In [1]:

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

In [2]:

```
crop = pd.read_csv(r"C:\Users\Utkarsh\Desktop\Juggad_hacks\Crop_recommendation.csv'
crop.head()
```

Out[2]:

| | 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 [3]:

```
crop.shape
```

Out[3]:

```
(2200, 8)
```

In [4]:

```
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 [5]:

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

Out[5]:

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

In [6]:

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

Out[6]:

```
0
```

In [7]:

```
crop.describe()
```

Out[7]:

| | 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 |

In [8]:

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

Out[8]:

| | 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 |

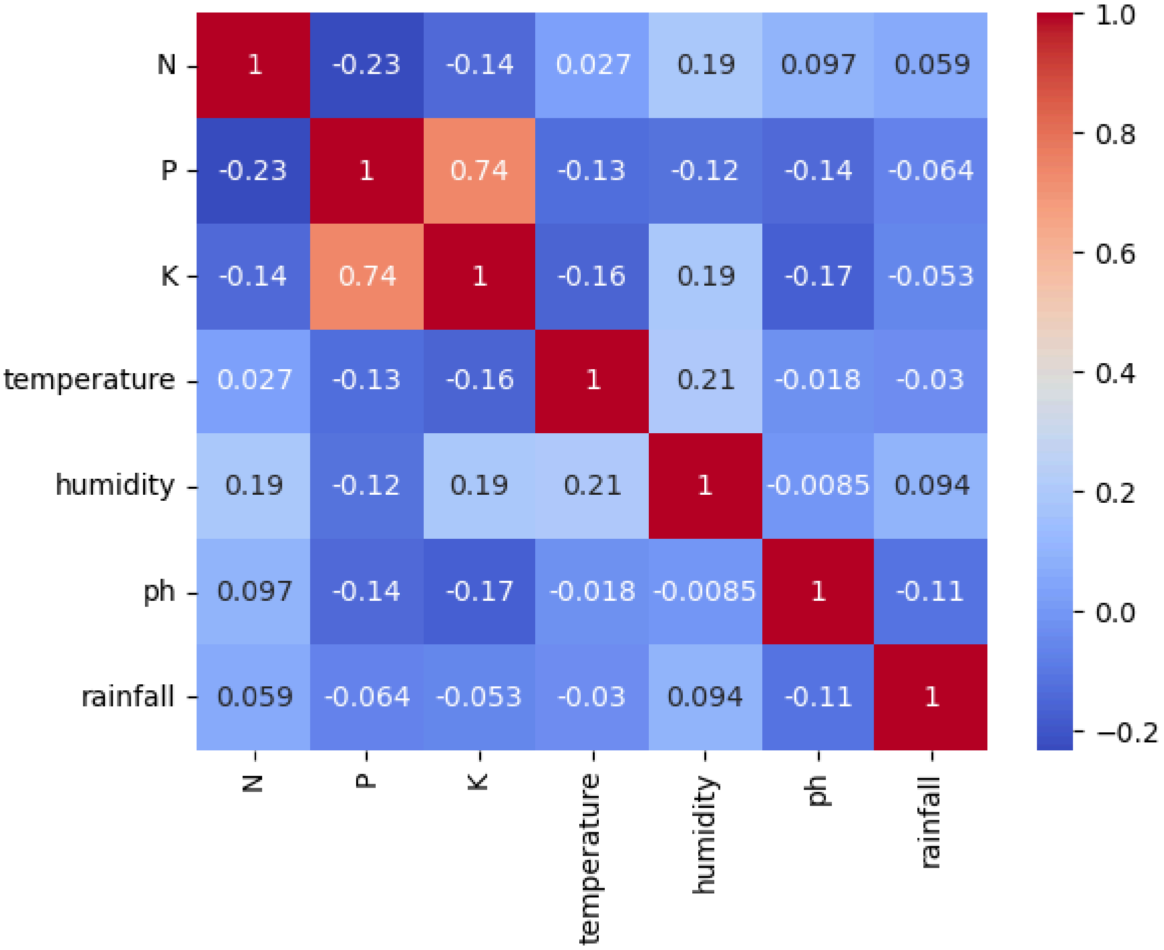
In [9]:

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

```
C:\Users\Utkarsh\anaconda3\lib\site-packages\scipy\__init__.py:155: UserWarning: A
NumPy version >=1.18.5 and <1.25.0 is required for this version of SciPy (detected
version 1.26.4
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

Out[9]:

```
<AxesSubplot:>
```

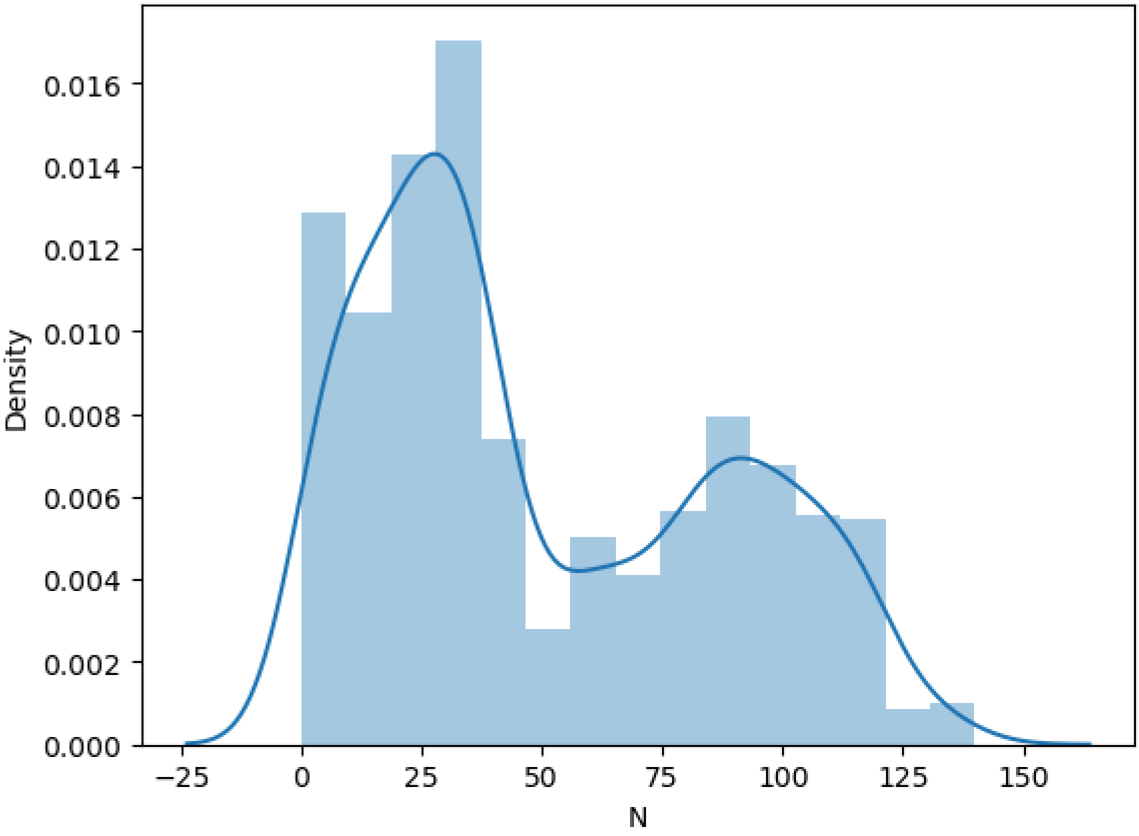


In [10]:
```
crop['label'].value_counts()
```

Out[10]:
```
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
```

In [11]:
```
import matplotlib.pyplot as plt
sns.distplot(crop['N'])
plt.show()
```

```
C:\Users\Utkarsh\anaconda3\lib\site-packages\seaborn\distributions.py:2619: Future
Warning: `distplot` is a deprecated function and will be removed in a future versi
on. Please adapt your code to use either `displot` (a figure-level function with s
imilar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [12]:

```
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 [13]:

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

Out[13]:

```
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 [14]:

```python
# crop.drop(['label'],axis=1,inplace=True)
crop.head()
```

Out[14]:

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

In [15]:

```python
#TRAIN, TEST, SPLIT
```

In [16]:

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

In [17]:

```python
X
```

Out[17]:

| | 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 [18]:

```
y.shape
```

Out[18]:

```
(2200,)
```

In [19]:

```
from sklearn.model_selection import train_test_split
```

In [20]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_sta
```

In [21]:

```
X_train.shape
```

Out[21]:

```
(1760, 7)
```

In [22]:

```
X_test.shape
```

Out[22]:

```
(440, 7)
```

In [23]:

```
X_train
```

Out[23]:

| | 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

In [24]:

```
#Scale the features using MinMaxScaler
```

In [25]:

```
from sklearn.preprocessing import MinMaxScaler
ms = MinMaxScaler()

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

In [27]:

```
#Standarization
```

In [28]:

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()


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

In [29]:

```
X_train
```

Out[29]:

```
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]])
```

In [30]:

```python
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:\Users\Utkarsh\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:
228: FutureWarning: Unlike other reduction functions (e.g. `skew`, `kurtosis`), th
e default behavior of `mode` typically preserves the axis it acts along. In SciPy
1.11.0, this behavior will change: the default value of `keepdims` will become Fal
se, the `axis` over which the statistic is taken will be eliminated, and the value
None will no longer be accepted. Set `keepdims` to True or False to avoid this war
ning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

```
Random Forest  with accuracy : 0.9954545454545455
Bagging  with accuracy : 0.9886363636363636
AdaBoost  with accuracy : 0.1409090909090909
Gradient Boosting  with accuracy : 0.9818181818181818
Extra Trees  with accuracy : 0.8818181818181818
```

In [31]:

```
rfc = RandomForestClassifier()
rfc.fit(X_train,y_train)
ypred = rfc.predict(X_test)
accuracy_score(y_test,ypred)
```

Out[31]:

```
0.9931818181818182
```

In [32]:

```
#Predictive System
```

In [33]:

```
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]
```

In [ ]:

```
N = 60
P = 90
k = 87
temperature = 16.5
humidity = 4.5
ph = 30.0
rainfall = 10.0

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


crop_dict = {1: "Rice", 2: "Maize", 3: "Jute", 4: "Cotton", 5: "Coconut", 6: "Papay
                 8: "Apple", 9: "Muskmelon", 10: "Watermelon", 11: "Grapes", 12: "N
                 14: "Pomegranate", 15: "Lentil", 16: "Blackgram", 17: "Mungbean",
                 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")
```

In [ ]:

```
import pickle
pickle.dump(rfc,open('model.pkl','wb'))
pickle.dump(ms,open('minmaxscaler.pkl','wb'))
pickle.dump(sc,open('standscaler.pkl','wb'))
```

In [ ]: