In [1]:

```
# Importing Required Libraries
```

In [2]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.stats import skew
from scipy import stats
from sklearn import preprocessing
from sklearn.preprocessing import MinMaxScaler
import seaborn as sns
```

In [3]:

```
%matplotlib inline
```

In [4]:

```
# Reading the CSV File and Storing in the form of a Data Frame
```

In [5]:

```
data=pd.read_csv('yield_prediction.csv')
```

In [6]:

```
data.head()
```

Out[6]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
0	Andaman and Nicobar Islands	NICOBARS	2000.0	Kharif	Arecanut	1254.0	2000.0
1	Andaman and Nicobar Islands	NICOBARS	2000.0	Kharif	Other Kharif pulses	2.0	1.0
2	Andaman and Nicobar Islands	NICOBARS	2000.0	Kharif	Rice	102.0	321.0
3	Andaman and Nicobar Islands	NICOBARS	2000.0	Whole Year	Banana	176.0	641.0
4	Andaman and Nicobar Islands	NICOBARS	2000.0	Whole Year	Cashewnut	720.0	165.0

In [7]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246091 entries, 0 to 246090
Data columns (total 7 columns):
 #   Column         Non-Null Count   Dtype  
---  ------         --------------   -----  
 0   State_Name     246091 non-null  object 
 1   District_Name  246091 non-null  object 
 2   Crop_Year      242834 non-null  float64
 3   Season         246091 non-null  object 
 4   Crop           246091 non-null  object 
 5   Area           238143 non-null  float64
 6   Production     242361 non-null  float64
dtypes: float64(3), object(4)
memory usage: 13.1+ MB
```

Handling Missing values

In [8]:

```
data.isnull().sum()
```

Out[8]:

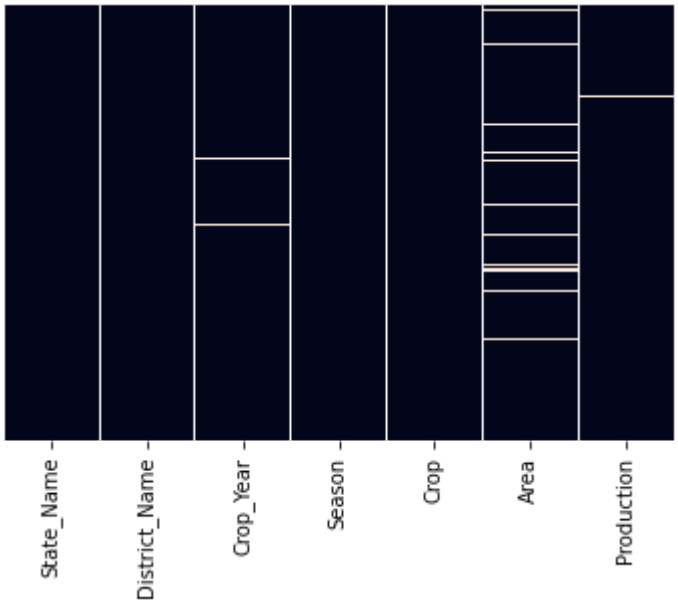
```
State_Name          0
District_Name       0
Crop_Year        3257
Season              0
Crop                0
Area             7948
Production       3730
dtype: int64
```

In [9]:

```
sns.heatmap(data.isnull(),yticklabels=False,cbar=False)
```

Out[9]:

<AxesSubplot:>



In [10]:

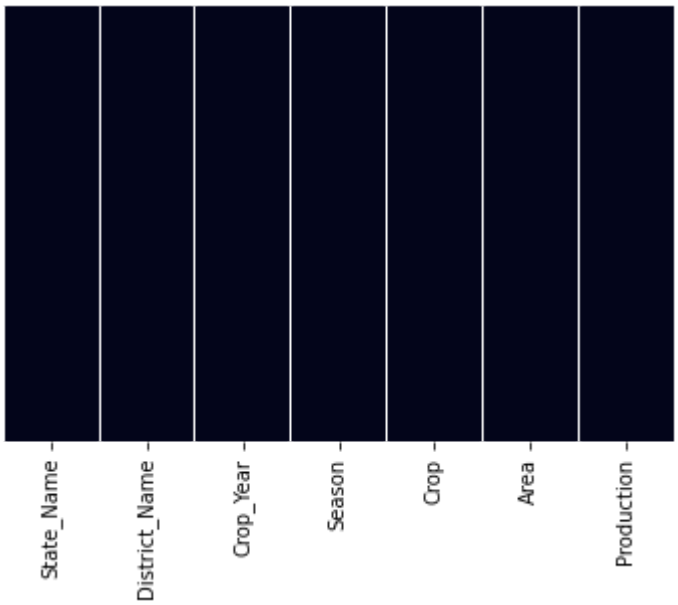
```
data['Area'].fillna(data['Area'].mean(), inplace=True)
data['Crop_Year'].fillna(data["Crop_Year"].mode()[0], inplace=True)
data['Production'].fillna(data['Production'].mean(), inplace=True)
```

In [11]:

```
sns.heatmap(data.isnull(),yticklabels=False,cbar=False)
```

Out[11]:

<AxesSubplot:>



In [ ]:

```
```

In [ ]:

```
```

In [12]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246091 entries, 0 to 246090
Data columns (total 7 columns):
 #   Column         Non-Null Count   Dtype  
---  ------         --------------   -----  
 0   State_Name     246091 non-null  object 
 1   District_Name  246091 non-null  object 
 2   Crop_Year      246091 non-null  float64
 3   Season         246091 non-null  object 
 4   Crop           246091 non-null  object 
 5   Area           246091 non-null  float64
 6   Production     246091 non-null  float64
dtypes: float64(3), object(4)
memory usage: 13.1+ MB
```

Checking Skewness

In [13]:

```
print(data['Production'].skew())
```

```
41.05385038354119
```

In [14]:

```
print(data['Area'].skew())
```

```
49.12767316618914
```

In [15]:

```
data['Production']= np.log1p(data['Production'])
```

In [16]:

```
data['Area']= np.log1p(data['Area'])
```

In [17]:

```
print(data['Production'].skew())
```

```
0.19210510407634226
```

In [18]:

```
print(data['Area'].skew())
```

```
-0.03956418866536974
```

In [ ]:

```

```

Scaling

In [19]:

```
from sklearn.preprocessing import StandardScaler
scaler=StandardScaler()
data['Area'] = scaler.fit_transform(data[['Area']])
data['Production'] = scaler.fit_transform(data[['Production']])
```

PCA

In [20]:

```
from sklearn.decomposition import PCA
x = pd.DataFrame()
x["Area"]=data['Area']
x["Production"]=data["Production"]
pca = PCA(n_components=0.99)
pc = pd.DataFrame(pca.fit_transform(x))
```

In [21]:

```
x.head(10)
```

Out[21]:

	Area	Production
0	0.234695	0.251489
1	-1.917539	-1.848179
2	-0.656737	-0.303757
3	-0.463693	-0.094030
4	0.037077	-0.505134
5	1.187604	3.409395
6	-1.021777	-0.656150
7	-2.062107	-1.724943
8	-1.670397	-1.216161
9	-0.985175	-0.497897

In [22]:

```
pca = PCA(n_components=0.99)
pc = pd.DataFrame(pca.fit_transform(x))
```

In [23]:

```
pc.head(10)
```

Out[23]:

	0	1
0	0.343784	0.011875
1	-2.662764	0.049045
2	-0.679172	0.249595
3	-0.394370	0.261392
4	-0.330966	-0.383401
5	3.250569	1.571044
6	-1.186473	0.258537
7	-2.677849	0.238411
8	-2.041105	0.321193
9	-1.048690	0.344558

In [24]:

```
#data.drop(['Area','Production','Crop_Year'],axis=1)
```

In [25]:

```
data['Area']=pc[0]
#data['Production']=pc['1']
```

In [26]:

```
pd.set_option("display.max_rows", None, "display.max_columns", None)
#df
```

In [27]:

```
data.Crop.value_counts()
```

Out[27]:

```
Rice                    15104
Maize                   13947
Moong(Green Gram)       10318
Urad                     9850
Sesamum                  9046
Groundnut                8834
Sugarcane                7921
Wheat                    7899
Rapeseed &Mustard        7592
Arhar/Tur                7578
Gram                     7361
Jowar                    7065
Onion                    7012
Potato                   6931
Dry chillies             6489
Sunflower                5571
Bajra                    5427
Small millets            4652
```

In [28]:

```
df=data
```

Handling Categorical Values

In [29]:

```
#Finding ctegorical values from df
categorical=[]
for i in df:
    if df.dtypes[i] == object:

        categorical.append(i)
print(categorical)
```

```
['State_Name', 'District_Name', 'Season', 'Crop']
```

In [30]:

```
from sklearn import preprocessing
le = preprocessing.LabelEncoder()
le.fit(df['Crop'])
le_name_mapping = dict(zip(le.classes_, le.transform(le.classes_)))

print(le_name_mapping)
```

```
{'Apple': 0, 'Arcanut (Processed)': 1, 'Arecanut': 2, 'Arhar/Tur': 3, 'Ash G
ourd': 4, 'Atcanut (Raw)': 5, 'Bajra': 6, 'Banana': 7, 'Barley': 8, 'Bean':
9, 'Beans & Mutter(Vegetable)': 10, 'Beet Root': 11, 'Ber': 12, 'Bhindi': 1
3, 'Bitter Gourd': 14, 'Black pepper': 15, 'Blackgram': 16, 'Bottle Gourd':
17, 'Brinjal': 18, 'Cabbage': 19, 'Cardamom': 20, 'Carrot': 21, 'Cashewnut':
22, 'Cashewnut Processed': 23, 'Cashewnut Raw': 24, 'Castor seed': 25, 'Caul
iflower': 26, 'Citrus Fruit': 27, 'Coconut ': 28, 'Coffee': 29, 'Colocosia':
30, 'Cond-spcs other': 31, 'Coriander': 32, 'Cotton(lint)': 33, 'Cowpea(Lobi
a)': 34, 'Cucumber': 35, 'Drum Stick': 36, 'Dry chillies': 37, 'Dry ginger':
38, 'Garlic': 39, 'Ginger': 40, 'Gram': 41, 'Grapes': 42, 'Groundnut': 43,
'Guar seed': 44, 'Horse-gram': 45, 'Jack Fruit': 46, 'Jobster': 47, 'Jowar':
48, 'Jute': 49, 'Jute & mesta': 50, 'Kapas': 51, 'Khesari': 52, 'Korra': 53,
'Lab-Lab': 54, 'Lemon': 55, 'Lentil': 56, 'Linseed': 57, 'Litchi': 58, 'Maiz
e': 59, 'Mango': 60, 'Masoor': 61, 'Mesta': 62, 'Moong(Green Gram)': 63, 'Mo
th': 64, 'Niger seed': 65, 'Oilseeds total': 66, 'Onion': 67, 'Orange': 68,
'Other  Rabi pulses': 69, 'Other Cereals & Millets': 70, 'Other Citrus Frui
t': 71, 'Other Dry Fruit': 72, 'Other Fresh Fruits': 73, 'Other Kharif pulse
s': 74, 'Other Vegetables': 75, 'Paddy': 76, 'Papaya': 77, 'Peach': 78, 'Pea
r': 79, 'Peas  (vegetable)': 80, 'Peas & beans (Pulses)': 81, 'Perilla': 82,
'Pineapple': 83, 'Plums': 84, 'Pome Fruit': 85, 'Pome Granet': 86, 'Potato':
87, 'Pulses total': 88, 'Pump Kin': 89, 'Ragi': 90, 'Rajmash Kholar': 91, 'R
apeseed &Mustard': 92, 'Redish': 93, 'Ribed Guard': 94, 'Rice': 95, 'Ricebea
n (nagadal)': 96, 'Rubber': 97, 'Safflower': 98, 'Samai': 99, 'Sannhamp': 10
0, 'Sapota': 101, 'Sesamum': 102, 'Small millets': 103, 'Snak Guard': 104,
'Soyabean': 105, 'Sugarcane': 106, 'Sunflower': 107, 'Sweet potato': 108, 'T
apioca': 109, 'Tea': 110, 'Tobacco': 111, 'Tomato': 112, 'Total foodgrain':
113, 'Turmeric': 114, 'Turnip': 115, 'Urad': 116, 'Varagu': 117, 'Water Melo
n': 118, 'Wheat': 119, 'Yam': 120, 'other fibres': 121, 'other misc. pulse
s': 122, 'other oilseeds': 123}
```

In [31]:

```
label_encoder = preprocessing.LabelEncoder()

for i in categorical:
    df[i]= label_encoder.fit_transform(df[i])
```

In [32]:

```
df.head(1000)
```

Out[32]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
0	0	427	2000.0	1	2	0.343784	0.251489
1	0	427	2000.0	1	74	-2.662764	-1.848179
2	0	427	2000.0	1	95	-0.679172	-0.303757
3	0	427	2000.0	4	7	-0.394370	-0.094030
4	0	427	2000.0	4	22	-0.330966	-0.505134
5	0	427	2000.0	4	28	3.250569	3.409395
6	0	427	2000.0	4	38	-1.186473	-0.656150
7	0	427	2000.0	4	106	-2.677849	-1.724943
8	0	427	2000.0	4	108	-2.041105	-1.216161
9	0	427	2000.0	4	109	-1.048690	-0.497897
10	0	427	2001.0	1	2	0.350238	0.260616

In [33]:

```
df=df.sample(frac=1)
```

In [34]:

```
df.head(100)
```

Out[34]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
100893	15	437	2005.0	4	106	0.643747	1.119967
4333	1	335	2004.0	2	102	-0.270349	-0.460909
199572	30	13	2003.0	2	67	0.031374	0.448810
46426	6	66	2000.0	1	3	0.008998	-0.132324
118372	16	494	2000.0	1	103	1.157894	0.493454
216189	30	284	1997.0	1	64	-2.764990	-1.848179
150412	22	142	2014.0	5	87	0.086812	0.376441
198476	30	4	2005.0	1	33	-0.614685	-0.708569
93982	14	473	1998.0	1	6	1.998687	1.180539
139881	19	173	2014.0	4	59	-0.180743	-0.036023
124860	16	622	2002.0	2	57	0.215644	0.043990

In [35]:

```
y=df['Production']
```

In [36]:

```
df=df.drop('Production',axis=1)
```

In [37]:

```
x=df
```

In [38]:

```
x.head()
```

Out[38]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area
100893	15	437	2005.0	4	106	0.643747
4333	1	335	2004.0	2	102	-0.270349
199572	30	13	2003.0	2	67	0.031374
46426	6	66	2000.0	1	3	0.008998
118372	16	494	2000.0	1	103	1.157894

Spliting data into training and testing

In [39]:

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

In [40]:

```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2,random_state=0)
```

Evaluation Metrics

In [41]:

```
from sklearn.metrics import mean_squared_error, mean_absolute_error,r2_score
rms=[]
mse=[]
mae=[]
r2=[]
def evaluation(model, x_test, y_test, rms , mse, mae, r2):
        pred = model.predict(x_test)

        rms.append(np.sqrt(mean_squared_error(y_test, pred)))
        mse.append(mean_squared_error(y_test, pred))
        mae.append(mean_absolute_error(y_test, pred))
        r2.append(r2_score(y_test,pred)*100)

        print("Result\n","-----------------------------------------")
        print("\nRoot Mean Squared Error: ",np.sqrt(mean_squared_error(y_test, pred)))
        print("\nMean Squared Error: \t",mean_squared_error(y_test, pred))
        print("\nMean Absolute Error: \t",mean_absolute_error(y_test, pred))
        print("\nR2 Score: \t\t",r2_score(y_test,pred))
```

Linear Regression

In [42]:

```
from sklearn.linear_model import LinearRegression

regressor = LinearRegression()
lr=regressor.fit(x_train, y_train)

#y_pred_test_Forestreg=model.predict(x_test)
lr.score(x_test,y_test)
```

Out[42]:

```
0.8929864676825939
```

In [43]:

```
evaluation(lr, x_test, y_test,  rms , mse, mae, r2)
```

```
Result
 ---------------------------------------------

Root Mean Squared Error:  0.32789998259451164

Mean Squared Error:       0.10751839858548105

Mean Absolute Error:      0.19885791642258094

R2 Score:                 0.8929864676825939
```

RandomForest

In [44]:

```
from sklearn.ensemble import RandomForestRegressor

 # create regressor object
regressor = RandomForestRegressor(n_estimators = 100, random_state = 0)

# fit the regressor with x and y data
r=regressor.fit(x_train, y_train)
```

In [45]:

```
r.score(x_test,y_test)
```

Out[45]:

```
0.9732011694601688
```

In [46]:

```
evaluation(r, x_test, y_test,  rms , mse, mae, r2)
```

```
Result
 ----------------------------------------------

Root Mean Squared Error:  0.1640891876936303

Mean Squared Error:       0.026925261517955427

Mean Absolute Error:      0.08254610702349571

R2 Score:                 0.9732011694601688
```

DecisionTreeRegressor

In [47]:

```
from sklearn.tree import DecisionTreeRegressor
model=DecisionTreeRegressor()

model.fit(x_train,y_train)
```

Out[47]:

```
DecisionTreeRegressor()
```

In [48]:

```
model.score(x_test,y_test)
```

Out[48]:

```
0.9492054246817138
```

In [49]:

```
evaluation(model, x_test, y_test,  rms , mse, mae, r2)
```

```
Result
 ----------------------------------------------

Root Mean Squared Error:  0.22590753182108161

Mean Squared Error:       0.05103421293349301

Mean Absolute Error:      0.10447186644400323

R2 Score:                 0.9492054246817138
```

Scores of Models

In [50]:

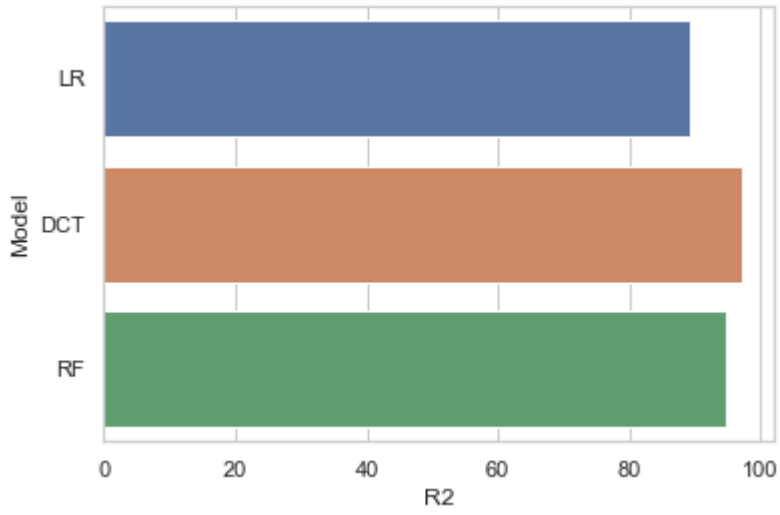
```
df=pd.DataFrame()
df['Model']=["LR","DCT","RF"]
df['RMSE']=rms
df['MSE']=mse
df['MAE']=mae
df['R2']=r2

df
```

Out[50]:

	Model	RMSE	MSE	MAE	R2
0	LR	0.327900	0.107518	0.198858	89.298647
1	DCT	0.164089	0.026925	0.082546	97.320117
2	RF	0.225908	0.051034	0.104472	94.920542

In [51]:

```
sns.set(style="whitegrid")
ax=sns.barplot(y='Model',x='R2',data=df)
```



In [ ]:

```

```