In [1]:
```
import numpy as np
import pandas as pd
```

Read the Data

In [2]:
```
#Importing the data
crop = pd.read_csv('Crop_recommendation.csv')
```

In [3]:
```
crop
```

Out[3]:

	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
...	...	...	...	...	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507	coffee
2196	99	15	27	27.417112	56.636362	6.086922	127.924610	coffee
2197	118	33	30	24.131797	67.225123	6.362608	173.322839	coffee
2198	117	32	34	26.272418	52.127394	6.758793	127.175293	coffee
2199	104	18	30	23.603016	60.396475	6.779833	140.937041	coffee

2200 rows × 8 columns

In [4]:
```
crop.head()
```

Out[4]:

	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

In [5]:
```
#Shape of Data
crop.shape
```

Out[5]: (2200, 8)

In [6]:
```
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
```

In [7]:
```
crop.isna().sum()
```

Out[7]:
```
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64
```

In [8]:
```
crop.duplicated().sum()
```

Out[8]:
```
0
```

In [9]:
```
#describing the data
crop.describe()
```

Out[9]:

	N	P	K	temperature	humidity	ph	
count	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.
mean	50.551818	53.362727	48.149091	25.616244	71.481779	6.469480	103.
std	36.917334	32.985883	50.647931	5.063749	22.263812	0.773938	54.
min	0.000000	5.000000	5.000000	8.825675	14.258040	3.504752	20.
25%	21.000000	28.000000	20.000000	22.769375	60.261953	5.971693	64.
50%	37.000000	51.000000	32.000000	25.598693	80.473146	6.425045	94.
75%	84.250000	68.000000	49.000000	28.561654	89.948771	6.923643	124.
max	140.000000	145.000000	205.000000	43.675493	99.981876	9.935091	298.

Exploring data

In [10]:
```
correlation = crop.corr()
correlation
```

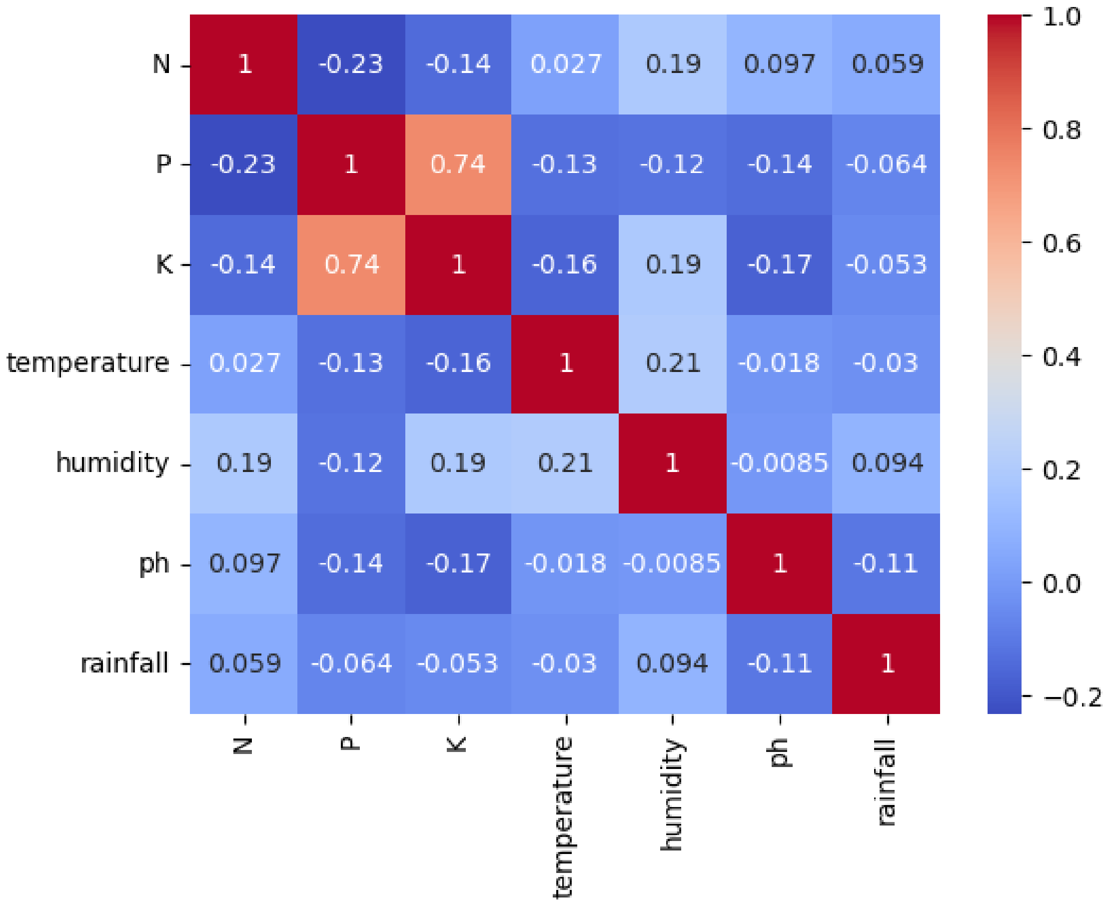
```
C:\Users\Dell\AppData\Local\Temp\ipykernel_11968\1129341823.py:1: FutureW
arning: The default value of numeric_only in DataFrame.corr is deprecate
d. In a future version, it will default to False. Select only valid colum
ns or specify the value of numeric_only to silence this warning.
  correlation = crop.corr()
```

Out[10]:

	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

In [11]:
```
import seaborn as sns
sns.heatmap(correlation, annot=True, cbar=True, cmap='coolwarm')
```

Out[11]: <Axes: >



In [12]:
```
crop['label'].unique()
```

Out[12]:
```
array(['rice', 'maize', 'chickpea', 'kidneybeans', 'pigeonpeas',
       'mothbeans', 'mungbean', 'blackgram', 'lentil', 'pomegranate',
       'banana', 'mango', 'grapes', 'watermelon', 'muskmelon', 'apple',
       'orange', 'papaya', 'coconut', 'cotton', 'jute', 'coffee'],
      dtype=object)
```

In [13]:
```
crop['label'].value_counts()
```

Out[13]:
```
rice           100
maize          100
jute           100
cotton         100
coconut        100
papaya         100
orange         100
apple          100
muskmelon      100
watermelon     100
grapes         100
mango          100
banana         100
pomegranate    100
lentil         100
blackgram      100
mungbean       100
mothbeans      100
pigeonpeas     100
kidneybeans    100
chickpea       100
coffee         100
Name: label, dtype: int64
```

Data Encoding

In [14]:
```
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)
```

In [15]:
```
crop['crop_num'].value_counts()
```

Out[15]:
```
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
```

In [16]:
```
crop.sample(2)
```

Out[16]:

	N	P	K	temperature	humidity	ph	rainfall	label	crop_num
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice	1
714	51	56	18	28.127878	64.209777	6.706506	70.863408	blackgram	16

Train Test Split

In [17]:
```
X = crop.drop(['crop_num','label'],axis=1)
y = crop['crop_num']
```

In [18]:
```
X
```

Out[18]:

	N	P	K	temperature	humidity	ph	rainfall
0	90	42	43	20.879744	82.002744	6.502985	202.935536
1	85	58	41	21.770462	80.319644	7.038096	226.655537
2	60	55	44	23.004459	82.320763	7.840207	263.964248
3	74	35	40	26.491096	80.158363	6.980401	242.864034
4	78	42	42	20.130175	81.604873	7.628473	262.717340
...	...	...	...	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507
2196	99	15	27	27.417112	56.636362	6.086922	127.924610
2197	118	33	30	24.131797	67.225123	6.362608	173.322839
2198	117	32	34	26.272418	52.127394	6.758793	127.175293
2199	104	18	30	23.603016	60.396475	6.779833	140.937041

2200 rows × 7 columns

In [19]:
```
X.shape
```

Out[19]: (2200, 7)

In [20]:
```
y.shape
```

Out[20]: (2200,)

In [21]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2, ranc
```

In [22]:
```
X_train.shape
```

Out[22]: (1760, 7)

In [23]:
```
X_test.shape
```

Out[23]:
```
(440, 7)
```

In [24]:
```
X_train
```

Out[24]:

	N	P	K	temperature	humidity	ph	rainfall
1656	17	16	14	16.396243	92.181519	6.625539	102.944161
752	37	79	19	27.543848	69.347863	7.143943	69.408782
892	7	73	25	27.521856	63.132153	7.288057	45.208411
1041	101	70	48	25.360592	75.031933	6.012697	116.553145
1179	0	17	30	35.474783	47.972305	6.279134	97.790725
...	...	...	...	...	...	...	...
1638	10	5	5	21.213070	91.353492	7.817846	112.983436
1095	108	94	47	27.359116	84.546250	6.387431	90.812505
1130	11	36	31	27.920633	51.779659	6.475449	100.258567
1294	11	124	204	13.429886	80.066340	6.361141	71.400430
860	32	78	22	23.970814	62.355576	7.007038	53.409060

1760 rows × 7 columns

Scale the features using MinMaxScaler

In [25]:
```
from sklearn.preprocessing import MinMaxScaler
ms = MinMaxScaler()

X_train = ms.fit_transform(X_train)
X_test = ms.fit_transform(X_test)
```

In [26]:
```
X_train
```

Out[26]:
```
array([[0.12142857, 0.07857143, 0.045     , ..., 0.9089898 , 0.48532225,
        0.29685161],
       [0.26428571, 0.52857143, 0.07      , ..., 0.64257946, 0.56594073,
        0.17630752],
       [0.05      , 0.48571429, 0.1       , ..., 0.57005802, 0.58835229,
        0.08931844],
       ...,
       [0.07857143, 0.22142857, 0.13      , ..., 0.43760347, 0.46198144,
        0.28719815],
       [0.07857143, 0.85      , 0.995     , ..., 0.76763665, 0.44420505,
        0.18346657],
       [0.22857143, 0.52142857, 0.085     , ..., 0.56099735, 0.54465022,
        0.11879596]])
```

Standarization

In [27]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()

sc.fit(X_train)
X_train = sc.transform(X_train)
X_test = sc.transform(X_test)
```

In [28]:
```
X_train
```

Out[28]:
```
array([[-9.03426596e-01, -1.12616170e+00, -6.68506601e-01, ...,
         9.36586183e-01,  1.93473784e-01,  5.14970176e-03],
       [-3.67051340e-01,  7.70358846e-01, -5.70589522e-01, ...,
        -1.00470485e-01,  8.63917548e-01, -6.05290566e-01],
       [-1.17161422e+00,  5.89737842e-01, -4.53089028e-01, ...,
        -3.82774991e-01,  1.05029771e+00, -1.04580687e+00],
       ...,
       [-1.06433917e+00, -5.24091685e-01, -3.35588533e-01, ...,
        -8.98381379e-01, -6.34357580e-04, -4.37358211e-02],
       [-1.06433917e+00,  2.12501638e+00,  3.05234239e+00, ...,
         3.86340190e-01, -1.48467347e-01, -5.69036842e-01],
       [-5.01145154e-01,  7.40255346e-01, -5.11839275e-01, ...,
        -4.18045489e-01,  6.86860180e-01, -8.96531475e-01]])
```

Training Models

In [29]:
```
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 instance 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 : 0.9568181818181818
Naive Bayes with accuracy : 0.9931818181818182
Support Vector Machine with accuracy : 0.9704545454545455
K-Nearest Neighbors with accuracy : 0.9568181818181818
Decision Tree with accuracy : 0.9818181818181818
Random Forest with accuracy : 0.990909090909091
Bagging with accuracy : 0.9818181818181818
AdaBoost with accuracy : 0.1409090909090909
Gradient Boosting with accuracy : 0.9636363636363636
Extra Trees with accuracy : 0.925
```

In [38]:
```
rfc = GaussianNB()
rfc.fit(X_train,y_train)
ypred = rfc.predict(X_test)
accuracy_score(y_test,ypred)
```

Out[38]: 0.9931818181818182

Predictive System

In [39]:
```
def recommendation(N,P,K,temperature,humidity, ph, rainfall):
    features = np.array([[N,P,K,temperature,humidity, ph, rainfall]])
    prediction = rfc.predict(features).reshape(1,-1)

    return prediction[0]
```

In [60]:
```

N = 90
P = 42
K = 43

temperature = 20
humidity = 82
ph = 6.5
rainfall = 202

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

crop_dict = {1: "Rice", 2: "Maize", 3: "Jute", 4: "Cotton", 5: "Coconut", 6
                 8: "Apple", 9: "Muskmelon", 10: "Watermelon", 11: "Grapes"
                 14: "Pomegranate", 15: "Lentil", 16: "Blackgram", 17: "Mur

                 19: "Pigeonpeas", 20: "Kidneybeans", 21: "Chickpea", 22: "
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 environme
```

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

In [59]:
```
import pickle
pickle.dump(rfc, open('model.pkl','wb'))
```

In [34]:
```
import sklearn

print(sklearn.__version__)
```

```
1.2.2
```

In [ ]:
```

```