D.Y. PATIL COLLEGE OF ENGINEERING & TECHNOLOGY,
KASABA BAWADA, KOLHAPUR

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

D Y PATIL
COLLEGE of
ENGINEERING & TECHNOLOGY
(AN AUTONOMOUS INSTITUTE)
KASABA BAWADA, KOLHAPUR

A

Project – I Report

on

"Crop Recommendation System"

Submitted by:

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Class: T.Y B.Tech.

(CSE AIML)

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CERTIFICATE

This is to certify that the following members have satisfactorily completed the Project-I work entitled **"Crop Recommendation System"** at T.Y.B.Tech. CSE (AIML) Semester-V as prescribed in the curriculum of DYPCET Autonomy for the academic year 2023-24.

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(Project-I Guide) — **(**HOD CSE (AIML))

Mr. Nitish Shinde — **Dr. S. D. Chede**

(Project- I Coordinator) — (Principal)

External Examiner

ACKNOWLEDGEMENT

The success & find outcome of this project required a lot of guidance & assistance from many people and We are extremely privileged to have got all along the completion of our project. All that we have done is only due to such supervision & assistance & We would not forget to thanks them.

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We would like to express our gratitude and deep regards to department project coordinator **Mr.Nitish Shinde** for his guidance and support throughout the completion of project work. We would like to express our heart full gratitude to him for his continuous encouragement & motivation.

It is our pleasure to acknowledge the help we have been received from institute and the Individual. We would like to thank our Principal **Dr. S. D. Chede** Principal, D. Y. Patil College of Engineering and Technology, Kolhapur in particular for always giving encouragement, support and the excellent facilities provided.

Date:

Place: Kolhapur

Roll no.	**Name**	**Signature**
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ABSTRACT

Crop Recommendation System for agriculture is based on various input parameters. The system takes into account several factors such as soil type, climate, rainfall, temperature, humidity, and pH levels to determine the most suitable crops for a given region. By analyzing historical data and using predictive models, the system provides personalized recommendations tailored to the specific conditions of a farm or agricultural area. The recommender model is built as a hybrid model using the classifier machine learning algorithm. Based on the appropriate parameters, the system will recommend the crop. Technology based crop recommendation system for agriculture helps the farmers to increase the crop yield by recommending a suitable crop for their land with the help of geographic and the climatic parameters.

The proposed hybrid recommender model is found to be effective in commending a suitable crop. Crop yield production value pupation has a positive practical significance for guiding agricultural production and for notifying the change in market rate of crop to the farmer. The concept of this paper is to implement the crop selection method so that this method helps in solving many agriculture and farmers problems this improves our Indian economy by maximizing the yield rate of crop production. Different types of land condition. So, the quality of the crops is identified using ranking process. By this process the rate of the low quality and high-quality crop is also notified. The usage of ensemble of classifiers paves a path way to make a better decision on predictions due to the usage of multiple classifiers. Further a ranking process is applied for decision making in order to select the classifiers results. This system is used to predict the cost of crop which is yielded for further

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1. INTRODUCTION

The Crop Recommendation System is a machine learning-based application that provides recommendations for suitable crops based on various environmental and soil conditions. It aims to assist farmers and agricultural professionals in making informed decisions about crop selection, optimizing yields, and maximizing profitability. The system takes into account several factors such as soil type, climate, rainfall, temperature, humidity, and pH levels to determine the most suitable crops for a given region. By analyzing historical data and using predictive models, the system provides personalized recommendations tailored to the specific conditions of a farm or agricultural area. In the world of developing technologies, the success of sharing information will help the agriculturists in realizing and developing their potential. The information sharing is that the valuable and timely information is being shared between agriculturists, either formally or informally. The willingness of information sharing refers to the open attitude among agriculturists.

This open attitude determines the degree and scope of information sharing. Using web-technologies like html and CSS we build the web application; we create dataset by gathering data from multiple resources and place them in place which is used to predict the price of the crop and results are subjected to non-linear test later priorities are set and rankings are given to the list of crops. Place information in our application and share that information to agriculturists whose data is collected and stored in the MySQL server. We software to automatically send the updated information to the agriculturists in the form of text message. So that agriculturists no need to go to near by towns and cities to know the updated information. We will be machine learning algorithms to predict the price of the crop for the next two months. For prediction purpose we will be using Support vector machine (SVM), Naïve Bayes (NB) and K-Nearest Neighbour (KNN) algorithms to predict the cost of the crop production. Further, a ranking process is applied for decision making in order to select the classifiers results.

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2. LITERATURE REVIEW.

[1] Jignesh m. Jetha Nikhil Gond Aliya, Vinita Shah, **"A Review on Data Mining Techniques for Fertilizer Recommendation 2018".**

To keep up nutrition levels in the soil in case of deficiency, fertilizers are added to soil. The standard issue existing among the Indian agriculturists choose approximate amount of fertilizers and add them manually. Excess or deficient extension of fertilizers can harm the plants life and reduce the yield. This paper gives overview of various data mining frameworks used on cultivating soil dataset for fertilizer recommendation.

[2] M.C.S. Geetha **"A Survey on Data Mining Techniques in Agriculture, 2015".**

Agriculture is the most critical application area especially in the developing nations like India. Use of information technology in agriculture can change the situation of decision making and farmers can yield in better way. This paper integrates the work of several authors in a single place so it is valuable for specialists to get data of current situation of data mining systems and applications in context to farming field.

[3] S. Srija, R. Geetha Chanda, S. Lavanya, Dr. M. Kalpana **"Ph. DAgroNutri Android Application,2016".**

This paper communicates the idea regarding the making of Agro Nutri an android application that helps in conveying the harvest particular fertilizer amount to be applied. The idea is to calculate the measure of NPK composts to be applied depend on the blanked proposal of the crop of interest. This application works depends on the product chosen by the farmer and that is taken as input, thus providing the farmers. The future scope of the Agro Nutri is that GPRS can be included so that according to location nutrients are suggested.

[4] Karan **"Deep Machine Learning: Applications in Indian Agriculture, 2016".**

Kaur Agriculture is a field that has been lacking from adaption of technologies and their advancements. Indian agriculturists should be up to the mark with the universal procedures. Machine learning is a native concept that can be applied to every field on all inputs and outputs. It has effectively settled its ability over ordinary calculations of software engineering and measurements. Machine learning calculations have improved the exactness of artificial intelligence machines including sensor-based frameworks utilized in accuracy farming. This paper has evaluated the different uses of machine learning in the farming area. It additionally gives a knowledge into the inconveniences looked by Indian farmers and how they can be resolved using these procedures.

[5] Geeks for Geeks (How it works) - Simply Explained. [Online]

Recommendation system that will take in the different environmental attributes such as the nitrogen, phosphorous, potassium content in the soil, temperature, etc., and predict what is the best crop that the user can plant so that it survives in the given climatic conditions**.**

3. PROBLEM STATEMENT

The ultimate purpose of crop recommendation system is to assist farmers and agricultural professionals in making informed decisions about crop selection, optimizing yields, and maximizing profitability.

The system takes into account several factors such as soil type, climate, rainfall, temperature, humidity, and pH levels to determine the most suitable crops for a given region. By analyzing historical data and using predictive models, the system provides personalized recommendations tailored to the specific conditions of a farm or agricultural area. The solution will benefit farmers to maximize productivity in agriculture, reduce soil degradation in cultivated fields, and reduce fertilizer use in crop production by recommending the right crop by considering various attributes.

.

4. OBJECTIVES

Following are the objectives of Crop recommendation system using Machine Learning:

1. Data set collection from various sources.

2. Data parsing and cleansing technique is applied to make the raw data into processing data.

3. The data collected is subject to machine learning system along with run time analysis makes an efficient crop value updating system.

4. Usage of Ensemble of classifiers makes the model more robust and efficient.

5. Ranking technique used in the project helps us to make efficient decisions.

6. Creating a web application for user registrations and collection of data.

7. The main objective is to obtain a better variety of crops that can be grown over the season. The proposed system would help to minimize the difficulties faced by farmers in choosing a crop and maximize the yield.

8. The model predicts the best crop by studying factors such as soil type, climate, rainfall, temperature, humidity, and pH levels to determine the most suitable crops for a given region. By analyzing historical data and using predictive models, the system provides personalized recommendations tailored to the specific conditions of a farm or agricultural area

5. PROPOSED WORK

5.1 SYSTEM REQUIREMENTS.

1. Hardware Requirements:

1. CPU: A modern multi-core processor (Intel i5/i7, AMD Ryzen) is required.
2. Storage: A minimum of 512GB is advised.
3. RAM: A minimum of 8GB, 16GB is required.

2. Software Requirements:

1. Operating system: Windows OS
2. Programming language: Python, HTML, CSS
3. Database: MySQL, PHP
4. Internet and browsing facilities.

5.2 SYSTEM ARCHITECTURE.

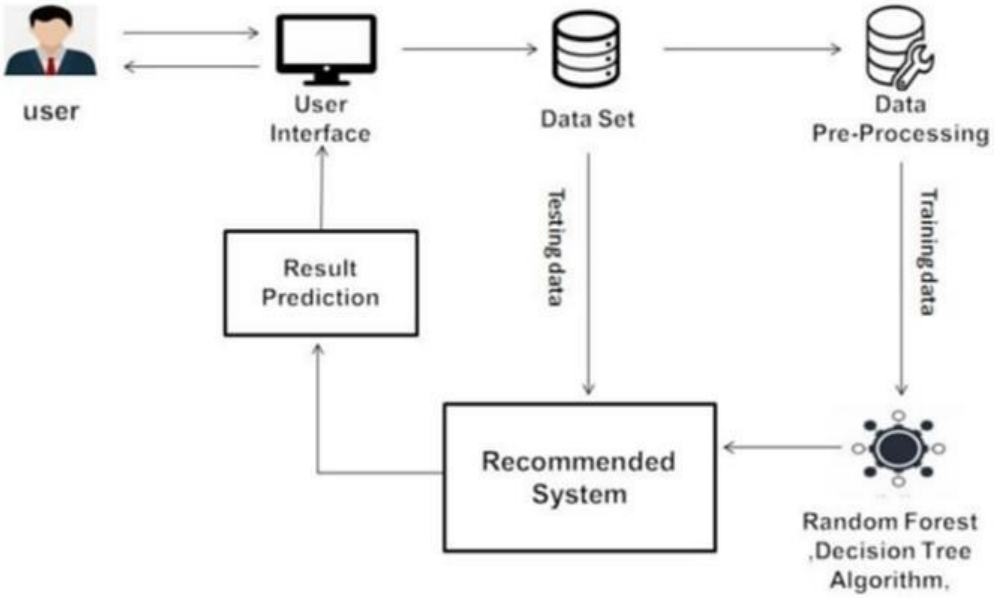


Fig 5.2.1: System Architecture

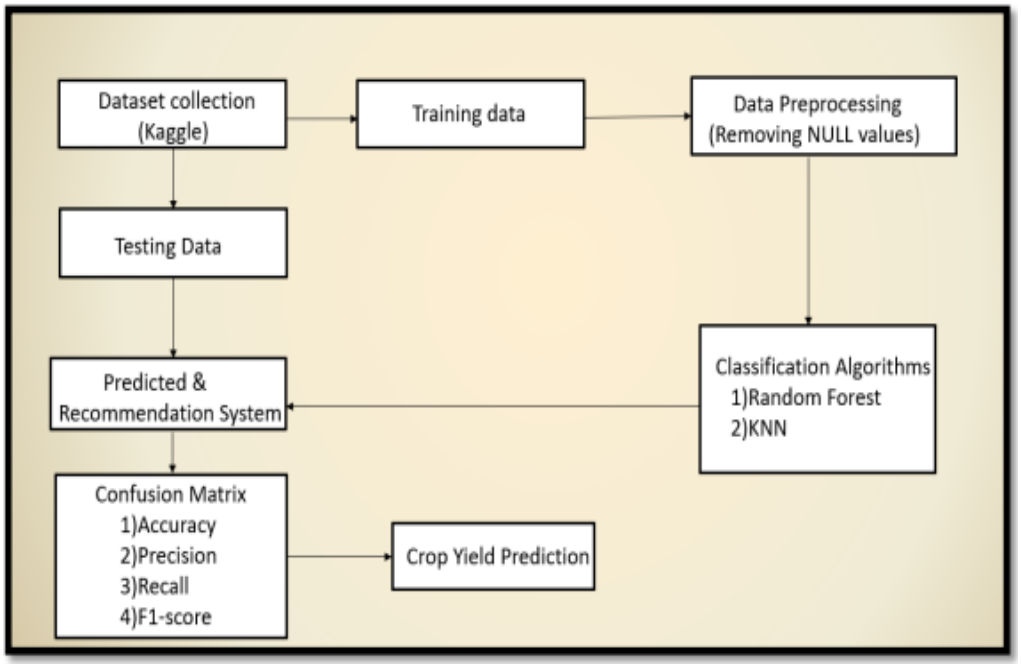


Fig 5.2.2: System Architecture

Crop recommendation

A crop recommendation system that will take in the different environmental attributessuch as the nitrogen, phosphorous, potassium content in the soil, temperature, etc., and predict what is the best crop that the user can plant so that it survives in the given climatic conditions. Crop recommendation system that uses machine learning works by analyzing various data inputs to suggest the best crops for a specific area or field. Here's how it generally works:

2. **Data Collection:**

   The system gathers relevant data, such as climate information, soil characteristics, historical crop yields, local weather patterns, and even satellite imagery.

3. **Data Pre-processing:**

   The collected data is cleaned, transformed, and organized to be suitable for analysis. This involves handling missing values, standardizing units, and preparing the data for training.

4. **Feature Extraction:**

   Relevant features, or characteristics, are selected from the data that can impact crop growth, such as temperature, rainfall, humidity, soil pH, nutrient levels, etc.

5. **Model Selection:**

   A suitable machine learning model is chosen based on the nature of the problem. This could be a regression model, decision tree, random forest, neural network, or any other model that fits the data and can make predictions.

6. **Training the Model:**

   The model is trained using historical data where the inputs are the selected features and the outputs are the corresponding crop yields or success rates. The model learns patterns and relationships from this data.

7. **Validation and Testing:**

   The trained model is validated using separate sets of data that it hasn't seen before. This helps assess how well the model generalizes to new data.

8. **Prediction and Recommendation:**

   Once the model is trained and validated, it's ready to make predictions. When given input data about a specific area or field, the model generates recommendations for suitable crops based on its learned patterns.

9. **Feedback Loop:**

   The system can continually improve by incorporating new data from actual crop outcomes. This feedback loop helps the model adapt and refine its recommendations over time.

10. **User Interaction:**

    Users, such as farmers, can interact with the system by providing information about their land and receiving personalized crop suggestions. The system might also display confidence levels for its recommendations.

11. **Deployment:**

    The trained model can be deployed as part of a web or mobile application, allowing users to access recommendations easily.

Overall, the crop recommendation system uses machine learning to process complex relationships between various factors that affect crop growth. It helps farmers make informed decisions, optimize yields, and manage resources more efficiently.

5.3 METHODOLOGY.

Developing a crop recommendation system using machine learning involves several steps. Here's a high-level methodology:

1. Data Collection:

- Gather historical data on crops, including crop types, planting dates, weather conditions, soil properties, and yields.
- Collect data on the geographic location of farms or fields.

2. Data Preprocessing:

- Clean and preprocess the data, handling missing values and outliers.
- Normalize or standardize numerical features.
- Encode categorical variables.

3. Feature Selection/Engineering:

- Identify relevant features that affect crop choice, such as climate data, soil quality, and location.
- Create new features if needed, like seasonal weather patterns or soil indices.

4. Model Selection:

- Choose machine learning algorithms suitable for the problem, such as decision trees, random forests, or neural networks.
- Consider using collaborative filtering or content-based filtering techniques.

5. Training:

- Split the data into training and testing sets.
- Train the selected machine learning model on the training data.

6. Model Evaluation:

- Assess the model's performance using metrics like accuracy, precision, recall, or F1-score.
- Use cross-validation to ensure the model generalizes well.

7. Recommendation Generation:

- For a given location and other relevant information, use the trained model to generate crop recommendations.
- Consider offering multiple recommendations based on different factors or scenarios.

8. User Interface:

- Develop a user-friendly interface (e.g., a web or mobile app) to input user data and display crop recommendations.

9. Deployment:

- Deploy the system in an accessible manner for farmers or agricultural stakeholders.
- Continuously monitor and update the model as new data becomes available.

10. Feedback Loop:

- Encourage users to provide feedback on the recommendations.
- Use this feedback to improve the system over time.

11. Scaling:

- Consider scalability for handling a large number of users and data points.

5.4 MODULE DETAILS.

1. **Data Collection and Preparation**:

Gathered Crop data from various sources such as GitHub, Kaggle. Cleaned the data by handling missing values: impute missing values for numerical features (e.g., using mean or median) and decide on a strategy for categorical features. Detected and addressed outliers that could adversely affect model performance.

2. **Feature Engineering**:

Identified relevant features such as processor type, RAM, storage, graphics card, screen size, brand, operating system, etc. Engineered new features like price-to-performance ratios, brand popularity scores, or feature combinations that could influence laptop prices. Normalized numerical features to bring them to a common scale and reduced the impact ofdifferent ranges.

3. **Model Training**:

Splitted the dataset into training and testing sets (e.g., 70% for training and 30% for testing). Trained selected regression model using the training data and chosen algorithms.
Monitored the training process, and kept track of model performance on the training data.

4. **Hyperparameter Tuning**:

Identified hyperparameters specific to each algorithm (e.g., learning rate, max depth,number of estimators). Used techniques like grid search or random search to find the combination ofhyperparameters that optimize model performance.
Applied cross-validation during hyperparameter tuning to ensure robustness.

6. EXPERIMENTAL WORK.

In a machine learning project like this, the experimental work typically involved several key steps:

1) **Data Collection**: Gathered a dataset containing information about various laptops. This included specifications such as processor type, RAM, storage, screen size, brand, and, most importantly, the price.

2) **Data Preprocessing**: Cleaned the data, handling missing values, and converting categorical variables into a suitable format for machine learning algorithms.

3) **Feature Selecting**: Identified which features (specifications) are most relevant for predicting laptop prices. This involved statistical analysis and domain knowledge.

4) **Model Selecting**: Selected a machine learning algorithm suitable for regression tasks (since predicting prices is a regression problem). Common algorithms include linear regression, decision trees, or ensemblemethods like random forests.

5) **Training the Model**: Using a portion of the dataset to train the selected machine learning model. The model learns patterns in the data during this phase.

6) **Evaluating the model**: Assessing the model's performance using metrics like mean absolute error (MAE), mean squared error (MSE), or root mean squared error (RMSE) on a separate portion of the dataset that the model hasn't seen before (testing data).

7) **Hyperparameter Tuning the model**: Optimizing the model's hyperparameters to improve its performance.

7. RESULT ANALYSIS

1. Data collection & importing

In a crop recommendation system, data collection involves gathering information on soil quality, climate, and historical crop yields. This data is then imported into the system for analysis and decision-making to suggest the most suitable crops for a particular area.

```
import numpy as np
import pandas as pd
```

Importing Data

```
crop = pd.read_csv("Crop_recommendation.csv")
crop.head()
```

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

2. Dataset information

The dataset in a crop recommendation system typically includes details on soil characteristics, weather patterns, historical crop performance, and regional agricultural practices. This data is used to make informed recommendations for optimal crop selection based on local conditions.

```
crop.shape
```

```
(2200, 8)
```

```
crop.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2200 entries, 0 to 2199
Data columns (total 8 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   N            2200 non-null   int64  
 1   P            2200 non-null   int64  
 2   K            2200 non-null   int64  
 3   temperature  2200 non-null   float64
 4   humidity     2200 non-null   float64
 5   ph           2200 non-null   float64
 6   rainfall     2200 non-null   float64
 7   label        2200 non-null   object 
dtypes: float64(4), int64(3), object(1)
memory usage: 137.6+ KB
```

```
crop.isnull().sum()
```

```
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64
```

```
crop.duplicated().sum()
```

```
0
```

```
crop.describe()
```

	N	P	K	temperature	humidity	ph	rainfall
count	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000
mean	50.551818	53.362727	48.149091	25.616244	71.481779	6.469480	103.463655
std	36.917334	32.985883	50.647931	5.063749	22.263812	0.773938	54.958389
min	0.000000	5.000000	5.000000	8.825675	14.258040	3.504752	20.211267
25%	21.000000	28.000000	20.000000	22.769375	60.261953	5.971693	64.551686
50%	37.000000	51.000000	32.000000	25.598693	80.473146	6.425045	94.867624
75%	84.250000	68.000000	49.000000	28.561654	89.948771	6.923643	124.267508
max	140.000000	145.000000	205.000000	43.675493	99.981876	9.935091	298.560117

3. Exploration of Dataset

Dataset exploration in a crop recommendation system involves the analysis of available data to understand factors like soil quality, climate conditions, historical crop yields, and other relevant information.

```
corr = crop.corr()
corr
```

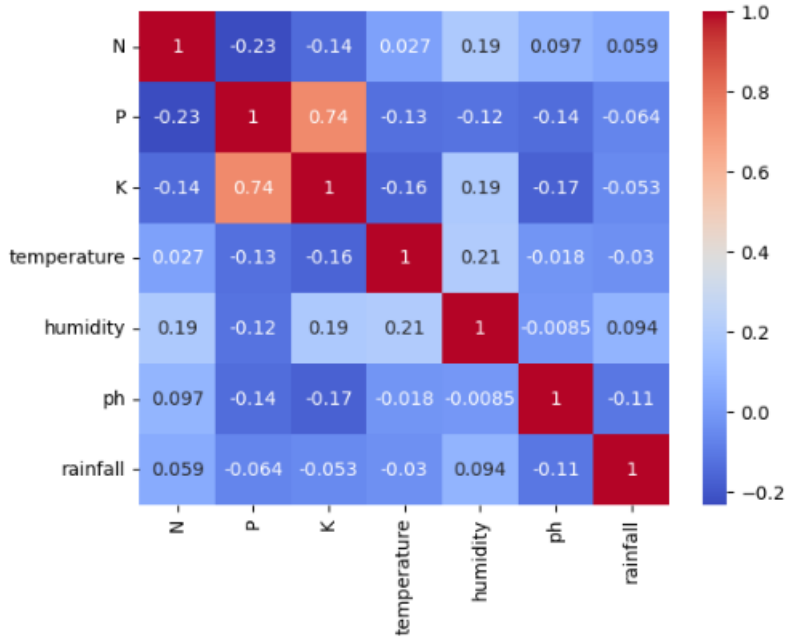
	N	P	K	temperature	humidity	ph	rainfall
N	1.000000	-0.231460	-0.140512	0.026504	0.190688	0.096683	0.059020
P	-0.231460	1.000000	0.736232	-0.127541	-0.118734	-0.138019	-0.063839
K	-0.140512	0.736232	1.000000	-0.160387	0.190859	-0.169503	-0.053461
temperature	0.026504	-0.127541	-0.160387	1.000000	0.205320	-0.017795	-0.030084
humidity	0.190688	-0.118734	0.190859	0.205320	1.000000	-0.008483	0.094423
ph	0.096683	-0.138019	-0.169503	-0.017795	-0.008483	1.000000	-0.109069
rainfall	0.059020	-0.063839	-0.053461	-0.030084	0.094423	-0.109069	1.000000

4. Visualization of Dataset

Data visualization is the process of creating graphical representations, like charts and graphs, to present complex data in a visual format, making it easier to understand, identify trends, and communicate insights effectively in fields like data analysis, research, and business reporting.

```
import seaborn as sns
sns.heatmap(corr,annot=True,cbar=True, cmap='coolwarm')
```

```
<AxesSubplot:>
```



5. Encoding on dataset

In data processing, encoding refers to the transformation of categorical variables into numerical values, enabling machine learning algorithms to work with such data, allowing for the analysis and prediction of outcomes based on these encoded features.

```
crop_dict = {
    'rice': 1,
    'maize': 2,
    'jute': 3,
    'cotton': 4,
    'coconut': 5,
    'papaya': 6,
    'orange': 7,
    'apple': 8,
    'muskmelon': 9,
    'watermelon': 10,
    'grapes': 11,
    'mango': 12,
    'banana': 13,
    'pomegranate': 14,
    'lentil': 15,
    'blackgram': 16,
    'mungbean': 17,
    'mothbeans': 18,
    'pigeonpeas': 19,
    'kidneybeans': 20,
    'chickpea': 21,
    'coffee': 22
}
crop['crop_num']=crop['label'].map(crop_dict)
```

```
crop['crop_num'].value_counts()
```

```
1     100
2     100
3     100
4     100
5     100
6     100
7     100
8     100
9     100
10    100
11    100
12    100
13    100
14    100
15    100
16    100
17    100
18    100
19    100
20    100
21    100
22    100
Name: crop_num, dtype: int64
```

6. Algorithms with its accuracy on dataset

Training Models

In [27]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.tree import ExtraTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.metrics import accuracy_score

# create instances of all models
models = {
    'Logistic Regression': LogisticRegression(),
    'Naive Bayes': GaussianNB(),
    'Support Vector Machine': SVC(),
    'K-Nearest Neighbors': KNeighborsClassifier(),
    'Decision Tree': DecisionTreeClassifier(),
    'Random Forest': RandomForestClassifier(),
    'Bagging': BaggingClassifier(),
    'AdaBoost': AdaBoostClassifier(),
    'Gradient Boosting': GradientBoostingClassifier(),
    'Extra Trees': ExtraTreeClassifier(),
}


for name, md in models.items():
    md.fit(X_train,y_train)
    ypred = md.predict(X_test)

    print(f"{name}  with accuracy : {accuracy_score(y_test,ypred)}")
```

```
Logistic Regression  with accuracy : 0.9636363636363636
Naive Bayes  with accuracy : 0.9954545454545455
Support Vector Machine  with accuracy : 0.9681818181818181
K-Nearest Neighbors  with accuracy : 0.9590909090909091
Decision Tree  with accuracy : 0.9818181818181818
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction func
tions (e.g. `skew`, `kurtosis`), the default behavior of `mode` typically preserves the axis it acts along. In SciPy 1.11.0, th
is behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken will b
e eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

```
Random Forest  with accuracy : 0.9931818181818182
Bagging  with accuracy : 0.9863636363636363
AdaBoost  with accuracy : 0.1409090909090909
Gradient Boosting  with accuracy : 0.9818181818181818
Extra Trees  with accuracy : 0.9090909090909091
```

7. Accuracy Chart

Sr. No.	Regression Model Name	Accuracy
1.	Random Forest Regression	99.3181
2.	Logistic Regression	96.3636
3.	K-Nearest Neighbours	95.9090

Input and output

Predictive System

```
def recommendation(N,P,k,temperature,humidity,ph,rainfal):
    features = np.array([[N,P,k,temperature,humidity,ph,rainfal]])
    transformed_features = ms.fit_transform(features)
    transformed_features = sc.fit_transform(transformed_features)
    prediction = rfc.predict(transformed_features).reshape(1,-1)

    return prediction[0]
```

```
N = 40
P = 50
k = 50
temperature = 40.0
humidity = 20
ph = 100
rainfall = 100

predict = recommendation(N,P,k,temperature,humidity,ph,rainfall)


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 predict[0] in crop_dict:
    crop = crop_dict[predict[0]]
    print("{} is a best crop to be cultivated ".format(crop))
else:
    print("Sorry are not able to recommend a proper crop for this environment")
```

```
Papaya is a best crop to be cultivated
```

Output

Papaya is a best crop to be cultivated

8. CONCLUSION.

The development of a crop recommendation system is a significant advancement in modern agriculture. By leveraging data analytics, machine learning, and agronomic knowledge, this system streamlines the decision-making process for farmers. The system's ability to analyze various parameters such as soil quality, climate, and historical data empowers farmers to make informed choices, maximizing crop yield and profitability. Additionally, it enhances sustainability by suggesting crops that are well-suited to the local environment, reducing resource wastage and environmental impact. Its user-friendly interface and accessibility enable even small-scale farmers to benefit from optimized crop selections, improving their livelihoods. However, ongoing improvements and adaptations are essential to ensure the system remains up-to-date and adaptable to changing agricultural conditions and emerging technologies. In essence, the crop recommendation system marks a pivotal step towards more efficient, data-driven, and sustainable agricultural practices.

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