MANJARA CHARITABLE TRUST
RAJIV GANDHI INSTITUTE OF TECHNOLOGY
DEPARTMENT OF APPLIED SCIENCES & HUMANITIES
(Permanently Affiliated to University of Mumbai)
Department of Electronics and Telecommunication Engineering

University of Mumbai

Academic Year 2023-24

Project Report on

Crop Recommendation Using Machine Learning

Submitted in partial fulfilment of the requirements

For the award of the degree of

Bachelor of Engineering

In

Electronics and Telecommunication Engineering

BY

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Under the Supervision of **Prof. Ragini Bhoyar**

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CERTIFICATE

This is to certify that **SHWETA BACHUTE (A706), EKTA BHOWAD (A711), OMKAR GOSAVI (A719), KEDAR SAWANT (A734)** Of **B.E. Division A** have completed the project working on the subject of Major Project **"Crop Recommendation Using Machine Learning"** as prescribed by the University of Mumbai during the academic year 2023-2024 under the guidance of **Prof. Ragini Bhoyar** in the Department of Electronics & Telecommunication Engineering (EXTC).

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Dr. S. D. Deshmukh
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Dr. Sanjay U. Bokade
(Principle)

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PROJECT STAGE REPORT APPROVAL

This project report entitled **"Crop Recommendation Using Machine Learning"** by **SHWETA BACHUTE (A706), EKTA BHOWAD (A711), OMKAR GOSAVI (A719), KEDAR SAWANT (A734)** is approved as the 7th Semester Major Project by the Department of Electronics and Telecommunication Engineering from University of Mumbai, in academic year 2023-24.

Examiners:

1. **Internal:**

2. **External:**

Date: 03 May 2024
Place: Mumbai

ACKNOWLEDGEMENT

The work of a mini project **"Crop Recommendation Using Machine Learning"** is a contribution and effort of a team. We take this opportunity to express deep gratitude towards our mini project guide Prof. Ragini Bhoyar, for providing guidance encouragement, and inspiration throughout the project work.

We wish to express our sincere thanks to the Head of the Department and members of the Department of Electronics & Telecommunication for their support and completion of the project work. We would also like to thank our all-batch mates for their valuable guidance.

(Students Signatures)

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DECLARATION

We declare that this written submission for our BE project entitled **"Crop Recommendation Using Machine Learning"** presents our ideas in our own words and where others' ideas or words have been included; we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(Students Signatures)

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Date: 03 May 2024
Place: Mumbai

ACKNOWLEDGMENTS

It is indeed a matter of great pleasure and proud privilege to be able to present this project on "**Crop Recommendation Using Machine Learning.**" We would like to express our regards and gratitude to the Principal **Dr. Sanjay U. Bokade** and Head of Department **Dr. Sanjay. D. Deshmukh**. The completion of this project work is a milestone in student life and its execution is inevitable in the hands of a guide. We are highly indebted to the project guide **Prof. Ragini Bhoyar** for her invaluable guidance and appreciation for giving from and substance to this report. It is due to her enduring efforts, patience, and enthusiasm, which has given a sense of direction and purposefulness to this project and ultimately made it a success. We would also like to tender our sincere thanks to the staff members for their cooperation.

ABSTRACT

The requirement for sustainable practices to guarantee effective crop cultivation is posing an increasing challenge to the agriculture sector. To address this, this study presents a novel project aimed at putting into practice a cutting-edge crop recommendation system. Using real-time data on important environmental parameters like as temperature, moisture content of soil, weather, and contextual subtleties, the system utilises machine learning models that have been trained beforehand to examine complex inputs. To ensure precision and accuracy, the training process makes use of modern technologies such as support vector machines (SVM), random forests, decision trees, and others. With the use of data-driven insights, the robust model that is produced offers farmers customised and optimised crop suggestions that will increase agricultural production and promote sustainable farming methods. This approach is a big step forward because it highlights the agriculture sector's efficiency and resilience.

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INTRODUCTION

In the context of agricultural sustainability, knowing how important environmental variables—like temperature and soil moisture—interact dynamically is essential to crop cultivation's success. Our innovative response centres on the application of a state-of-the-art crop recommendation system. This method leverages real-time data on soil moisture content, outside temperature, meteorological conditions, and the month-specific contextual details. Through the utilisation of pretrained machine learning models, our approach aims to thoroughly examine these diverse inputs and provide customised suggestions regarding which crops would be best suited for a certain soil type.

This creative method makes use of a variety of machine learning algorithms, such as support vector machines (SVM), random forests, and decision trees. By means of rigorous training and careful assessment, we seek to determine the model's accuracy and precision and then choose the best deployment strategy. After completing this intensive training, a very clever and resilient model will be created that can generate predictions based on the information provided by the customer, making it easier to provide customised and optimised crop suggestions.

Our programme aims to provide farmers with timely, accurate, and data-driven information so they may make well-informed decisions to increase agricultural output by promoting a data-driven strategy. Our system's main goals are to increase total crop productivity and promote sustainable farming techniques. By strengthening the agricultural sector's resilience, we hope to bring in a new era of agricultural wealth and advancement.

LITERATURE SURVEY

In [1] the Smart Irrigation and Monitoring System integrates DHT11 and YL100 Soil Moisture sensors with a WeMos board to effectively monitor air temperature, humidity, and soil moisture levels. The collected data is then transmitted to an IoT Hub for in-depth analysis. This system leverages machine learning algorithms to process the sensor data alongside weather forecasts, enabling it to make informed decisions about when irrigation is needed. The system can alert farmers in a timely manner, ensuring efficient water management for their crops. To provide a user-friendly experience, both web and mobile applications are developed, allowing farmers to customize irrigation schedules and parameters tailored to different plant types. This innovative solution promises to enhance agricultural practices by optimizing water usage and increasing crop yield.

In [2] data preprocessing was conducted, followed by the extraction of polarimetric parameters to create a comprehensive soil moisture database. Machine-learning models were then trained and assessed with feature selection techniques to enhance the accuracy of soil moisture estimation. The results highlight the effectiveness of machine learning when integrated with polarization decomposition parameters, with the Random Forest (RF) model showing promise. However, the study does acknowledge certain limitations, notably the constraints posed by a relatively small sample size and limited coverage of diverse crop types. To address these constraints, future research should focus on exploring broader geographical areas and employing advanced methodologies like deep learning. In sum, this approach provides valuable support for modelling soil moisture in agricultural contexts, offering potential benefits for optimizing irrigation and crop management.

In [3] a pH meter is connected to an Arduino while a temperature sensor, specifically the DHT11, is linked to a Raspberry Pi. The pH meter provides crucial data that aids in assessing nutrient levels in the soil. Simultaneously, the soil moisture sensor readings determine when the water pump should be activated. The primary objective of this research is to develop an automated monitoring system that enables real-time tracking of soil pH, temperature, and moisture. This system not only controls valves based on soil moisture levels but also delivers valuable pH and nutrient information. By facilitating real-time analysis, this innovative system offers the potential to significantly enhance agricultural productivity and profitability by optimizing resource usage, ultimately benefiting both the environment and farmers.

PROBLEM STATEMENT

The problem revolves around developing a robust and accurate crop recommendation system using machine learning techniques to provide personalized crop suggestions to farmers based on their specific agricultural and environmental conditions.

1) Data Collection and Preprocessing: Gathering relevant data including soil characteristics (e.g., pH levels, nutrient content), climatic data (e.g., temperature, rainfall patterns), geographical information, historical crop yields

2) Feature Selection and Engineering: Identifying and selecting the most informative features (e.g., soil type, temperature, precipitation) that influence crop growth and yield. Engineering new features or transforming existing ones to enhance the predictive power of the model.

3) Model Development: Designing and implementing machine learning algorithms capable of learning patterns from the collected data to predict suitable crops for given environmental conditions. Exploring various algorithms such as decision trees, random forests, support vector machines, or neural networks to determine the most effective approach for crop recommendation.

4) Model Evaluation and Validation: Evaluating the performance of the developed models using appropriate metrics such as accuracy, precision, recall, and F1-score. Validating the model predictions through cross-validation techniques and comparing them against historical crop performance and expert recommendations.

5) Deployment and Integration: Building a user-friendly interface that allows farmers to input their location, soil characteristics, climate data, and other relevant information.

Integrating the developed crop recommendation model into the interface to provide real-time, personalized crop suggestions based on user inputs. Deploying the system on scalable and accessible platforms such as web applications or mobile apps to reach all farmers.

OBJECTIVES

The primary objectives of the machine learning-based crop recommendation system are as follows:

1)Provide accurate and personalized crop recommendations to farmers based on their specific Humidity, Temperature, Soil, and Climate Conditions.

2)Optimize crop selection to maximize yields, minimize resource usage, and increase profitability for farmers.

3)Facilitate data-driven decision-making in agriculture, leveraging machine learning techniques to enhance crop management practices.

4)Empower farmers with actionable insights and recommendations to improve overall farm productivity and sustainability.

BLOCK DIAGRAM

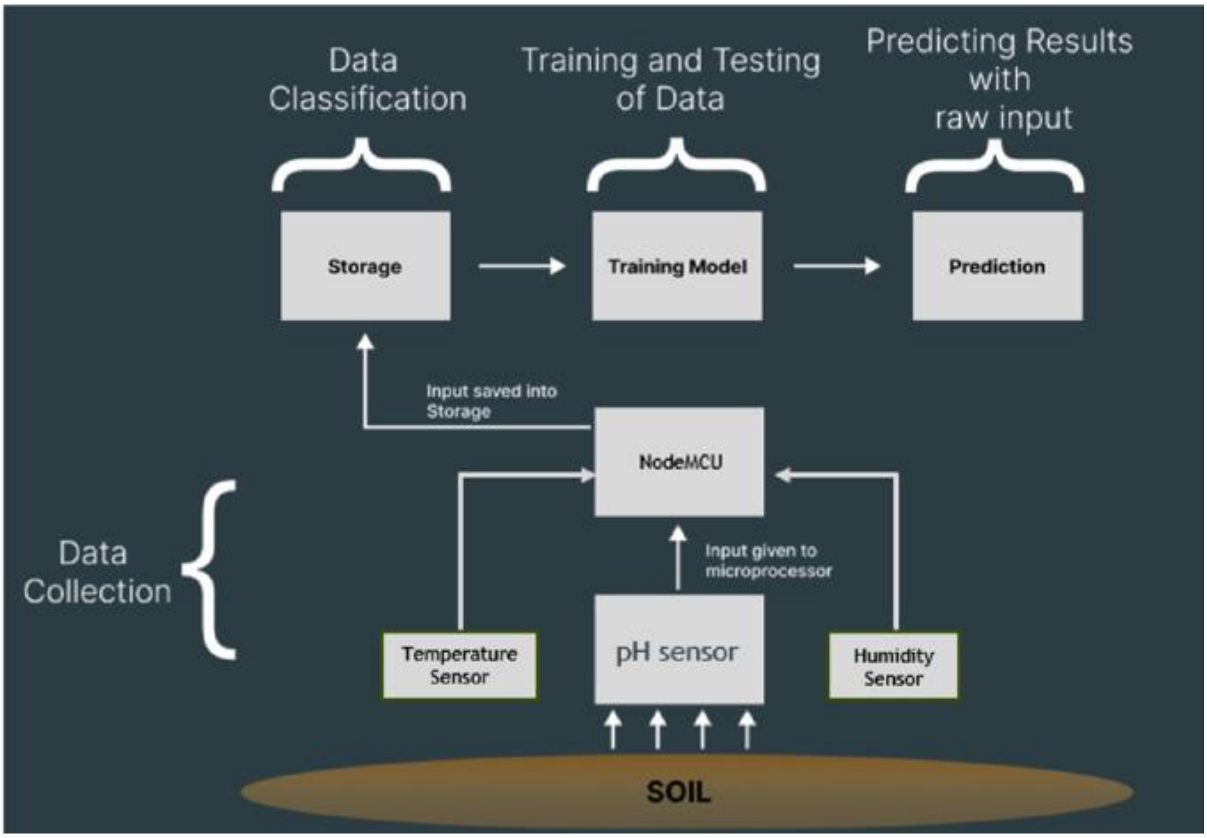

Figure 1: Block Diagram of Process

WORKING PRINCIPLE

Step 1: Gathering data:

1. By connecting soil moisture sensors with NodeMCU we will collect soil moisture, pH levels, temperature.

Step 2: Data Preprocessing:

1. We will use different soil sample and their data to make one dataset.
2. Ensure that the collected data is in a consistent format and free from errors or missing values.

Step 3: Classification of data:

1. Classify the crops into different categories based on their tolerance to soil moisture, pH levels, temperature, and seasonal preferences.

Step 4: Crop Selection Criteria:

1. Soil Moisture: Choose crops that match the measured soil moisture levels within their optimal range.
2. Soil pH: Select crops that prefer the soil pH value observed in the field.
3. Temperature: Choose crops that thrive within the current temperature range.

4. Month of the Year: Recommend crops that are suitable for the specific month or growing season.

Step 5: Crop Recommendation Algorithm:

1. Develop an algorithm that takes the collected data as input and provides crop recommendations based on the predefined crop selection criteria. The algorithm should be able to prioritize the crops based on how well they match the environmental conditions.

DETAILS OF HARDWARE AND SOFTWARE COMPONENTS

NODEMCU ESP32

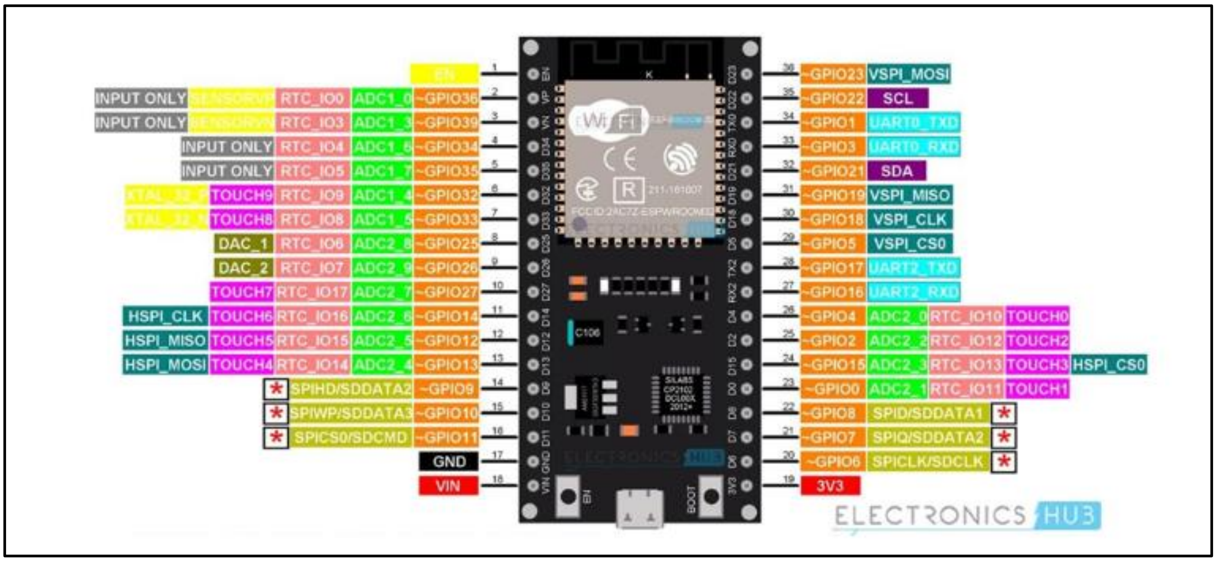

Figure 2: NODEMCU

A well-liked development board built around the ESP32 microcontroller is the NodeMCU ESP32 WROOM. It is an open-source platform that makes prototyping and IoT (Internet of Things) projects easier. Espress if Systems created the potent microcontroller known as the ESP32. Because it combines Bluetooth and Wi-Fi, it can be used for a variety of Internet of Things applications. Programming the ESP32 is made simple by the user-friendly Lua scripting language environment offered by the NodeMCU firmware. For developers who know Lua or would rather use a higher-level scripting language, this makes it convenient. The development board NodeMCU ESP32 WROOM incorporates the ESP32 microcontroller with essential parts like GPIO headers, USB interface, and voltage regulators. This makes the development and prototype process easier. Analog-to-digital converters (ADCs), pulse-width modulation (PWM) outputs, GPIO ports for interacting with external devices, integrated Wi-Fi, and Bluetooth connectivity, and more are common characteristics of the NodeMCU ESP32 WROOM. The Arduino IDE, MicroPython, or Lua scripting language can be used to programme the NodeMCU ESP32 WROOM, depending on the developer's taste. Other programming languages and environments are also supported. The NodeMCU ESP32 WROOM's adaptability makes it ideal for a variety of uses, including as robots, IoT devices, home automation, sensor networks, and more.

DHT11 SENSOR

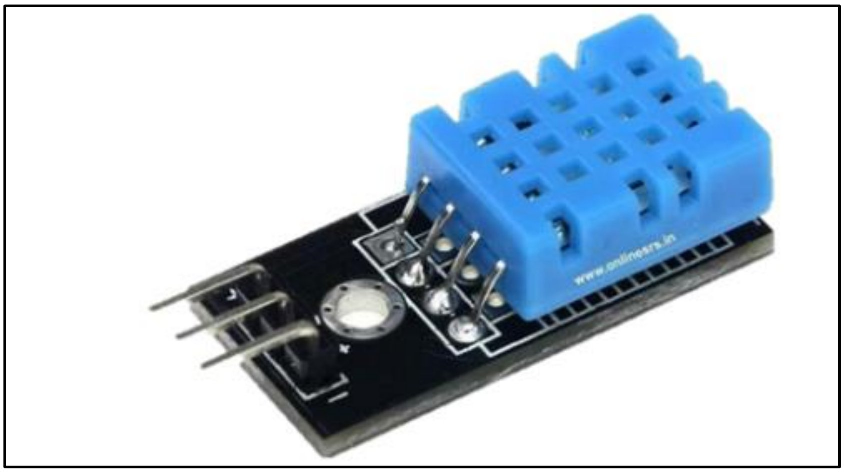

Figure 3: DHT11 Sensor

Temperature Range: 0°C to 50°C (32°F to 122°F)

Humidity Range: 20 to 90 percent

Operating Voltage: 3.3V to 5V DC

Sampling Rate: Approximately 1 reading per second

Operating current: 0.3mA (measuring) 60uA (standby)

Resolution: Temperature and Humidity both are 16 bits

Accuracy: –1 C and –1

Output: Serial data

The DHT11 sensor consists of a capacitive humidity sensor and a thermistor to measure temperature. It operates by utilizing a thermosensitive resistor to measure the ambient temperature and a humidity sensing component to detect moisture levels in the air. The sensor converts the temperature and humidity readings into digital signals, which can be read by a microcontroller or other digital devices. The DHT11 sensor communicates using a simple single-wire serial interface, making it easy to integrate with microcontrollers like Arduino, Raspberry Pi, and other development boards. The sensor provides a digital signal output, which consists of a series of pulses that encode the temperature and humidity readings.

Vcc: Power supply 3.5V to 5.5V

Data: Outputs both Temperature and Humidity through serial Data

Ground: Connected to the ground of the circuit

ALGORITHM

1. Collect and preprocess data: Gather data on various crops, including their growth requirements, yield, and other relevant factors. Preprocess the data to ensure it is clean, consistent, and ready for analysis.

2. Select a machine learning model: Choose a suitable machine learning model for crop recommendation, such as decision trees, random forests, or support vector machines.

3. Split the data: Divide the data into training and testing sets. The training set will be used to train the model, while the testing set will be used to evaluate its performance.

4. Train the model: Use the training set to train the machine learning model. This involves feeding the model with input data (such as soil type, climate, and other environmental factors) and the corresponding output (the recommended crop).

5. Evaluate the model: Use the testing set to evaluate the performance of the model. This involves comparing the predicted output (the recommended crop) with the actual output (the known recommended crop).

6. Fine-tune the model: check for the accuracy, precision, and performance score in confusion matrix or in classification report, If the model's performance is not satisfactory, one-tune it by adjusting its parameters or selecting a different model.

7. Deploy the model: Once the model is trained and evaluated, deploy it in a production environment where it can be used to recommend crops based on input data. 8. Monitor and update the model: Monitor the model's performance over time and update it as needed to ensure it continues to provide accurate crop recommendations.

SOFTWARE SPECIFICATIONS

- **CODE**

```
import pandas as pd                                # to manipulate dataset
from sklearn.model_selection import train_test_split  # to train x and y
data
from sklearn.ensemble import RandomForestClassifier   # using Random forest
classifier library
from sklearn.metrics import classification_report, accuracy_score #for
printing accuracy
import matplotlib.pyplot as plt                    # for plotting graphs
%matplotlib inline

data = pd.read_csv('Crop.csv')   # importing our data set

data.head()

X = data[['temperature', 'ph', 'humidity']]        # Storing value of
temperature, humidity and ph value data to X variable
Y = data['label']                                  # Storing Label names (Plant
names) in Y variable

plt.figure(figsize=(10, 6))
plt.scatter(X['temperature'], Y, color='r', label='Temperature')   # red
color for Temperature
plt.scatter(X['ph'], Y, color='g', label='pH')                      # green
color for pH value
plt.scatter(X['humidity'], Y, color='b', label='Humidity')          # blue
color for Humidity
plt.xlabel('Values')      # name of x axis
plt.ylabel('Plant Names') # name of Y axis
plt.title('Scatter plot of Temperature, pH, and Humidity against Plant
Names')    # name of Chart
plt.legend()  # printing legend on Graph
plt.show()    # plotting actual Graph

# Dividing X and Y data in 80:20 ratio
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.2,
random_state=42) # (test size is 0.2 means 20)

# Create a Random Forest Classifier with 100 estimators
```

```
clf = RandomForestClassifier(n_estimators=100, random_state=42)

#fitting trained data
clf.fit(X_train, y_train)

# using x-test data for prediction so that it can be used for comparision
with y-test
y_pred = clf.predict(X_test)

# creating classfication report based on y-test (labels) abd y-pred
(predicted result based on x-test)
print("Classification Report:\n", classification_report(y_test, y_pred))

# Printing Accuracy
print("Accuracy:", accuracy_score(y_test, y_pred))

#prediction for new values
new_temperature = 20.87
new_ph = 7.122349
new_humidity = 82

# Making prediction for the new values
new_prediction = clf.predict([[new_temperature, new_ph, new_humidity]])

# Printing Predicted Result
print("Predicted Label for the given values:", new_prediction[0])
```

RESULT

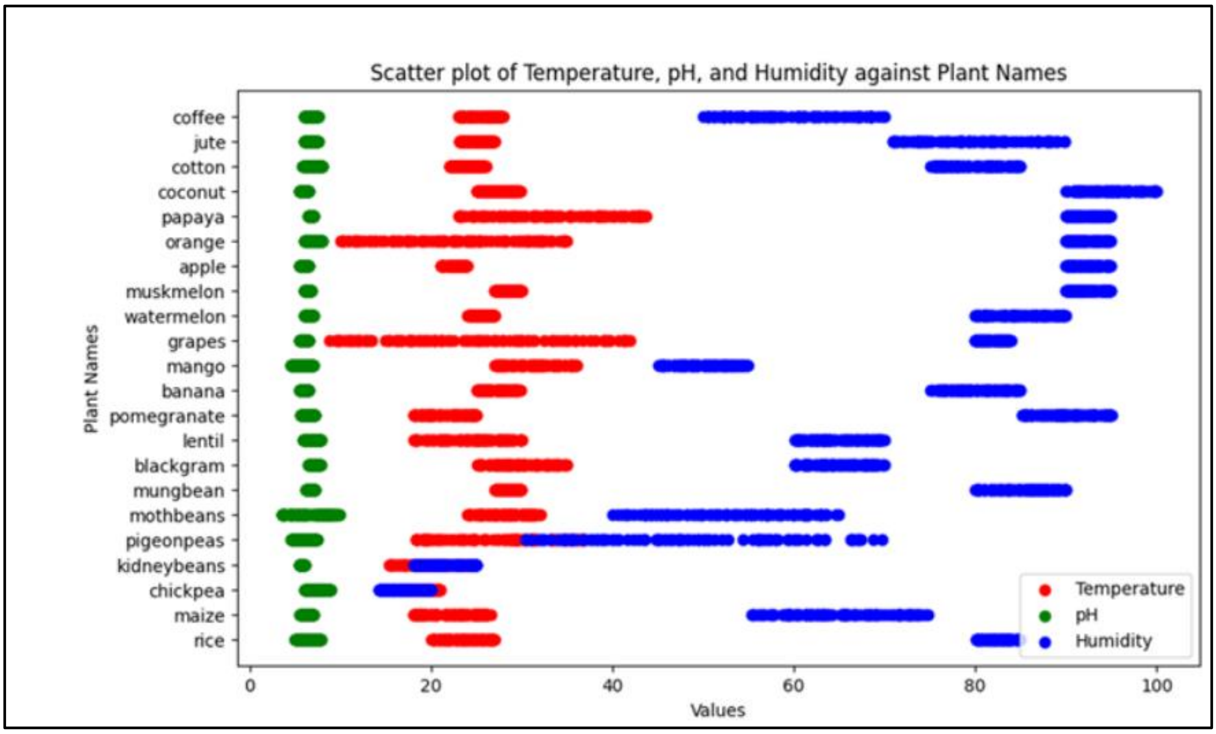

Figure 4: Output

Future Scope

1. Integration of IoT and Remote Sensing: Incorporating real-time data from IoT sensors and satellite imagery can enhance the accuracy of crop recommendation systems by providing up-to-date information on soil moisture, crop health, and weather conditions.
2. Multi-criteria Decision Making: Future systems can employ advanced multi-criteria decision-making techniques to consider diverse factors such as economic viability, social impact, and environmental sustainability in crop recommendations.
3. Machine Learning Algorithms: Continued research into more advanced machine learning algorithms, such as deep learning and reinforcement learning, can further improve the predictive capabilities of crop recommendation systems, especially in handling complex and nonlinear relationships.
4. Localized Solutions: Tailoring recommendations to the specific needs and constraints of local communities can enhance the adoption and effectiveness of crop recommendation systems, considering factors like cultural practices, market demand, and infrastructure availability.
5. User Interface and Adoption: Developing user-friendly interfaces and providing adequate training and support to farmers are crucial for the widespread adoption and successful implementation of crop recommendation systems.
6. Collaborative Platforms: Creating collaborative platforms where farmers, agronomists, researchers, and policymakers can exchange knowledge and insights can foster innovation and continuous improvement in crop recommendation techniques.
7. Climate Resilience: As climate change continues to impact agricultural productivity and patterns, crop recommendation systems will play a vital role in helping farmers adapt to changing conditions by recommending resilient crop varieties and management practices.

CONCLUSION

Crop recommendation systems powered by machine learning represent a transformative approach to optimizing agricultural practices. By harnessing the capabilities of machine learning algorithms to analyze diverse datasets encompassing soil properties, climate conditions, historical crop performance, and farmer preferences, these systems offer personalized recommendations tailored to specific agricultural contexts. The adoption of precision agriculture principles allows for efficient resource allocation while minimizing environmental impact. Furthermore, these systems contribute to maximizing crop yields and profitability by suggesting the most suitable crops based on various factors such as soil type, moisture levels, temperature, and disease prevalence. They also serve as invaluable tools for risk mitigation, aiding farmers in adapting to challenges posed by climate change, market fluctuations, and pest outbreaks. As accessibility to these systems improves, particularly in remote or resource-constrained areas, their potential impact on global food security becomes increasingly significant. Moving forward, ongoing advancements in technology, such as the integration of real-time data from IoT sensors alongside continued research into more sophisticated machine learning algorithms, will further enhance the accuracy and effectiveness of crop recommendation systems.

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