Crop Recommendation System

A MINI PROJECT REPORT

18CSC305J - ARTIFICIAL INTELLIGENCE

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BONAFIDE CERTIFICATE

Certified that Mini project report titled **“Crop Recommendation System”** is the bona fide work of **Pranshu Yadav(RA2111003010422), Kartikey Lohani (RA2111003010446), Pushkala S R(RA2111003010448)** who carried out the minor project under my supervision. Certified further, that to the best of my knowledge, the work reported herein does not form any other project report 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. S. Padmini
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ABSTRACT

In the dynamic landscape of modern agriculture, the Crop Recommendation System emerges as a groundbreaking solution, seamlessly blending the prowess of machine learning (ML) and deep learning (DL) methodologies. This visionary platform redefines conventional farming practices by harnessing a wealth of agricultural data—ranging from soil composition and climate patterns to historical crop performance and disease incidence rates. Through an intricate fusion of ML algorithms, such as decision trees and random forests, and sophisticated DL architectures like convolutional and recurrent neural networks, the system orchestrates a symphony of data-driven insights tailored to the intricate nuances of individual farming ecosystems.

At its core, the system boasts an intuitive web interface—an agricultural command center that empowers farmers with real-time access to actionable intelligence. From recommending the optimal crop varieties suited to prevailing environmental conditions, to fine-tuning fertilizer application strategies for maximal yield potential, and even preemptively identifying and mitigating potential disease outbreaks—the Crop Recommendation System serves as a steadfast ally in the farmer's quest for agricultural excellence.

Beyond mere recommendations, this transformative platform embodies a paradigm shift in agricultural stewardship, fostering a culture of sustainability and resilience. By bolstering crop yields, optimizing resource allocation, and fortifying defenses against the ever-looming specter of climate change and pestilence, the Crop Recommendation System not only drives economic prosperity but also cultivates a harmonious coexistence between humanity and nature.

In essence, the Crop Recommendation System represents the vanguard of agricultural innovation—a beacon of hope illuminating the path towards a more prosperous, sustainable, and resilient future for farmers and ecosystems alike.

ABBREVIATIONS

ML	Machine Learning
DL	Deep Learning
SVM	Support Vector Machine
XGBOOST	eXtreme Gradient Boosting
API	Application Program Interface
UI	User Interface

INTRODUCTION

In the backdrop of India's agrarian economy, characterized by its reliance on traditional farming practices and the challenges posed by evolving environmental conditions and demographic shifts, there arises a pressing need for innovative solutions to enhance agricultural productivity and sustainability. This project endeavors to address these challenges by introducing an advanced web-based agricultural decision support system empowered by cutting-edge Machine Learning (ML) and Deep Learning (DL) techniques.

With agriculture serving as the backbone of India's economy, employing a significant portion of its population and contributing substantially to its Gross Domestic Product (GDP), the sector's modernization is imperative for ensuring food security, poverty alleviation, and rural development. However, conventional farming methods are often limited in their ability to adapt to the complexities of modern agricultural practices, including optimizing crop selection, managing soil fertility, and combating crop diseases.

To bridge this gap, our project presents an integrated solution that revolutionizes agricultural decision-making by providing farmers with personalized recommendations for crop selection, fertilizer application, and disease detection. Leveraging ML algorithms such as Support Vector Machines (SVM), Naïve Bayes, and eXtreme Gradient Boosting (XGBoost), our system analyzes vast datasets encompassing soil characteristics, climate patterns, and historical crop performance to offer tailored insights into optimal crop choices and nutrient management strategies.

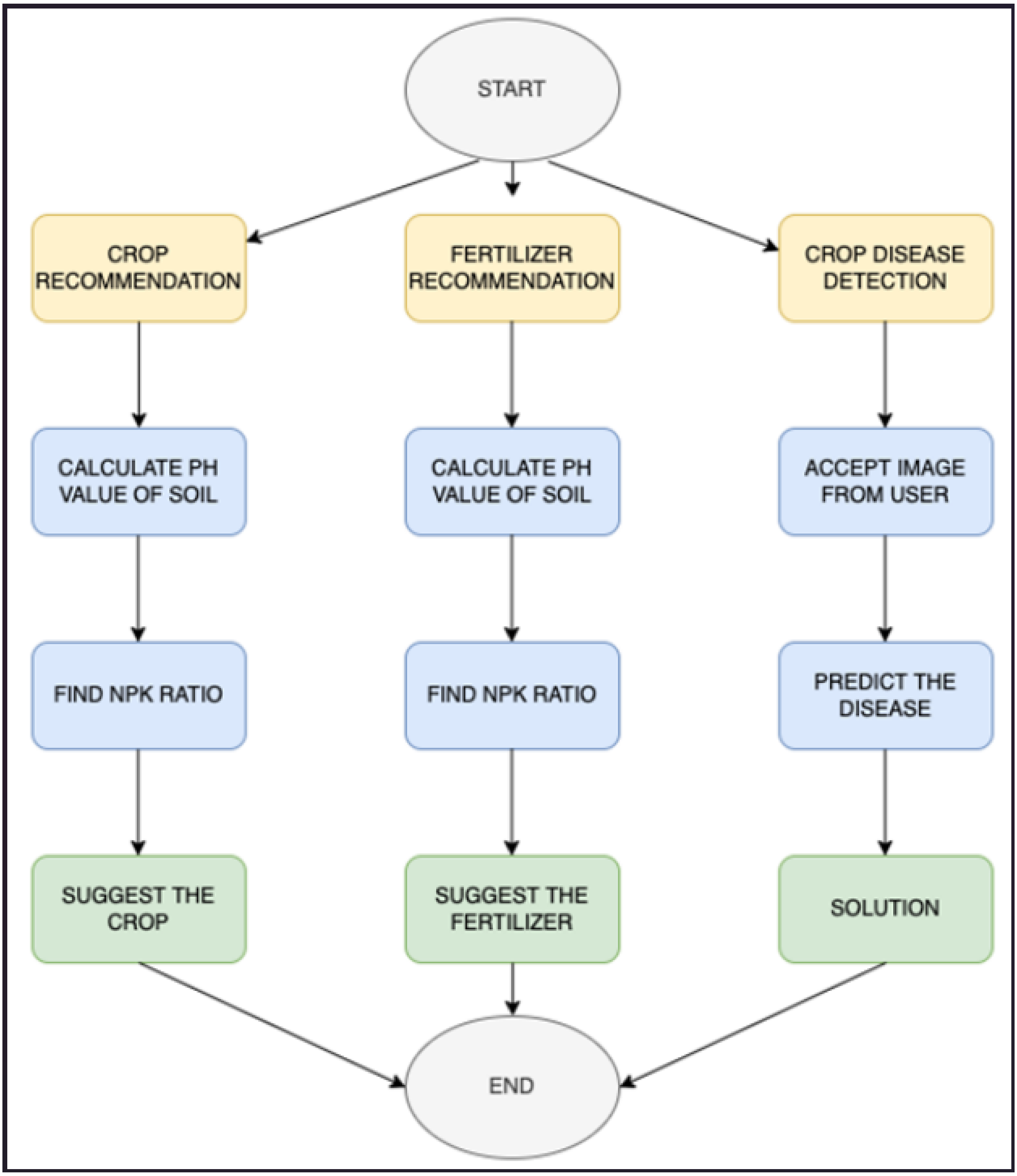
Furthermore, our project incorporates DL techniques to accurately identify and diagnose crop diseases based on images of diseased plant leaves. By harnessing the power of DL algorithms, our system enables early detection of crop diseases, thereby facilitating timely interventions to mitigate crop losses and ensure sustainable farming practices.

In summary, our project represents a significant step towards modernizing India's agricultural sector, equipping farmers with the tools and knowledge needed to navigate the complexities of modern farming practices effectively. By embracing innovation and harnessing the potential of ML and DL technologies, we aspire to drive positive transformation in Indian agriculture, fostering sustainable growth, resilience, and prosperity for generations to come.

LITERATURE SURVEY

Author(s)	Title	Dataset	Methods	Remarks
Patil, Prashant S. et al.	"Crop Recommendation System using Machine Learning"	AgriDataset: Kaggle Agricultural Dataset	Decision Trees, K-Nearest Neighbors, Random Forests	Explored traditional ML methods for crop recommendation using popular algorithms, dataset from Kaggle was utilized.
Singh, Ravi et al.	"Deep Learning Based Crop Recommendation System"	Crop Health and Disease dataset	Convolutional Neural Networks (CNNs), LSTM	Implemented CNNs and LSTMs to recommend crops based on soil health and disease detection.
Sharma, Ankit et al.	"Smart Farming: Crop Recommendation Using Machine Learning"	USDA-NASS Crop Production Dataset	Support Vector Machines (SVM), Neural Networks	Utilized SVM and Neural Networks on USDA-NASS dataset for crop recommendation, focused on practical farm application.
Gupta, Akash et al.	"A Review on Crop Recommendation System using Machine Learning"	Various publicly available datasets	Decision Trees, Random Forests, SVM, Neural Networks	Conducted a comprehensive review of ML methods applied to crop recommendation, emphasized on dataset diversity.
Kumar, Rajesh et al.	"Crop Recommendation System using Deep Learning Techniques"	Crop Health and Disease dataset	Recurrent Neural Networks (RNNs), LSTM	Explored RNNs and LSTM for crop recommendation, emphasizing on temporal patterns in crop health and diseases.
Lee, Jihoon et al.	"Enhanced Crop Recommendation System using Ensemble Learning"	AgriData: Custom dataset	Ensemble Methods (Random Forest, Gradient Boosting)	Introduced ensemble learning techniques for crop recommendation, combining multiple models for improved accuracy.

SYSTEM ARCHITECTURE AND DESIGN



Description of Model and components:

System Flow:

Crop Recommendation Module:

- The process begins when the user initiates the Crop Recommendation module.
- It starts by calculating the pH value of the soil to assess its acidity or alkalinity.
- Next, the system determines the NPK (Nitrogen, Phosphorus, Potassium) ratio of the soil, which is crucial for plant growth.
- Based on the soil characteristics, climate conditions, and other environmental factors, the system suggests suitable crops for cultivation.
- Finally, the process reaches the End point after providing the crop recommendation.

Fertilizer Recommendation Module:

- When the user triggers the Fertilizer Recommendation module, the process begins.
- Similar to the Crop Recommendation module, the system calculates the pH value of the soil and determines the NPK ratio.
- Using this information, it recommends appropriate fertilizers to balance the soil's nutrient levels and optimize plant growth.
- After suggesting the fertilizer, the process reaches the End point.

Crop Disease Detection Module:

- The process starts when the user uploads an image of a plant leaf for disease detection.
- The system accepts the image and analyzes it using machine learning or deep learning algorithms to predict the presence of any diseases.
- Upon detection of a disease, the system provides a solution or recommendations for disease management.
- After providing the solution, the process reaches the End point.

End Point:

- All modules converge to the End point, indicating the completion of the overall process.
- At this stage, the system has provided recommendations for crop selection, fertilizer usage, and disea management based on the user's input and analysis of soil and plant data.

METHODOLOGY

1. Data Collection:

- Gather relevant agricultural data including soil health parameters, climate conditions, historical crop yields, fertilizer usage, and crop disease data.
- Utilize publicly available datasets from sources like Kaggle, government agricultural departments, research institutions, or collect data through surveys and field experiments.

2. Data Preprocessing:

- Clean the collected data by handling missing values, outliers, and inconsistencies.
- Normalize or scale the data to ensure uniformity and compatibility for analysis.
- Perform feature engineering to extract useful features and create new variables if needed.

3. Crop Recommendation:

- Utilize machine learning algorithms such as Decision Trees, Random Forests, or Support Vector Machines to predict suitable crops based on soil health parameters, climate conditions, and historical crop yields.
- Train the model using historical data on crop performance under various environmental conditions.
- Evaluate the model's performance using metrics like accuracy, precision, and recall, and fine-tune the model as needed.

4. Fertilizer Suggestion:

- Analyze soil nutrient levels and crop nutrient requirements to determine excess or deficient nutrients.
- Utilize rule-based systems or machine learning classifiers to recommend suitable fertilizers and application rates to balance soil nutrient levels and optimize crop growth.
- Incorporate domain knowledge and expert recommendations to refine fertilizer suggestions based on crop-specific needs and environmental factors.

5. Disease Detection:

- Develop a deep learning model, such as Convolutional Neural Networks (CNNs), to analyze images of plant leaves and detect signs of crop diseases.
- Train the model using a labeled dataset of diseased and healthy plant images, incorporating transfer learning if necessary.
- Implement algorithms to identify the type of crop associated with the uploaded image and provide diagnosis and treatment recommendations for detected diseases.

6. Integration and Deployment:

- Integrate the crop recommendation, fertilizer suggestion, and disease detection modules into a unified system.
- Develop a user-friendly interface (web or mobile app) for farmers to input their agricultural parameters and receive recommendations.
- Deploy the system on a cloud platform or local server for accessibility and scalability.

7. Evaluation and Validation:

- Evaluate the system's performance using real-world agricultural data and compare its recommendations with expert advice or field trial results.
- Gather feedback from farmers to assess the system's usability, effectiveness, and relevance in practical farming scenarios.
- Continuously monitor and update the system based on user feedback, new research findings, and changes in agricultural practices or environmental conditions.

By following this methodology, the Crop Recommendation System can effectively assist farmers in making informed decisions to improve crop yield, optimize fertilizer usage, and mitigate crop diseases, ultimately enhancing agricultural productivity and sustainability.

CODING AND TESTING

```
# Importing libraries

from __future__ import print_function
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import classification_report
from sklearn import metrics
from sklearn import tree
import warnings
warnings.filterwarnings('ignore')

#Lading dataset

df = pd.read_csv('../Data-processed/crop-recommendation.csv')


#EDA


df.head()
df.size
df.shape
df.columns
df.dtypes

#Seperating features and target label

features = df[['N', 'P','K','temperature', 'humidity', 'ph', 'rainfall']]
target = df['label']
labels = df['label']

# Splitting into train and test data

from sklearn.model_selection import train_test_split
Xtrain, Xtest, Ytrain, Ytest = train_test_split(features,target,test_size = 0.2,random_state =2)
```

```
# Decision Tree

from sklearn.tree import DecisionTreeClassifier
DecisionTree = DecisionTreeClassifier(criterion="entropy",random_state=2,max_depth=5)
DecisionTree.fit(Xtrain,Ytrain)
predicted_values = DecisionTree.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Decision Tree')
print("DecisionTrees's Accuracy is: ", x*100)
print(classification_report(Ytest,predicted_values))
from sklearn.model_selection import cross_val_score
score = cross_val_score(DecisionTree, features, target,cv=5)
score


# Support Vector Machine (SVM)


from sklearn.svm import SVC
# data normalization with sklearn
from sklearn.preprocessing import MinMaxScaler
# fit scaler on training data
norm = MinMaxScaler().fit(Xtrain)
X_train_norm = norm.transform(Xtrain)
# transform testing dataabs
X_test_norm = norm.transform(Xtest)
SVM = SVC(kernel='poly', degree=3, C=1)
SVM.fit(X_train_norm,Ytrain)
predicted_values = SVM.predict(X_test_norm)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('SVM')
print("SVM's Accuracy is: ", x)
print(classification_report(Ytest,predicted_values))
score = cross_val_score(SVM,features,target,cv=5)
score

# Guassian Naive Bayes

from sklearn.naive_bayes import GaussianNB
NaiveBayes = GaussianNB()
NaiveBayes.fit(Xtrain,Ytrain)
```

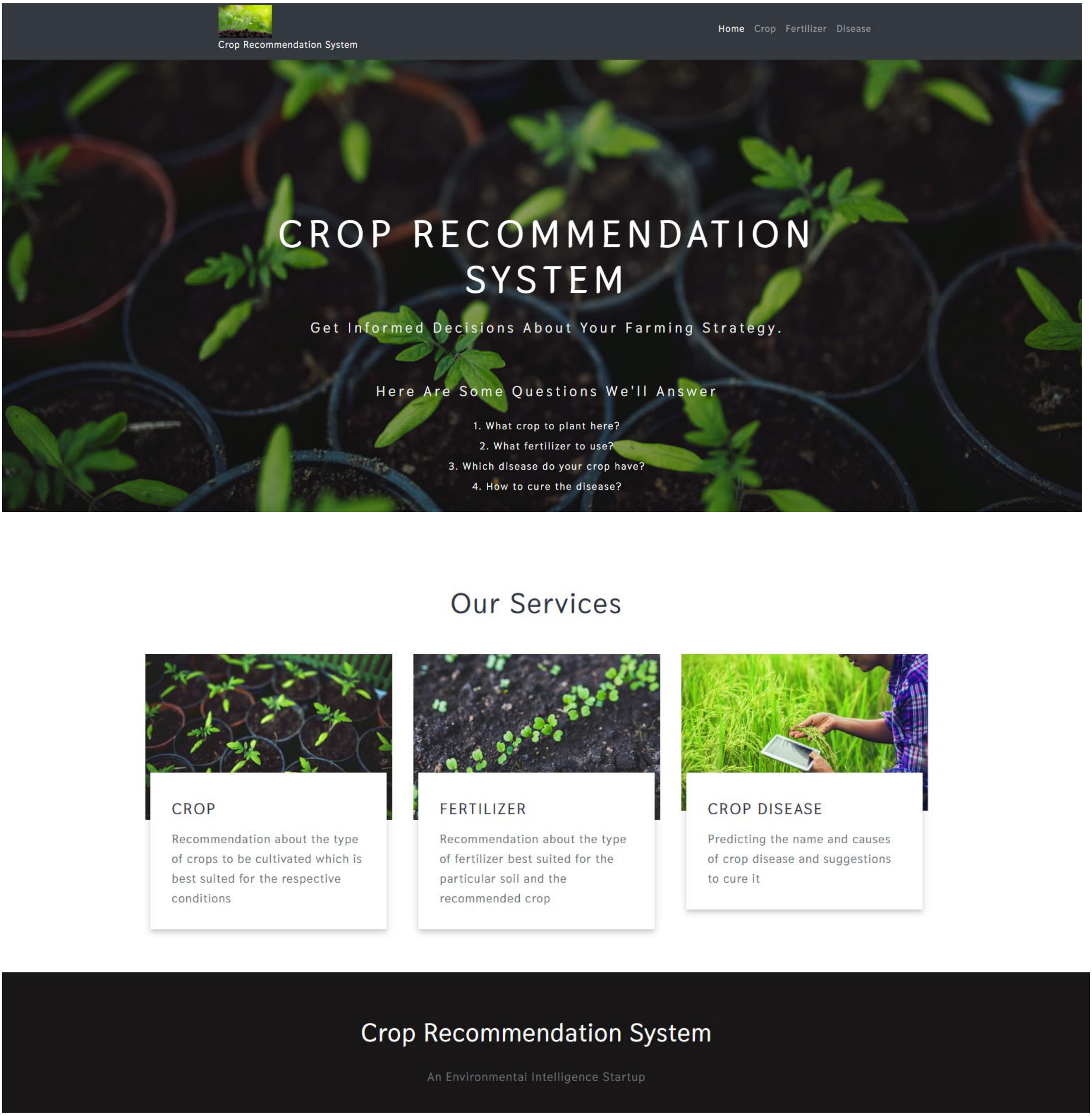
```
predicted_values = NaiveBayes.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Naive Bayes')
print("Naive Bayes's Accuracy is: ", x)
print(classification_report(Ytest,predicted_values))
score = cross_val_score(NaiveBayes,features,target,cv=5)
score

# Logistic Regression

from sklearn.linear_model import LogisticRegression
LogReg = LogisticRegression(random_state=2)
LogReg.fit(Xtrain,Ytrain)
predicted_values = LogReg.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Logistic Regression')
print("Logistic Regression's Accuracy is: ", x)
print(classification_report(Ytest,predicted_values))
score = cross_val_score(LogReg,features,target,cv=5)
score

#saving a model example LR

import pickle
# Dump the trained Naive Bayes classifier with Pickle
LR_pkl_filename = '../models/LogisticRegression.pkl'
# Open the file to save as pkl file
LR_Model_pkl = open(DT_pkl_filename, 'wb')
pickle.dump(LogReg, LR_Model_pkl)
# Close the pickle instances
LR_Model_pkl.close()

#XGBoost

import xgboost as xgb
XB = xgb.XGBClassifier()
XB.fit(Xtrain,Ytrain)
predicted_values = XB.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('XGBoost')
```

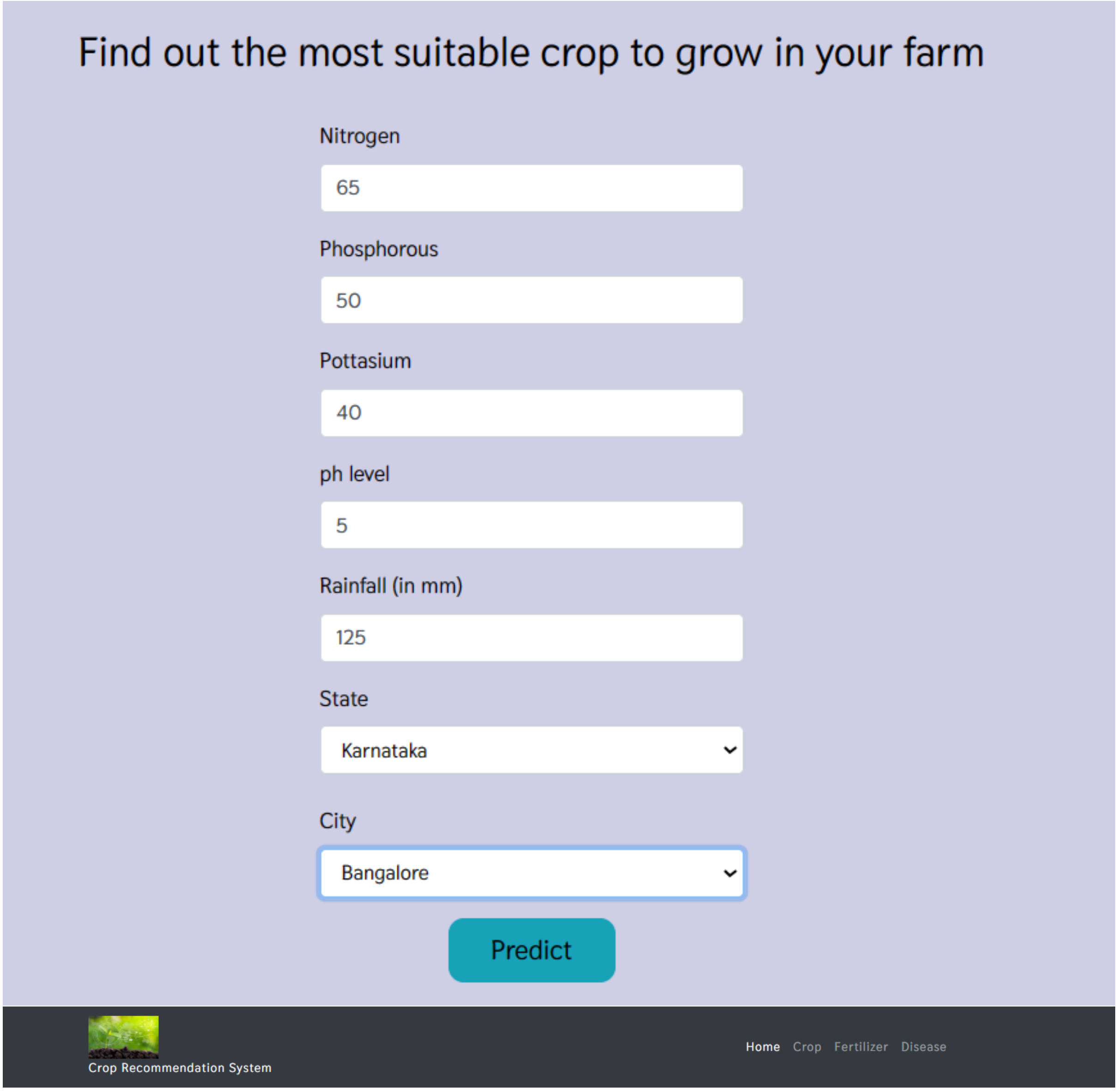
```
print("XGBoost's Accuracy is: ", x)
print(classification_report(Ytest,predicted_values))
score = cross_val_score(XB,features,target,cv=5)
score

#Accuracy Comparison


plt.figure(figsize=[10,5],dpi = 100)
plt.title('Accuracy Comparison')
plt.xlabel('Accuracy')
plt.ylabel('Algorithm')
sns.barplot(x = acc,y = model,palette='dark')


accuracy_models = dict(zip(model, acc))
for k, v in accuracy_models.items():
    print (k, '-->', v)
```

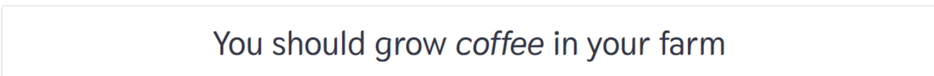
#TESTING

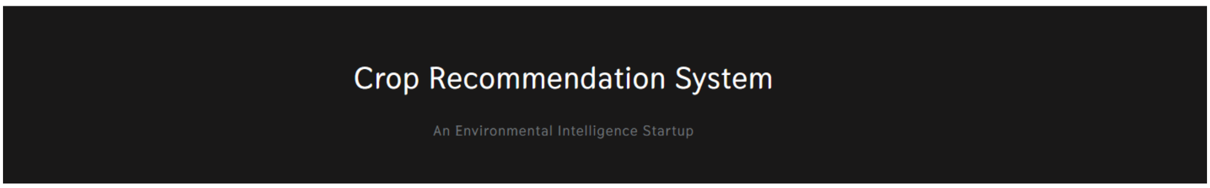
```
#Making a prediction


data = np.array([[104,18, 30, 23.603016, 60.3, 6.7, 140.91]])
prediction = RF.predict(data)
print(prediction)


data = np.array([[83, 45, 60, 28, 70.3, 7.0, 150.9]])
prediction = RF.predict(data)
print(prediction)
```

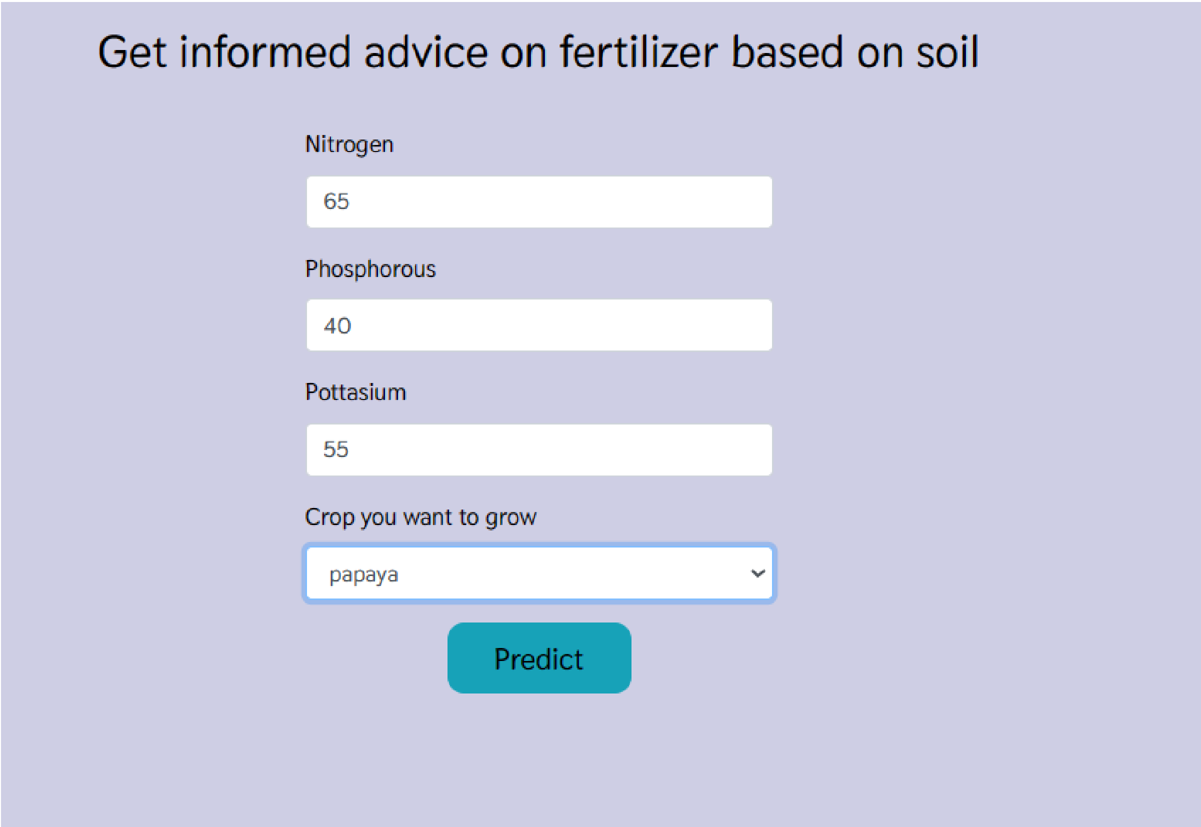
SCREENSHOTS AND RESULTS

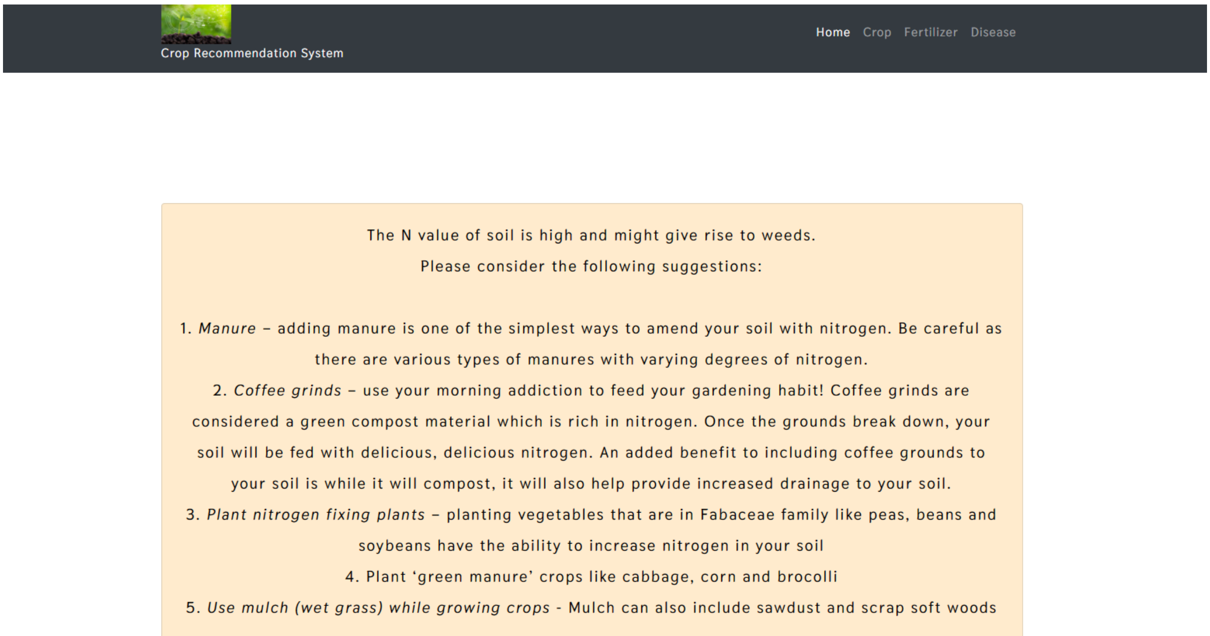


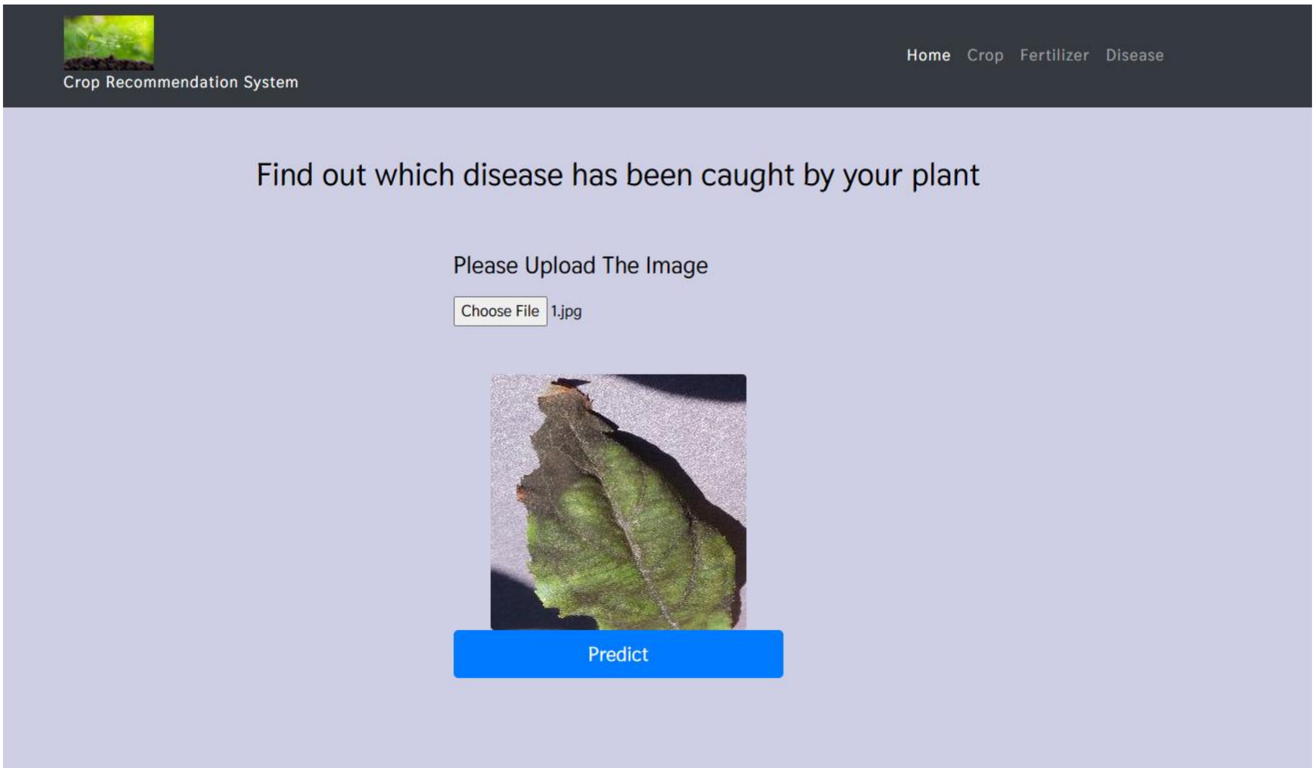

Find out the most suitable crop to grow in your farm
Nitrogen
65
Phosphorous
50
Pottasium
40
ph level
5
Rainfall (in mm)
125
State
Karnataka
City
Bangalore
Predict
Crop Recommendation System
Home
Crop
Fertilizer
Disease

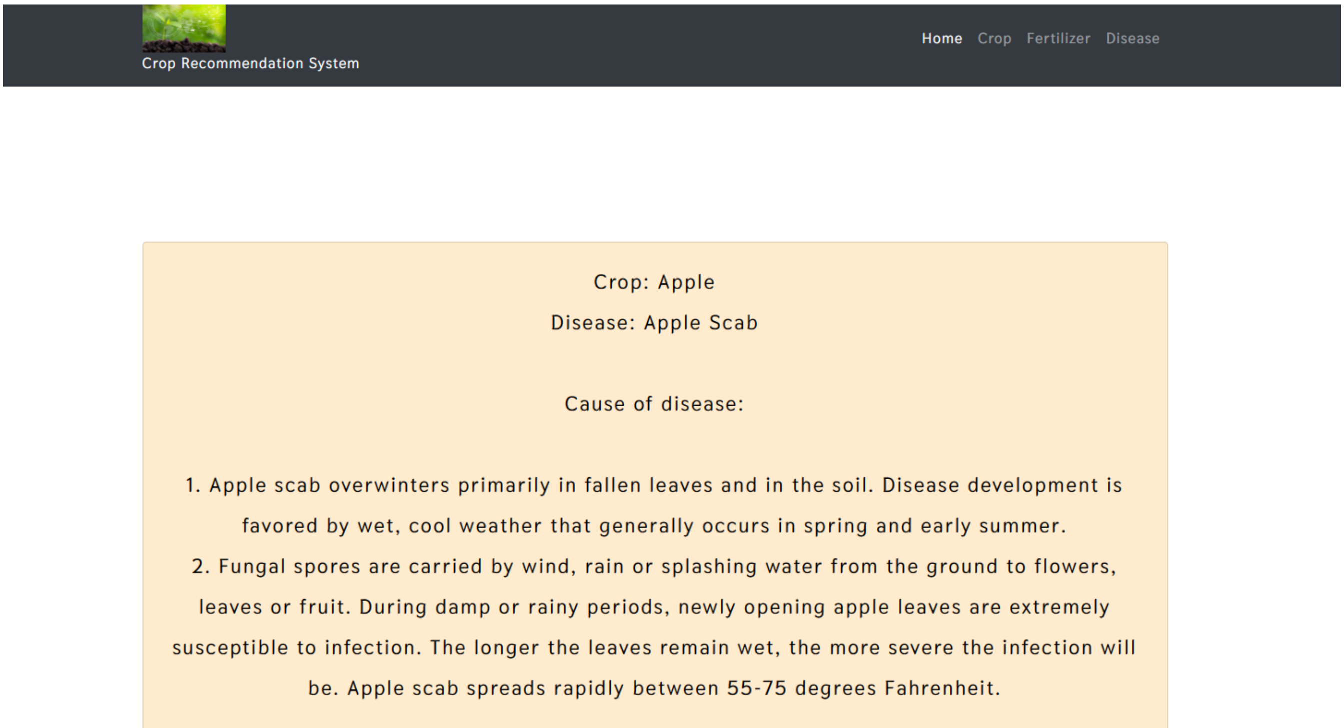

You should grow *coffee* in your farm


Crop Recommendation System
An Environmental Intelligence Startup


Get informed advice on fertilizer based on soil
Nitrogen
65
Phosphorous
40
Pottasium
55
Crop you want to grow
papaya
Predict


Crop Recommendation System
Home Crop Fertilizer Disease
The N value of soil is high and might give rise to weeds.
Please consider the following suggestions:
1. Manure – adding manure is one of the simplest ways to amend your soil with nitrogen. Be careful as there are various types of manures with varying degrees of nitrogen.
2. Coffee grinds – use your morning addiction to feed your gardening habit! Coffee grinds are considered a green compost material which is rich in nitrogen. Once the grounds break down, your soil will be fed with delicious, delicious nitrogen. An added benefit to including coffee grounds to your soil is while it will compost, it will also help provide increased drainage to your soil.
3. Plant nitrogen fixing plants – planting vegetables that are in Fabaceae family like peas, beans and soybeans have the ability to increase nitrogen in your soil
4. Plant 'green manure' crops like cabbage, corn and brocolli
5. Use mulch (wet grass) while growing crops - Mulch can also include sawdust and scrap soft woods


Crop Recommendation System
Home
Crop
Fertilizer
Disease
Find out which disease has been caught by your plant
Please Upload The Image
Choose File
1.jpg
Predict


Crop Recommendation System
Home
Crop
Fertilizer
Disease
Crop: Apple
Disease: Apple Scab
Cause of disease:
1. Apple scab overwinters primarily in fallen leaves and in the soil. Disease development is favored by wet, cool weather that generally occurs in spring and early summer.
2. Fungal spores are carried by wind, rain or splashing water from the ground to flowers, leaves or fruit. During damp or rainy periods, newly opening apple leaves are extremely susceptible to infection. The longer the leaves remain wet, the more severe the infection will be. Apple scab spreads rapidly between 55-75 degrees Fahrenheit.

How to prevent/cure the disease

1. Choose resistant varieties when possible.
2. Rake under trees and destroy infected leaves to reduce the number of fungal spores available to start the disease cycle over again next spring
3. Water in the evening or early morning hours (avoid overhead irrigation) to give the leaves time to dry out before infection can occur.
4. Spread a 3- to 6-inch layer of compost under trees, keeping it away from the trunk, to cover soil and prevent splash dispersal of the fungal spores.

Crop Recommendation System

An Environmental Intelligence Startup

About Us

IMPROVING AGRICULTURE, IMPROVING LIVES, CULTIVATING CROPS TO MAKE FARMERS INCREASE PROFIT.

We use state-of-the-art machine learning and deep learning technologies to help you guide through the entire farming process. Make informed decisions to understand the demographics of your area, understand the factors that affect your crop and keep them healthy for a super awesome successful yield.

CONCLUSION AND FUTURE ENHANCEMENTS

Conclusion:

The Crop Recommendation System represents a significant advancement in agricultural technology, offering farmers a comprehensive tool to optimize crop selection, fertilizer usage, and disease management. By harnessing the power of machine learning and deep learning algorithms, the system provides personalized recommendations tailored to each farm's unique conditions, including soil health, climate, and crop history. Through the integration of multiple modules for crop recommendation, fertilizer recommendation, and crop disease detection, farmers can make informed decisions that lead to improved yields, reduced input costs, and enhanced sustainability.

The implementation of the Crop Recommendation System marks a pivotal moment in modern agriculture, bridging the gap between traditional farming practices and cutting-edge technology. By empowering farmers with actionable insights and recommendations, the system facilitates more efficient resource utilization, minimizes environmental impact, and fosters resilience against crop diseases and adverse weather conditions. Furthermore, the user-friendly interface and accessibility of the system ensure that farmers of all backgrounds and experience levels can benefit from its capabilities, driving widespread adoption and positive impact across agricultural communities.

Future Enhancements:

- Integration of IoT Sensors: Incorporating data from IoT sensors installed in agricultural fields can provide real-time information on soil moisture, temperature, and nutrient levels, enhancing the accuracy of recommendations.

- Multi-Criteria Decision Making: Introduce multi-criteria decision-making techniques to consider additional factors such as market demand, profitability, and sustainability goals in crop recommendation and fertilizer selection.

- Enhanced Disease Detection: Further refine the disease detection module by expanding the dataset to include a wider range of crop diseases and implementing advanced image processing and pattern recognition algorithms.

- User Feedback Mechanism: Implement a feedback mechanism where farmers can provide feedback on the effectiveness of recommendations and contribute to the improvement of the system's performance over time.

- Integration with Precision Agriculture Technologies: Integrate with precision agriculture technologies such as GPS-guided machinery and variable rate application systems to enable precise and targeted application of fertilizers and pesticides based on recommendation insights.

- Support for Diverse Crop Varieties: Expand the system's database to include a broader range of crop varieties, including region-specific and niche crops, to cater to the diverse needs of farmers across different regions.

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