics, and business opportunities"**. applied sciences, 10(21), 7748.