copy-of-ps1-1

April 6, 2024

[ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import matplotlib
import tensorflow as tf
```

[ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

[ ]:
```
%cd ./drive/MyDrive/BrainDead/
%ls
```

```
[Errno 2] No such file or directory: './drive/MyDrive/BrainDead/'
/content/drive/MyDrive/BrainDead
rice_production_modified.xlsx  State_wise_rice_production_in_India.xlsx
```

[ ]:
```
from openpyxl import load_workbook


wb = load_workbook("/content/drive/MyDrive/BrainDead/
 ↪State_wise_rice_production_in_India.xlsx")


ws = wb["Table 2"]


ws.delete_rows(2)
ws.delete_rows(3)


wb.save("rice_production_modified.xlsx")
```

[ ]:
```
df_table1 = pd.read_excel("rice_production_modified.xlsx", sheet_name="Table␣
↪1", header=1)
df_table1.head()
```

[ ]:

	State/Union Territory	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	\
0	Andhra Pradesh	9601	11704	11872	13324	14241	10538	
1	Arunachal Pradesh	135	146.2	146.2	158.1	163.9	215.8	
2	Assam	3470.7	3552.5	2916	3319	4008.5	4335.9	
3	Bihar	2472.2	3495.5	4989.3	4418.1	5590.3	3599.3	
4	Chhattisgarh	4383.3	5011.6	5041.4	5426.6	4391.8	4110.4	

	2010-11	2011-12	2012-13
0	7882.4	7746.2	6862.4
1	234.0	255.0	263.0
2	4736.6	4516.3	5128.5
3	3102.1	7162.6	7529.3
4	6159.0	6028.4	6608.8

[ ]:
```
df_table2 = pd.read_excel("rice_production_modified.xlsx", sheet_name="Table␣
↪2", header=1).drop(labels = 'State/Union Territory', axis=1)
df_table2.head()
```

[ ]:

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	\
0	6969.7	7233.9	7488.7	7452.4	8166.2	8234.7	8658.9	7882.9	
1	276.2	285.0	204.0	220.0	233.3	240.0	244.7	247.1	
2	4927.1	5222.7	5125.1	4727.4	5283.7	5220.6	4984.6	5214.8	
3	5505.8	6356.7	6802.2	8239.3	8093.1	6155.5	6298.0	6747.0	
4	6716.4	6322.1	5789.4	8048.4	4930.8	6526.9	6774.8	7161.2	

	2021-22	2022-23*
0	7763.6	8542.3
1	252.4	-
2	4382.1	4979.8
3	7717.0	6725.2
4	8021.7	8238.3

[ ]:
```
print(df_table1.shape)
print(df_table2.shape)
```

```
(32, 10)
(32, 10)
```

[ ]:
```
df = pd.concat([df_table1, df_table2], axis=1)
df.set_index('State/Union Territory', inplace=True)
df.head()
```

[ ]:
```
                        2004-05 2005-06 2006-07 2007-08 2008-09 2009-10  \
State/Union Territory
Andhra Pradesh             9601   11704   11872   13324   14241   10538
Arunachal Pradesh           135   146.2   146.2   158.1   163.9   215.8
Assam                     3470.7  3552.5    2916    3319  4008.5  4335.9
Bihar                     2472.2  3495.5  4989.3  4418.1  5590.3  3599.3
Chhattisgarh              4383.3  5011.6  5041.4  5426.6  4391.8  4110.4

                         2010-11  2011-12  2012-13  2013-14  2014-15  2015-16  \
State/Union Territory
Andhra Pradesh            7882.4   7746.2   6862.4   6969.7   7233.9   7488.7
Arunachal Pradesh          234.0    255.0    263.0    276.2    285.0    204.0
Assam                     4736.6   4516.3   5128.5   4927.1   5222.7   5125.1
Bihar                     3102.1   7162.6   7529.3   5505.8   6356.7   6802.2
Chhattisgarh              6159.0   6028.4   6608.8   6716.4   6322.1   5789.4

                         2016-17  2017-18  2018-19  2019-20  2020-21  2021-22  \
State/Union Territory
Andhra Pradesh            7452.4   8166.2   8234.7   8658.9   7882.9   7763.6
Arunachal Pradesh          220.0    233.3    240.0    244.7    247.1    252.4
Assam                     4727.4   5283.7   5220.6   4984.6   5214.8   4382.1
Bihar                     8239.3   8093.1   6155.5   6298.0   6747.0   7717.0
Chhattisgarh              8048.4   4930.8   6526.9   6774.8   7161.2   8021.7

                        2022-23*
State/Union Territory
Andhra Pradesh            8542.3
Arunachal Pradesh              -
Assam                     4979.8
Bihar                     6725.2
Chhattisgarh              8238.3
```

[ ]:
```
df_T = df.transpose()
df_T.head()
```

[ ]:
```
State/Union Territory Andhra Pradesh Arunachal Pradesh   Assam   Bihar  \
2004-05                         9601              135  3470.7  2472.2
2005-06                        11704            146.2  3552.5  3495.5
2006-07                        11872            146.2    2916  4989.3
2007-08                        13324            158.1    3319  4418.1
2008-09                        14241            163.9  4008.5  5590.3

State/Union Territory Chhattisgarh NCT of Delhi    Goa Gujarat Haryana  \
2004-05                    4383.3         14.3  145.2  1238.2    3023
2005-06                    5011.6           24  147.3    1298    3210
2006-07                    5041.4         31.1  130.3    1390    3371
2007-08                    5426.6         31.4  121.6    1474    3613
```

```
2008-09                     4391.8         31.4  123.3    1303    3298

State/Union Territory Himachal Pradesh  … Punjab Rajasthan Sikkim  \
2004-05                            122  …  10437     150.4   21.6
2005-06                          112.1  …  10193       153   21.5
2006-07                          123.5  …  10138     169.8   21.5
2007-08                          121.5  …  10489     259.6   22.9
2008-09                          118.3  …  11000     241.1   21.7

State/Union Territory Tamil Nadu Telangana Tripura Uttar Pradesh Uttarakhand  \
2004-05                  5062.2         .   545.1        9555.6         572
2005-06                    5220         .   552.9       11133.7         590
2006-07                  6610.6         .   620.5         11124         556
2007-08                  5040.2         .   624.6         11780         593
2008-09                  5182.7         .   627.1         13097         582

State/Union Territory West Bengal ALL INDIA
2004-05                  14884.8   83131.7
2005-06                  14510.8   91793.4
2006-07                  14745.9   93355.3
2007-08                  14719.5   96692.9
2008-09                  15037.3   99182.5

[5 rows x 32 columns]
```

[ ]:
```
df_T
```

[ ]:
```
State/Union Territory Andhra Pradesh Arunachal Pradesh   Assam   Bihar  \
2004-05                       9601              135  3470.7  2472.2
2005-06                      11704            146.2  3552.5  3495.5
2006-07                      11872            146.2    2916  4989.3
2007-08                      13324            158.1    3319  4418.1
2008-09                      14241            163.9  4008.5  5590.3
2009-10                      10538            215.8  4335.9  3599.3
2010-11                     7882.4            234.0  4736.6  3102.1
2011-12                     7746.2            255.0  4516.3  7162.6
2012-13                     6862.4            263.0  5128.5  7529.3
2013-14                     6969.7            276.2  4927.1  5505.8
2014-15                     7233.9            285.0  5222.7  6356.7
2015-16                     7488.7            204.0  5125.1  6802.2
2016-17                     7452.4            220.0  4727.4  8239.3
2017-18                     8166.2            233.3  5283.7  8093.1
2018-19                     8234.7            240.0  5220.6  6155.5
2019-20                     8658.9            244.7  4984.6  6298.0
2020-21                     7882.9            247.1  5214.8  6747.0
2021-22                     7763.6            252.4  4382.1  7717.0
2022-23*                    8542.3                -  4979.8  6725.2
```

State/Union Territory	Chhattisgarh	NCT of Delhi	Goa	Gujarat	Haryana	\
2004-05	4383.3	14.3	145.2	1238.2	3023	
2005-06	5011.6	24	147.3	1298	3210	
2006-07	5041.4	31.1	130.3	1390	3371	
2007-08	5426.6	31.4	121.6	1474	3613	
2008-09	4391.8	31.4	123.3	1303	3298	
2009-10	4110.4	19.3	100.6	1292	3625	
2010-11	6159.0	19.6	115.0	1496.6	3472.0	
2011-12	6028.4	19.8	121.8	1790.0	3759.0	
2012-13	6608.8	19.7	122.8	1541.0	3976.0	
2013-14	6716.4	29.6	126.5	1636.0	3998.0	
2014-15	6322.1	25.9	120.5	1830.9	4006.0	
2015-16	5789.4	17.3	115.1	1702.0	4145.0	
2016-17	8048.4	17.3	113.2	1930.0	4453.0	
2017-18	4930.8	16.8	103.0	1890.9	4523.38	
2018-19	6526.9	16.8	98.8	1912.1	4516.1	
2019-20	6774.8	16.8	90.4	1983.1	4824.3	
2020-21	7161.2	19.8	87.3	2145.7	4424.9	
2021-22	8021.7	19.0	90.4	2101.1	4618.0	
2022-23*	8238.3	-	-	2395.2	5406.9	

State/Union Territory	Himachal Pradesh	…	Punjab	Rajasthan	Sikkim	\
2004-05	122	…	10437	150.4	21.6	
2005-06	112.1	…	10193	153	21.5	
2006-07	123.5	…	10138	169.8	21.5	
2007-08	121.5	…	10489	259.6	22.9	
2008-09	118.3	…	11000	241.1	21.7	
2009-10	105.9	…	11236	228.3	24.3	
2010-11	128.9	…	10837.0	265.5	21.0	
2011-12	131.6	…	10542.0	253.4	20.9	
2012-13	125.3	…	11374.0	222.5	21.3	
2013-14	120.8	…	11267.0	312.6	20.3	
2014-15	125.2	…	11107.0	366.7	20.1	
2015-16	129.9	…	11823.0	369.8	13.1	
2016-17	146.6	…	11586.2	452.7	19.7	
2017-18	114.79	…	13381.79	450.87	17.63	
2018-19	114.9	…	12821.6	453.2	17.2	
2019-20	143.8	…	11779.3	480.5	16.1	
2020-21	140.5	…	12783.7	634.0	16.2	
2021-22	167.5	…	12885.5	478.6	16.0	
2022-23*	119.2	…	13146.7	577.4	-	

State/Union Territory	Tamil Nadu	Telangana	Tripura	Uttar Pradesh	Uttarakhand	\
2004-05	5062.2	.	545.1	9555.6	572	
2005-06	5220	.	552.9	11133.7	590	
2006-07	6610.6	.	620.5	11124	556	

```
2007-08                    5040.2          .   624.6         11780         593
2008-09                    5182.7          .   627.1         13097         582
2009-10                    5665.2          .     640       10807.1         608
2010-11                    5792.4     6535.6   702.5         11992.0      550.4
2011-12                    7458.7     5148.8   718.3         14022.0      594.0
2012-13                    4049.9     4647.6   713.2         14416.0      579.8
2013-14                    5349.8     5755.0   711.8         14636.0      578.6
2014-15                    5727.8     4440.8   747.0         12167.9      603.7
2015-16                    7517.1     3047.0   794.8         12501.0      639.1
2016-17                    2369.4     5173.4   814.6         13754.0      630.0
2017-18                    6638.9     6262.2   812.1         13274.0      646.7
2018-19                    6130.9     6670.0   793.2         15545.3      617.6
2019-20                    7171.1     7427.8   810.2         15517.8      658.4
2020-21                    6881.2    10217.1   803.1         15520.0      714.9
2021-22                    7906.6    12409.6   811.0         15271.5      716.1
2022-23*                   7850.6    16013.9       -         15171.3      641.7

State/Union Territory West Bengal ALL INDIA
2004-05                   14884.8   83131.7
2005-06                   14510.8   91793.4
2006-07                   14745.9   93355.3
2007-08                   14719.5   96692.9
2008-09                   15037.3   99182.5
2009-10                   14340.7   89092.9
2010-11                   13045.9   95979.8
2011-12                   14605.8  105310.9
2012-13                   15023.7  105231.6
2013-14                   15370.7  106645.5
2014-15                   14677.2  104798.5
2015-16                   15953.9  104408.2
2016-17                   15302.5  109698.4
2017-18                   14967.0  112757.6
2018-19                   16242.2  116477.8
2019-20                   15881.4  118870.3
2020-21                   16524.4  124368.3
2021-22                   16728.7  129471.4
2022-23*                  15636.9    135542

[19 rows x 32 columns]
```

[ ]:
```
df = df.apply(pd.to_numeric, errors='coerce')
df_T = df_T.apply(pd.to_numeric, errors='coerce')
```

[ ]:
```
df_T.dtypes
```

[ ]:
```
State/Union Territory
Andhra Pradesh       float64
```

```
Arunachal Pradesh    float64
Assam                float64
Bihar                float64
Chhattisgarh         float64
NCT of Delhi         float64
Goa                  float64
Gujarat              float64
Haryana              float64
Himachal Pradesh     float64
Jammu & Kashmir      float64
Jharkhand            float64
Karnataka            float64
Kerala               float64
Madhya Pradesh       float64
Maharashtra          float64
Manipur              float64
Meghalaya            float64
Mizoram              float64
Nagaland             float64
Odisha               float64
Puducherry           float64
Punjab               float64
Rajasthan            float64
Sikkim               float64
Tamil Nadu           float64
Telangana            float64
Tripura              float64
Uttar Pradesh        float64
Uttarakhand          float64
West Bengal          float64
ALL INDIA            float64
dtype: object
```

[ ]:
```
df_T
```

[ ]:
```
State/Union Territory  Andhra Pradesh  Arunachal Pradesh   Assam   Bihar  \
2004-05                         9601.0              135.0  3470.7  2472.2
2005-06                        11704.0              146.2  3552.5  3495.5
2006-07                        11872.0              146.2  2916.0  4989.3
2007-08                        13324.0              158.1  3319.0  4418.1
2008-09                        14241.0              163.9  4008.5  5590.3
2009-10                        10538.0              215.8  4335.9  3599.3
2010-11                         7882.4              234.0  4736.6  3102.1
2011-12                         7746.2              255.0  4516.3  7162.6
2012-13                         6862.4              263.0  5128.5  7529.3
2013-14                         6969.7              276.2  4927.1  5505.8
2014-15                         7233.9              285.0  5222.7  6356.7
```

2015-16	7488.7	204.0	5125.1	6802.2
2016-17	7452.4	220.0	4727.4	8239.3
2017-18	8166.2	233.3	5283.7	8093.1
2018-19	8234.7	240.0	5220.6	6155.5
2019-20	8658.9	244.7	4984.6	6298.0
2020-21	7882.9	247.1	5214.8	6747.0
2021-22	7763.6	252.4	4382.1	7717.0
2022-23*	8542.3	NaN	4979.8	6725.2

State/Union Territory	Chhattisgarh	NCT of Delhi	Goa	Gujarat	Haryana	\
2004-05	4383.3	14.3	145.2	1238.2	3023.00	
2005-06	5011.6	24.0	147.3	1298.0	3210.00	
2006-07	5041.4	31.1	130.3	1390.0	3371.00	
2007-08	5426.6	31.4	121.6	1474.0	3613.00	
2008-09	4391.8	31.4	123.3	1303.0	3298.00	
2009-10	4110.4	19.3	100.6	1292.0	3625.00	
2010-11	6159.0	19.6	115.0	1496.6	3472.00	
2011-12	6028.4	19.8	121.8	1790.0	3759.00	
2012-13	6608.8	19.7	122.8	1541.0	3976.00	
2013-14	6716.4	29.6	126.5	1636.0	3998.00	
2014-15	6322.1	25.9	120.5	1830.9	4006.00	
2015-16	5789.4	17.3	115.1	1702.0	4145.00	
2016-17	8048.4	17.3	113.2	1930.0	4453.00	
2017-18	4930.8	16.8	103.0	1890.9	4523.38	
2018-19	6526.9	16.8	98.8	1912.1	4516.10	
2019-20	6774.8	16.8	90.4	1983.1	4824.30	
2020-21	7161.2	19.8	87.3	2145.7	4424.90	
2021-22	8021.7	19.0	90.4	2101.1	4618.00	
2022-23*	8238.3	NaN	NaN	2395.2	5406.90	

State/Union Territory	Himachal Pradesh	…	Punjab	Rajasthan	Sikkim	\
2004-05	122.00	…	10437.00	150.40	21.60	
2005-06	112.10	…	10193.00	153.00	21.50	
2006-07	123.50	…	10138.00	169.80	21.50	
2007-08	121.50	…	10489.00	259.60	22.90	
2008-09	118.30	…	11000.00	241.10	21.70	
2009-10	105.90	…	11236.00	228.30	24.30	
2010-11	128.90	…	10837.00	265.50	21.00	
2011-12	131.60	…	10542.00	253.40	20.90	
2012-13	125.30	…	11374.00	222.50	21.30	
2013-14	120.80	…	11267.00	312.60	20.30	
2014-15	125.20	…	11107.00	366.70	20.10	
2015-16	129.90	…	11823.00	369.80	13.10	
2016-17	146.60	…	11586.20	452.70	19.70	
2017-18	114.79	…	13381.79	450.87	17.63	
2018-19	114.90	…	12821.60	453.20	17.20	
2019-20	143.80	…	11779.30	480.50	16.10	

2020-21	140.50	…	12783.70	634.00	16.20	
2021-22	167.50	…	12885.50	478.60	16.00	
2022-23*	119.20	…	13146.70	577.40	NaN	

State/Union Territory	Tamil Nadu	Telangana	Tripura	Uttar Pradesh	\
2004-05	5062.2	NaN	545.1	9555.6	
2005-06	5220.0	NaN	552.9	11133.7	
2006-07	6610.6	NaN	620.5	11124.0	
2007-08	5040.2	NaN	624.6	11780.0	
2008-09	5182.7	NaN	627.1	13097.0	
2009-10	5665.2	NaN	640.0	10807.1	
2010-11	5792.4	6535.6	702.5	11992.0	
2011-12	7458.7	5148.8	718.3	14022.0	
2012-13	4049.9	4647.6	713.2	14416.0	
2013-14	5349.8	5755.0	711.8	14636.0	
2014-15	5727.8	4440.8	747.0	12167.9	
2015-16	7517.1	3047.0	794.8	12501.0	
2016-17	2369.4	5173.4	814.6	13754.0	
2017-18	6638.9	6262.2	812.1	13274.0	
2018-19	6130.9	6670.0	793.2	15545.3	
2019-20	7171.1	7427.8	810.2	15517.8	
2020-21	6881.2	10217.1	803.1	15520.0	
2021-22	7906.6	12409.6	811.0	15271.5	
2022-23*	7850.6	16013.9	NaN	15171.3	

State/Union Territory	Uttarakhand	West Bengal	ALL INDIA
2004-05	572.0	14884.8	83131.7
2005-06	590.0	14510.8	91793.4
2006-07	556.0	14745.9	93355.3
2007-08	593.0	14719.5	96692.9
2008-09	582.0	15037.3	99182.5
2009-10	608.0	14340.7	89092.9
2010-11	550.4	13045.9	95979.8
2011-12	594.0	14605.8	105310.9
2012-13	579.8	15023.7	105231.6
2013-14	578.6	15370.7	106645.5
2014-15	603.7	14677.2	104798.5
2015-16	639.1	15953.9	104408.2
2016-17	630.0	15302.5	109698.4
2017-18	646.7	14967.0	112757.6
2018-19	617.6	16242.2	116477.8
2019-20	658.4	15881.4	118870.3
2020-21	714.9	16524.4	124368.3
2021-22	716.1	16728.7	129471.4
2022-23*	641.7	15636.9	135542.0

[19 rows x 32 columns]

[ ]:
```
df_T.isnull().sum().sum()
```

[ ]:
```
17
```

[ ]:
```
df_T.isnull().sum()
```

[ ]:
```
State/Union Territory
Andhra Pradesh       0
Arunachal Pradesh    1
Assam                0
Bihar                0
Chhattisgarh         0
NCT of Delhi         1
Goa                  1
Gujarat              0
Haryana              0
Himachal Pradesh     0
Jammu & Kashmir      1
Jharkhand            0
Karnataka            0
Kerala               0
Madhya Pradesh       0
Maharashtra          0
Manipur              1
Meghalaya            1
Mizoram              1
Nagaland             1
Odisha               0
Puducherry           1
Punjab               0
Rajasthan            0
Sikkim               1
Tamil Nadu           0
Telangana            6
Tripura              1
Uttar Pradesh        0
Uttarakhand          0
West Bengal          0
ALL INDIA            0
dtype: int64
```

[ ]:
```
df_T.iloc[18].isnull().sum()
```

[ ]:
```
11
```

[ ]:
```
df_T.describe()
```

[ ]:

State/Union Territory	Andhra Pradesh	Arunachal Pradesh	Assam
count	19.000000	18.000000	19.000000
mean	9061.278947	217.772222	4529.047368
std	2212.017631	47.838943	739.191158
min	6862.400000	135.000000	2916.000000
25%	7617.450000	173.925000	4172.200000
50%	8166.200000	233.650000	4736.600000
75%	10069.500000	251.075000	5126.800000
max	14241.000000	285.000000	5283.700000

State/Union Territory	Bihar	Chhattisgarh	NCT of Delhi	Goa
count	19.000000	19.000000	18.000000	18.000000
mean	5842.026316	6089.015789	21.661111	115.172222
std	1737.536829	1259.750102	5.719126	17.431506
min	2472.200000	4110.400000	14.300000	87.300000
25%	4703.700000	5026.500000	17.300000	101.200000
50%	6298.000000	6159.000000	19.650000	117.800000
75%	6982.400000	6745.600000	25.425000	123.175000
max	8239.300000	8238.300000	31.400000	147.300000

State/Union Territory	Gujarat	Haryana	Himachal Pradesh	…
count	19.000000	19.000000	19.000000	…
mean	1702.621053	4013.820000	126.962632	…
std	333.273049	627.124925	14.401712	…
min	1238.200000	3023.000000	105.900000	…
25%	1432.000000	3542.500000	118.750000	…
50%	1702.000000	3998.000000	123.500000	…
75%	1921.050000	4484.550000	130.750000	…
max	2395.200000	5406.900000	167.500000	…

State/Union Territory	Punjab	Rajasthan	Sikkim	Tamil Nadu
count	19.000000	19.000000	18.000000	19.000000
mean	11517.252105	343.156316	19.612778	5980.278947
std	1037.304623	144.756229	2.916061	1397.244387
min	10138.000000	150.400000	13.100000	2369.400000
25%	10689.500000	234.700000	17.307500	5201.350000
50%	11267.000000	312.600000	20.600000	5792.400000
75%	12303.350000	452.950000	21.500000	7026.150000
max	13381.790000	634.000000	24.300000	7906.600000

State/Union Territory	Telangana	Tripura	Uttar Pradesh	Uttarakhand
count	13.000000	18.000000	19.000000	19.000000
mean	7211.446154	713.444444	13225.589474	614.315789
std	3621.205336	92.236845	1849.559244	46.838425
min	3047.000000	545.100000	9555.600000	550.400000
25%	5148.800000	630.325000	11886.000000	580.900000
50%	6262.200000	715.750000	13274.000000	603.700000

```
75%                    7427.800000  801.025000   14903.650000   640.400000
max                   16013.900000  814.600000   15545.300000   716.100000

State/Union Territory   West Bengal      ALL INDIA
count                     19.000000      19.000000
mean                   15168.384211  106463.631579
std                      867.613563   13946.740460
min                    13045.900000   83131.700000
25%                    14698.350000   96336.350000
50%                    15023.700000  105231.600000
75%                    15759.150000  114617.700000
max                    16728.700000  135542.000000

[8 rows x 32 columns]
```

[ ]:
```
for state in df_T.columns:
  if df_T[state].isnull().sum() != 0:
    df_T[state] = df_T[state].fillna(df_T[state].mean())
```

[ ]:
```
for state in df.index:
  if df.loc[state].isnull().sum() != 0:
    df.loc[state] = df.loc[state].fillna(df.loc[state].mean())
```

[ ]:
```
df_T.isnull().sum().sum()
```

[ ]:
```
0
```

[ ]:
```
df.isnull().sum().sum()
```

[ ]:
```
0
```

[ ]:
```
df_T
```

[ ]:
```
State/Union Territory  Andhra Pradesh  Arunachal Pradesh   Assam   Bihar  \
2004-05                         9601.0         135.000000  3470.7  2472.2
2005-06                        11704.0         146.200000  3552.5  3495.5
2006-07                        11872.0         146.200000  2916.0  4989.3
2007-08                        13324.0         158.100000  3319.0  4418.1
2008-09                        14241.0         163.900000  4008.5  5590.3
2009-10                        10538.0         215.800000  4335.9  3599.3
2010-11                         7882.4         234.000000  4736.6  3102.1
2011-12                         7746.2         255.000000  4516.3  7162.6
2012-13                         6862.4         263.000000  5128.5  7529.3
2013-14                         6969.7         276.200000  4927.1  5505.8
2014-15                         7233.9         285.000000  5222.7  6356.7
2015-16                         7488.7         204.000000  5125.1  6802.2
2016-17                         7452.4         220.000000  4727.4  8239.3
```

2017-18	8166.2	233.300000	5283.7	8093.1
2018-19	8234.7	240.000000	5220.6	6155.5
2019-20	8658.9	244.700000	4984.6	6298.0
2020-21	7882.9	247.100000	5214.8	6747.0
2021-22	7763.6	252.400000	4382.1	7717.0
2022-23*	8542.3	217.772222	4979.8	6725.2

State/Union Territory	Chhattisgarh	NCT of Delhi	Goa	Gujarat	\
2004-05	4383.3	14.300000	145.200000	1238.2	
2005-06	5011.6	24.000000	147.300000	1298.0	
2006-07	5041.4	31.100000	130.300000	1390.0	
2007-08	5426.6	31.400000	121.600000	1474.0	
2008-09	4391.8	31.400000	123.300000	1303.0	
2009-10	4110.4	19.300000	100.600000	1292.0	
2010-11	6159.0	19.600000	115.000000	1496.6	
2011-12	6028.4	19.800000	121.800000	1790.0	
2012-13	6608.8	19.700000	122.800000	1541.0	
2013-14	6716.4	29.600000	126.500000	1636.0	
2014-15	6322.1	25.900000	120.500000	1830.9	
2015-16	5789.4	17.300000	115.100000	1702.0	
2016-17	8048.4	17.300000	113.200000	1930.0	
2017-18	4930.8	16.800000	103.000000	1890.9	
2018-19	6526.9	16.800000	98.800000	1912.1	
2019-20	6774.8	16.800000	90.400000	1983.1	
2020-21	7161.2	19.800000	87.300000	2145.7	
2021-22	8021.7	19.000000	90.400000	2101.1	
2022-23*	8238.3	21.661111	115.172222	2395.2	

State/Union Territory	Haryana	Himachal Pradesh	…	Punjab	Rajasthan	\
2004-05	3023.00	122.00	…	10437.00	150.40	
2005-06	3210.00	112.10	…	10193.00	153.00	
2006-07	3371.00	123.50	…	10138.00	169.80	
2007-08	3613.00	121.50	…	10489.00	259.60	
2008-09	3298.00	118.30	…	11000.00	241.10	
2009-10	3625.00	105.90	…	11236.00	228.30	
2010-11	3472.00	128.90	…	10837.00	265.50	
2011-12	3759.00	131.60	…	10542.00	253.40	
2012-13	3976.00	125.30	…	11374.00	222.50	
2013-14	3998.00	120.80	…	11267.00	312.60	
2014-15	4006.00	125.20	…	11107.00	366.70	
2015-16	4145.00	129.90	…	11823.00	369.80	
2016-17	4453.00	146.60	…	11586.20	452.70	
2017-18	4523.38	114.79	…	13381.79	450.87	
2018-19	4516.10	114.90	…	12821.60	453.20	
2019-20	4824.30	143.80	…	11779.30	480.50	
2020-21	4424.90	140.50	…	12783.70	634.00	
2021-22	4618.00	167.50	…	12885.50	478.60	

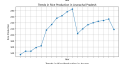
```
2022-23*               5406.90            119.20  …  13146.70     577.40

State/Union Territory     Sikkim  Tamil Nadu     Telangana     Tripura  \
2004-05                21.600000      5062.2   7211.446154  545.100000
2005-06                21.500000      5220.0   7211.446154  552.900000
2006-07                21.500000      6610.6   7211.446154  620.500000
2007-08                22.900000      5040.2   7211.446154  624.600000
2008-09                21.700000      5182.7   7211.446154  627.100000
2009-10                24.300000      5665.2   7211.446154  640.000000
2010-11                21.000000      5792.4   6535.600000  702.500000
2011-12                20.900000      7458.7   5148.800000  718.300000
2012-13                21.300000      4049.9   4647.600000  713.200000
2013-14                20.300000      5349.8   5755.000000  711.800000
2014-15                20.100000      5727.8   4440.800000  747.000000
2015-16                13.100000      7517.1   3047.000000  794.800000
2016-17                19.700000      2369.4   5173.400000  814.600000
2017-18                17.630000      6638.9   6262.200000  812.100000
2018-19                17.200000      6130.9   6670.000000  793.200000
2019-20                16.100000      7171.1   7427.800000  810.200000
2020-21                16.200000      6881.2  10217.100000  803.100000
2021-22                16.000000      7906.6  12409.600000  811.000000
2022-23*               19.612778      7850.6  16013.900000  713.444444

State/Union Territory  Uttar Pradesh  Uttarakhand  West Bengal  ALL INDIA
2004-05                       9555.6        572.0      14884.8    83131.7
2005-06                      11133.7        590.0      14510.8    91793.4
2006-07                      11124.0        556.0      14745.9    93355.3
2007-08                      11780.0        593.0      14719.5    96692.9
2008-09                      13097.0        582.0      15037.3    99182.5
2009-10                      10807.1        608.0      14340.7    89092.9
2010-11                      11992.0        550.4      13045.9    95979.8
2011-12                      14022.0        594.0      14605.8   105310.9
2012-13                      14416.0        579.8      15023.7   105231.6
2013-14                      14636.0        578.6      15370.7   106645.5
2014-15                      12167.9        603.7      14677.2   104798.5
2015-16                      12501.0        639.1      15953.9   104408.2
2016-17                      13754.0        630.0      15302.5   109698.4
2017-18                      13274.0        646.7      14967.0   112757.6
2018-19                      15545.3        617.6      16242.2   116477.8
2019-20                      15517.8        658.4      15881.4   118870.3
2020-21                      15520.0        714.9      16524.4   124368.3
2021-22                      15271.5        716.1      16728.7   129471.4
2022-23*                     15171.3        641.7      15636.9   135542.0

[19 rows x 32 columns]
```

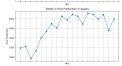
except telangana we have only one missing values for other states

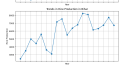
1 Trends Over Time

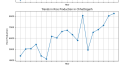
[ ]:
```
states = df_T.columns


fig, axs = plt.subplots(nrows=len(states), ncols=1, figsize=(8, 4*len(states)),␣
 ↪sharex=True)

for i, state in enumerate(states):
    axs[i].plot(df_T.index, df_T[state], marker='o', linestyle='-')
    axs[i].set_title(f'Trends in Rice Production in {state}')
    axs[i].set_ylabel('Rice Production')
    axs[i].set_xlabel('Year')
    axs[i].grid(True)
    axs[i].tick_params(axis='x', rotation=45)

fig.text(0.5, 0.04, 'Year', ha='center', va='center')


plt.tight_layout()
plt.show()
```

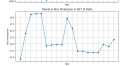

Trends in Rice Production in Andhra Pradesh
Year
Rice Production

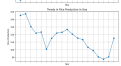

Trends in Rice Production in Arunachal Pradesh
Year
Rice Production

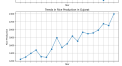

Trends in Rice Production in Assam
Year
Rice Production

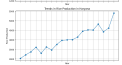

Trends in Rice Production in Bihar
Year
Rice Production

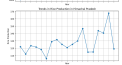

Trends in Rice Production in Chhattisgarh
Year
Rice Production

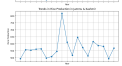

Trends in Rice Production in NCT of Delhi
Year
Rice Production

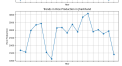

Trends in Rice Production in Goa
Year
Rice Production

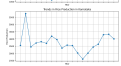

Trends in Rice Production in Gujarat
Year
Rice Production

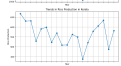

Trends in Rice Production in Haryana
Year
Rice Production

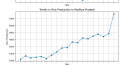

Trends in Rice Production in Himachal Pradesh
Year
Rice Production

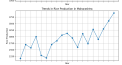

Trends in Rice Production in Jammu & Kashmir
Year
Rice Production

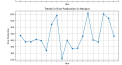

Trends in Rice Production in Jharkhand
Year
Rice Production

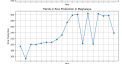

Trends in Rice Production in Karnataka
Year
Rice Production

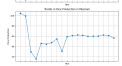

Trends in Rice Production in Kerala
Year
Rice Production

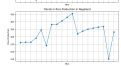

Trends in Rice Production in Madhya Pradesh
Year
Rice Production

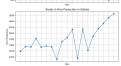

Trends in Rice Production in Maharashtra
Year
Rice Production

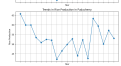

Trends in Rice Production in Manipur
Year
Rice Production

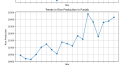

Trends in Rice Production in Meghalaya
Year
Rice Production

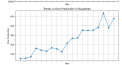

Trends in Rice Production in Mizoram
Year
Rice Production

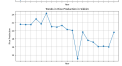

Trends in Rice Production in Nagaland
Year
Rice Production

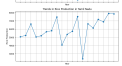

Trends in Rice Production in Odisha
Year
Rice Production

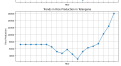

Trends in Rice Production in Puducherry
Year
Rice Production

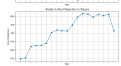

Trends in Rice Production in Punjab
Year
Rice Production

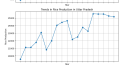

Trends in Rice Production in Rajasthan
Year
Rice Production

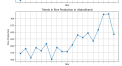

Trends in Rice Production in Sikkim
Year
Rice Production

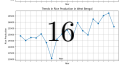

Trends in Rice Production in Tamil Nadu
Year
Rice Production


Trends in Rice Production in Telangana
Year
Rice Production


Trends in Rice Production in Tripura
Year
Rice Production

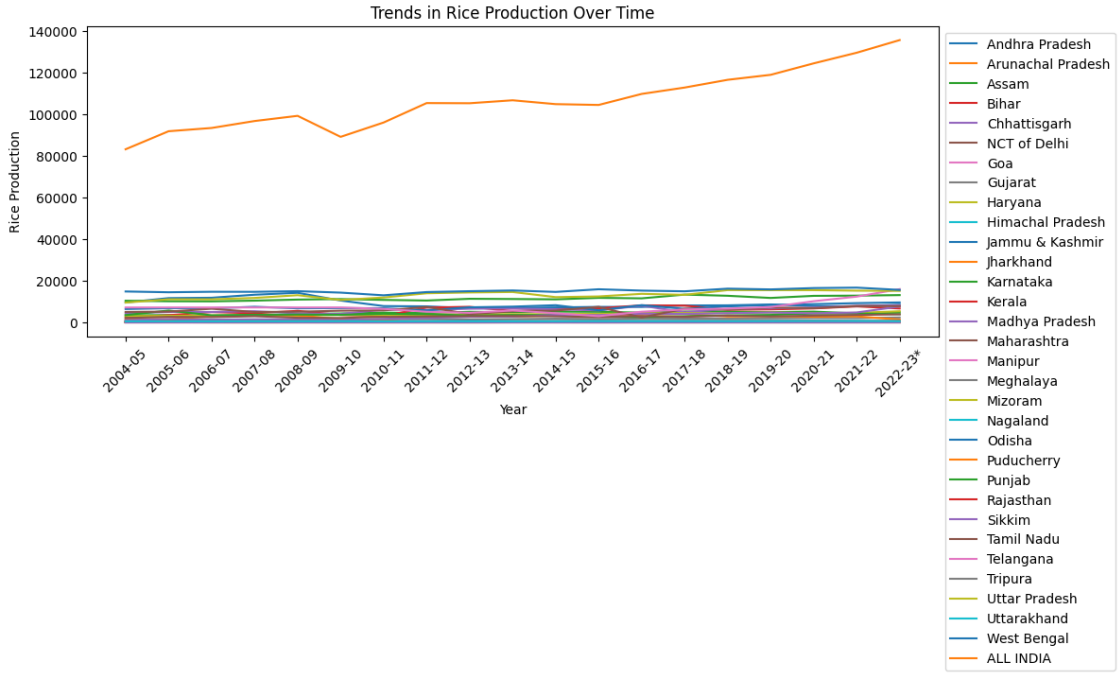

Trends in Rice Production in Uttar Pradesh
Year
Rice Production


Trends in Rice Production in Uttarakhand
Year
Rice Production


Trends in Rice Production in West Bengal
Year
Rice Production

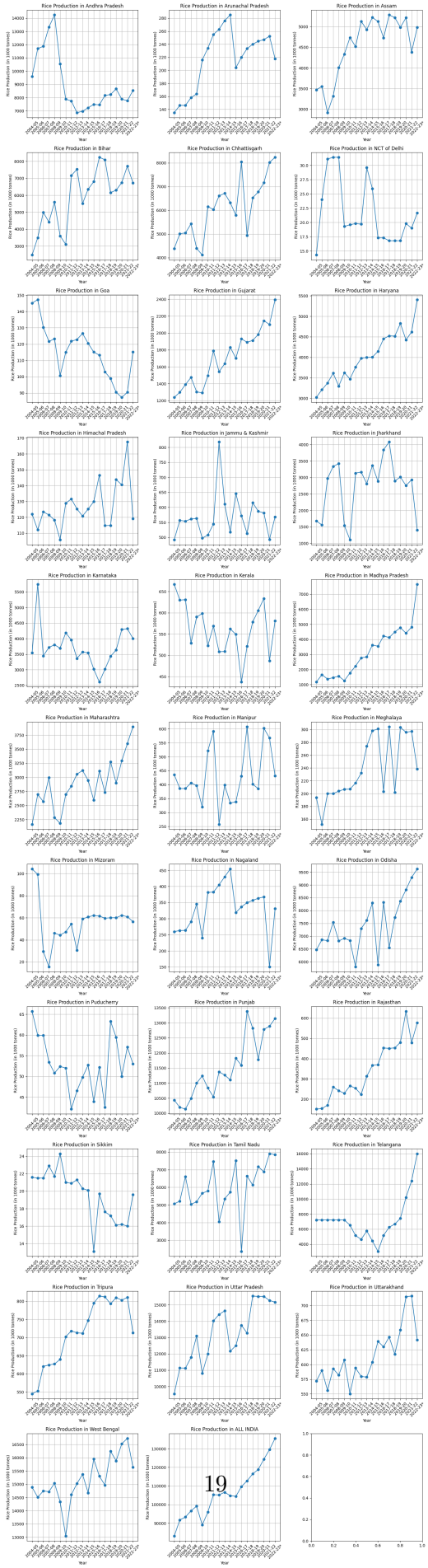

Trends in Rice Production in Goa, Bihar
Year
Rice Production

[ ]:
```
fig, ax = plt.subplots(figsize=(12, 6))


for state in df_T.columns:
    ax.plot(df_T.index, df_T[state], label=state)

ax.set_xlabel('Year')
ax.set_ylabel('Rice Production')
ax.set_title('Trends in Rice Production Over Time')


ax.legend(loc='upper left', bbox_to_anchor=(1, 1))


plt.xticks(rotation=45)


plt.tight_layout()
plt.show()
```



[ ]:
```
num_states = df.shape[0]
num_cols = 3
num_rows = (num_states + num_cols - 1) // num_cols
```

```
fig, axes = plt.subplots(num_rows, num_cols, figsize=(15, 5*num_rows))


if num_rows == 1:
    axes = [axes]

for i, state in enumerate(df.index):
    row_idx = i // num_cols
    col_idx = i % num_cols
    axes[row_idx][col_idx].plot(df.columns, df.loc[state].values, marker='o',␣
 ↪linestyle='-')
    axes[row_idx][col_idx].set_title(f'Rice Production in {state}')
    axes[row_idx][col_idx].set_xlabel('Year')
    axes[row_idx][col_idx].set_ylabel('Rice Production (in 1000 tonnes)')
    axes[row_idx][col_idx].tick_params(axis='x', rotation=45)
    axes[row_idx][col_idx].grid(True)


plt.tight_layout()
plt.show()
```

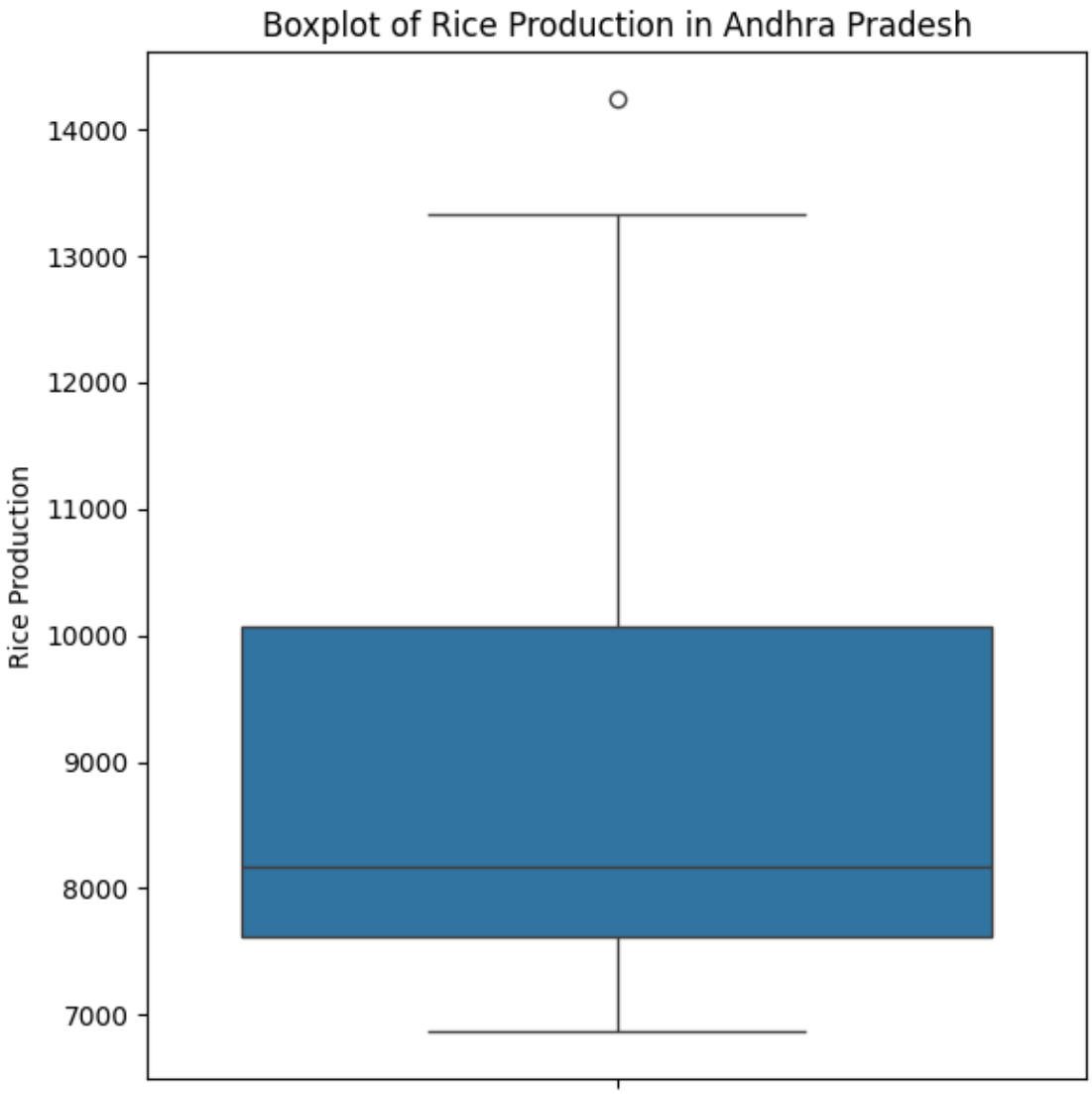

Rice Production in Andhra Pradesh
Rice Production in Arunachal Pradesh
Rice Production in Assam
Rice Production in Bihar
Rice Production in Chhattisgarh
Rice Production in NCT of Delhi
Rice Production in Goa
Rice Production in Gujarat
Rice Production in Haryana
Rice Production in Himachal Pradesh
Rice Production in Jammu & Kashmir
Rice Production in Jharkhand
Rice Production in Karnataka
Rice Production in Kerala
Rice Production in Madhya Pradesh
Rice Production in Maharashtra
Rice Production in Manipur
Rice Production in Meghalaya
Rice Production in Mizoram
Rice Production in Nagaland
Rice Production in Odisha
Rice Production in Puducherry
Rice Production in Punjab
Rice Production in Rajasthan
Rice Production in Sikkim
Rice Production in Tamil Nadu
Rice Production in Telangana
Rice Production in Tripura
Rice Production in Uttar Pradesh
Rice Production in Uttarakhand
Rice Production in West Bengal
Rice Production in ALL INDIA
Year

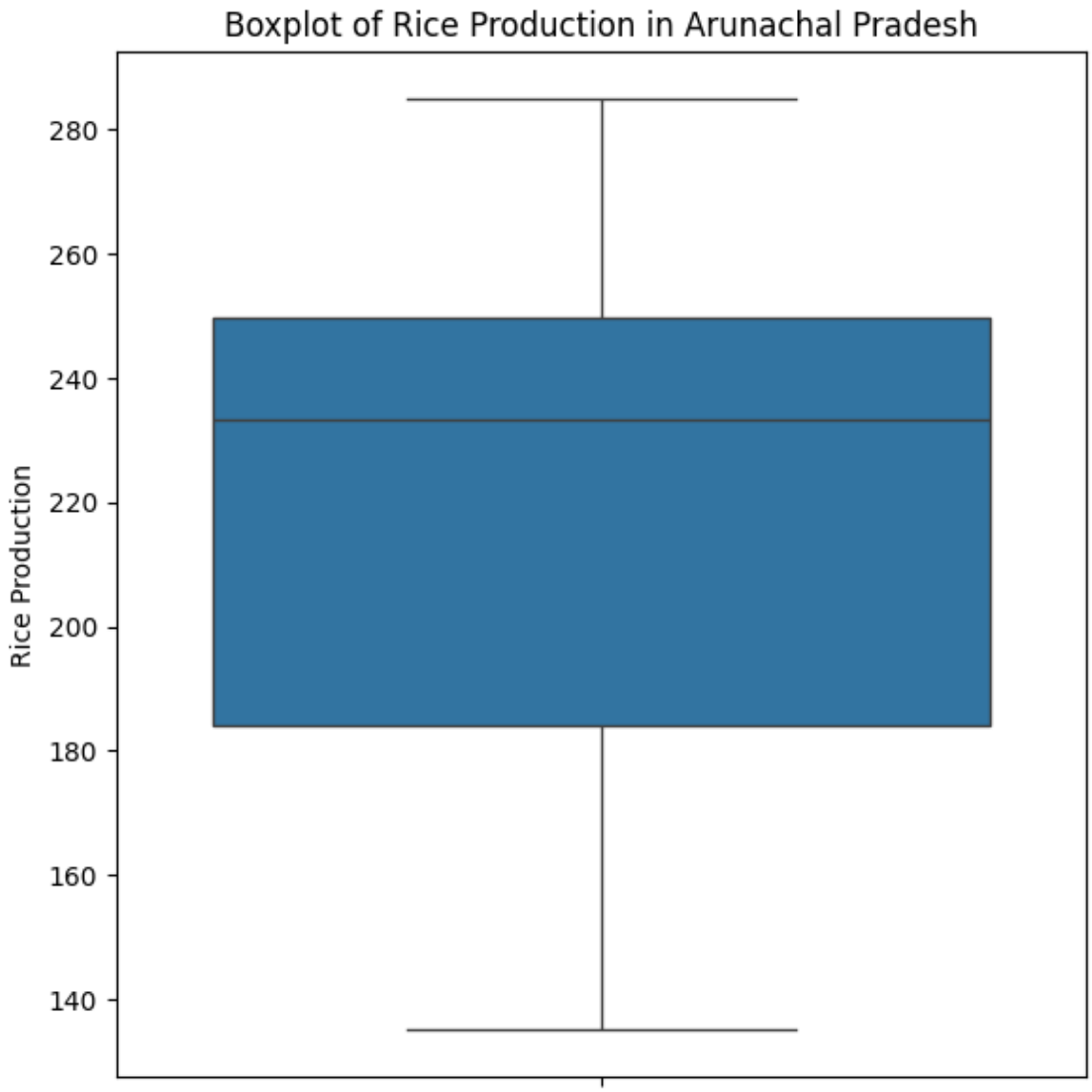
Observation: Rice production in Andhra pradesh, Delhi NCT, Goa, J and K, Jharkhand, Nagaland, Sikkim has fallen over the years and needs to increase

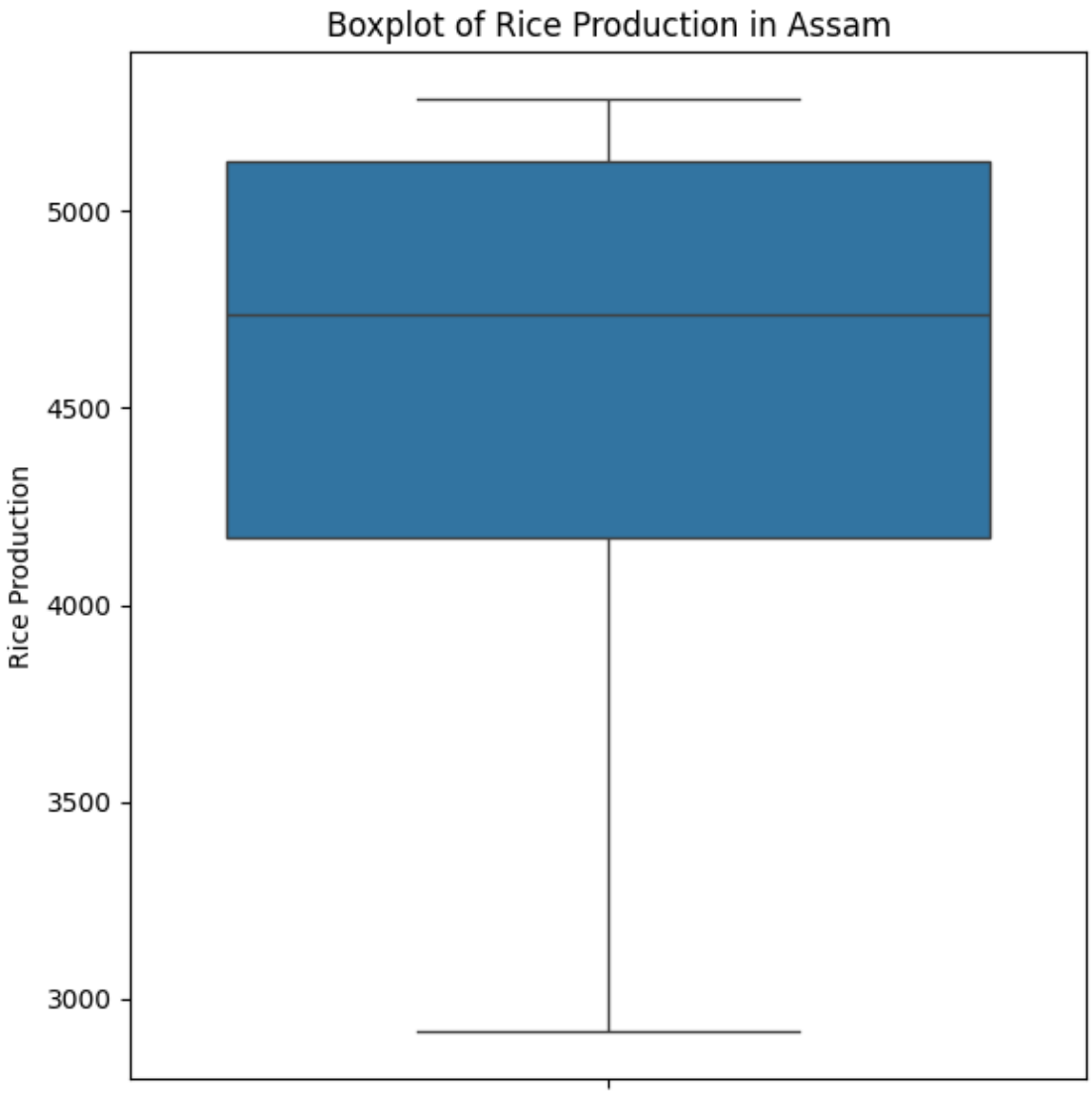
2 Outlier Detection

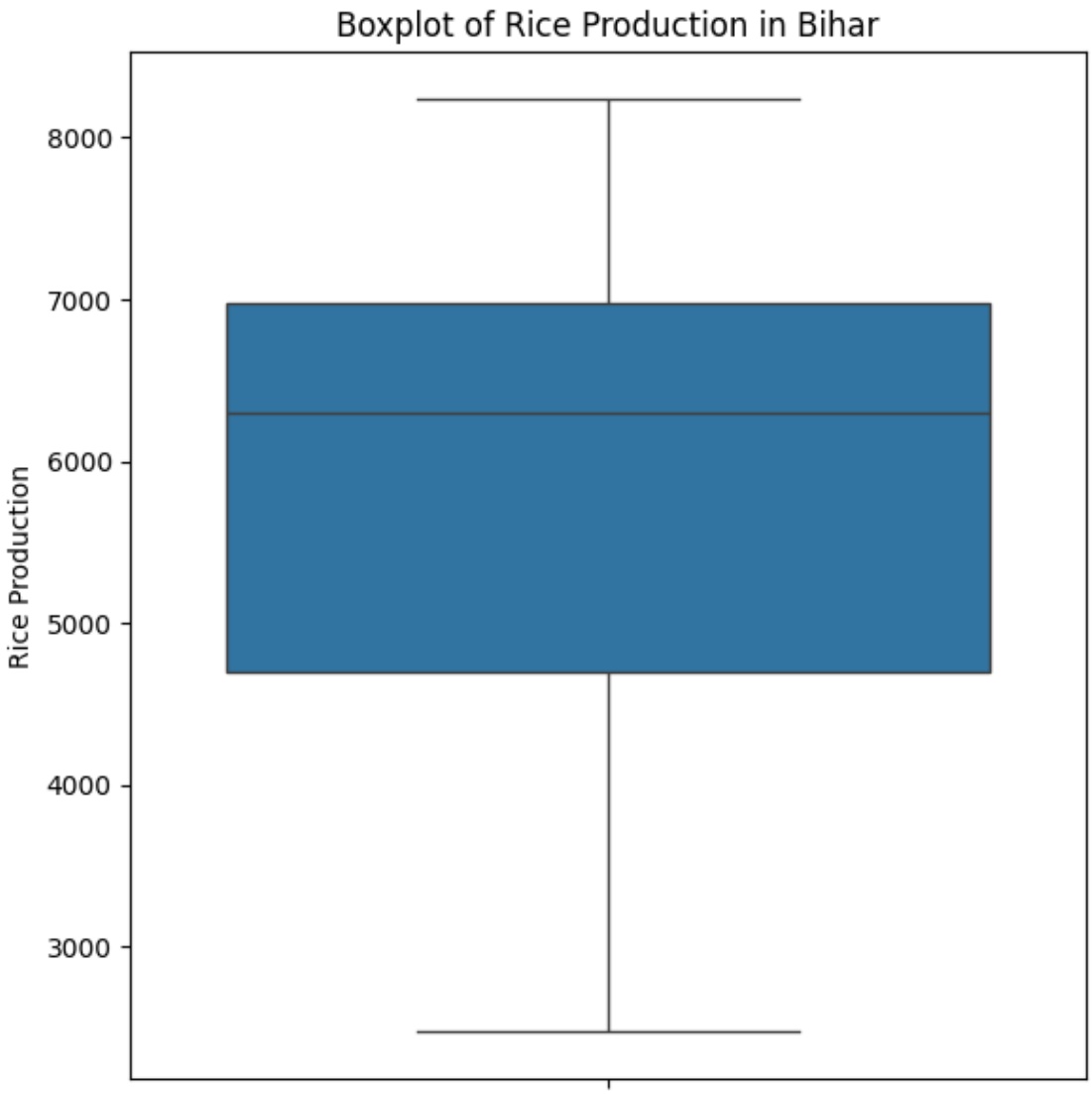
[ ]:
```
y = df_T['ALL INDIA']
df_T_A = df_T.drop(columns=['ALL INDIA'])
```

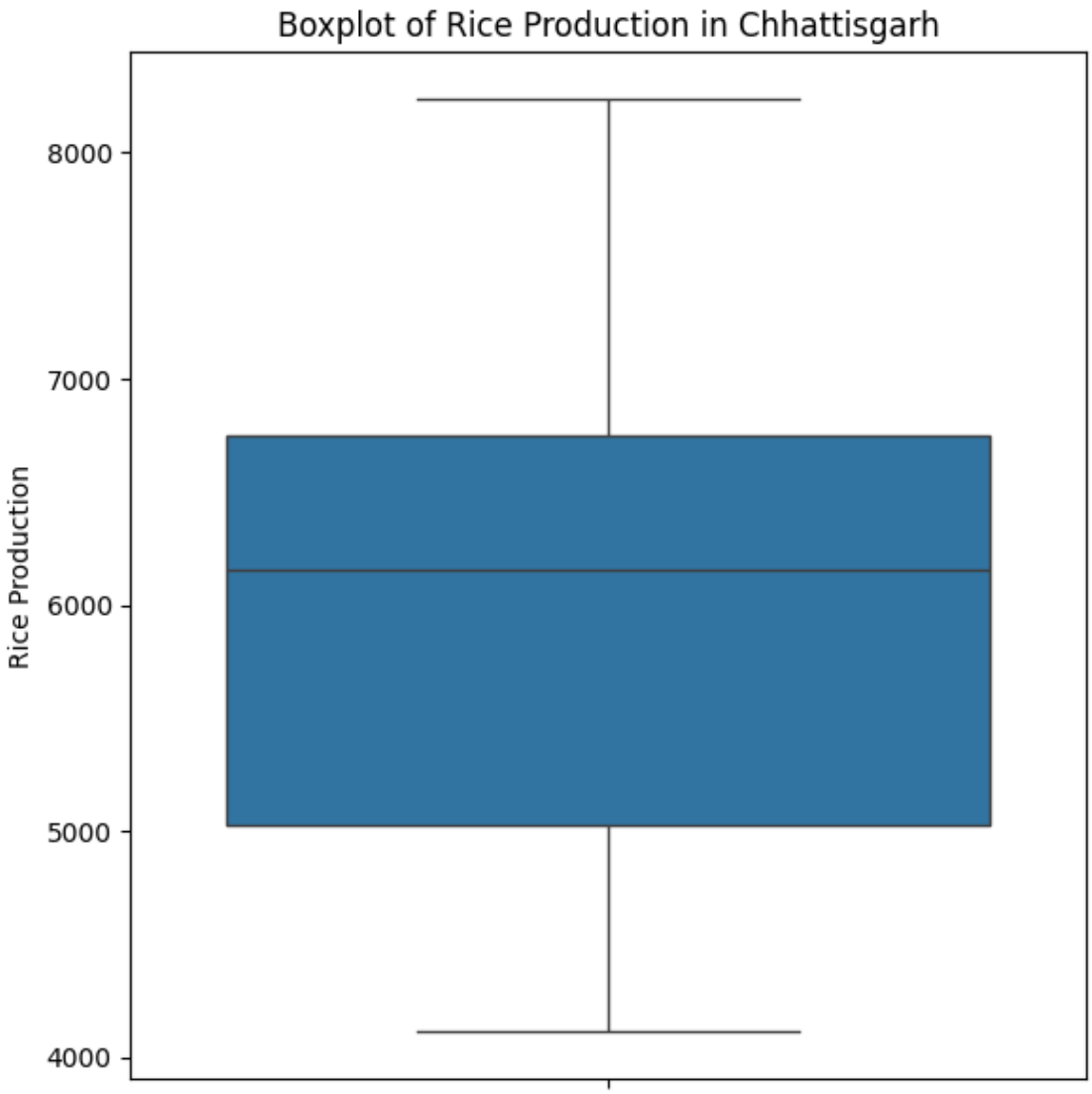
[ ]:
```
states = df_T.columns


for state in states:

    fig, ax = plt.subplots(figsize=(6, 6))


    sns.boxplot(y=df_T[state], ax=ax)


    ax.set_ylabel('Rice Production')
    ax.set_title(f'Boxplot of Rice Production in {state}')


    plt.tight_layout()
    plt.show()
```

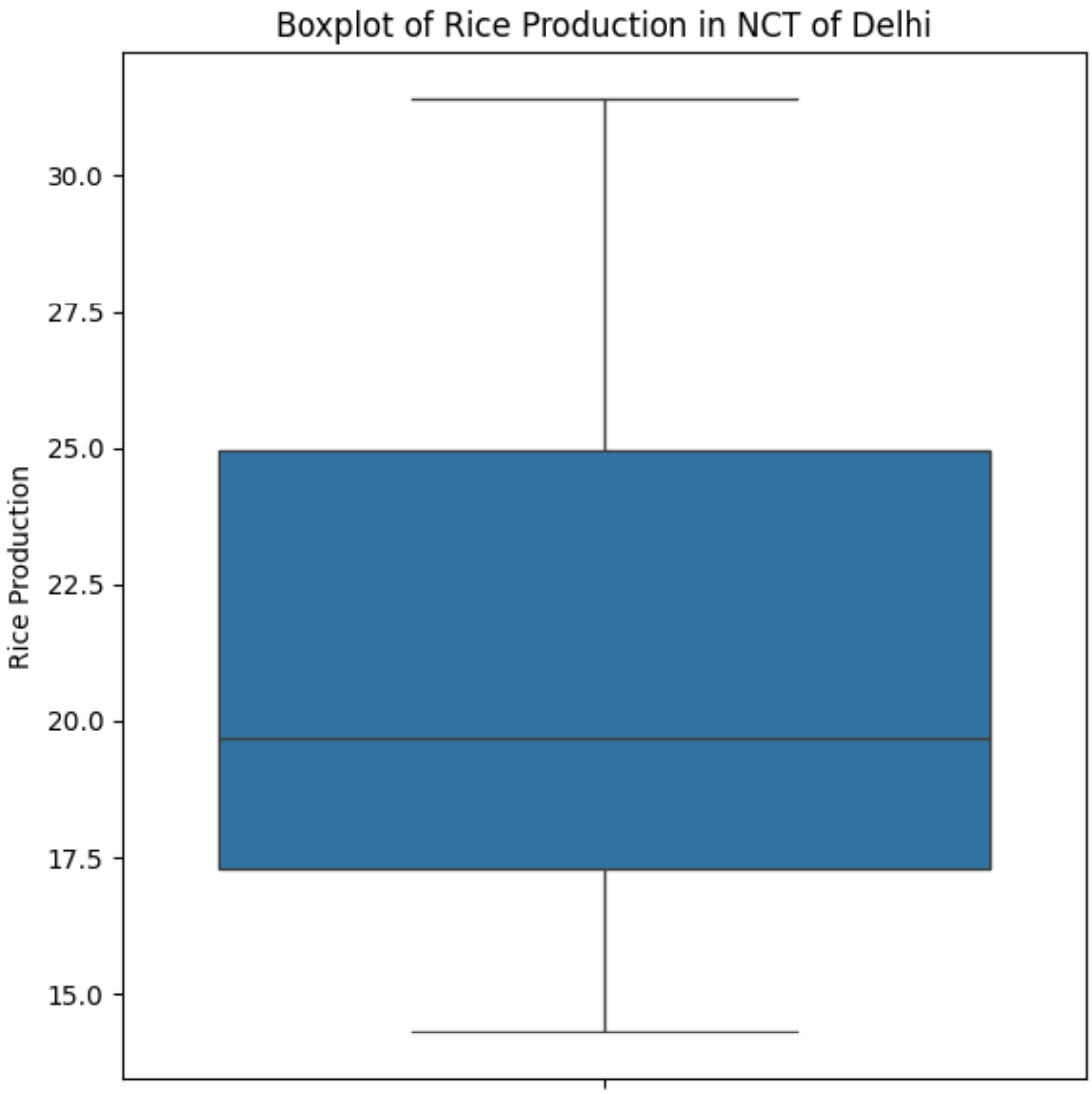

Boxplot of Rice Production in Andhra Pradesh
Rice Production
14000
13000
12000
11000
10000
9000
8000
7000

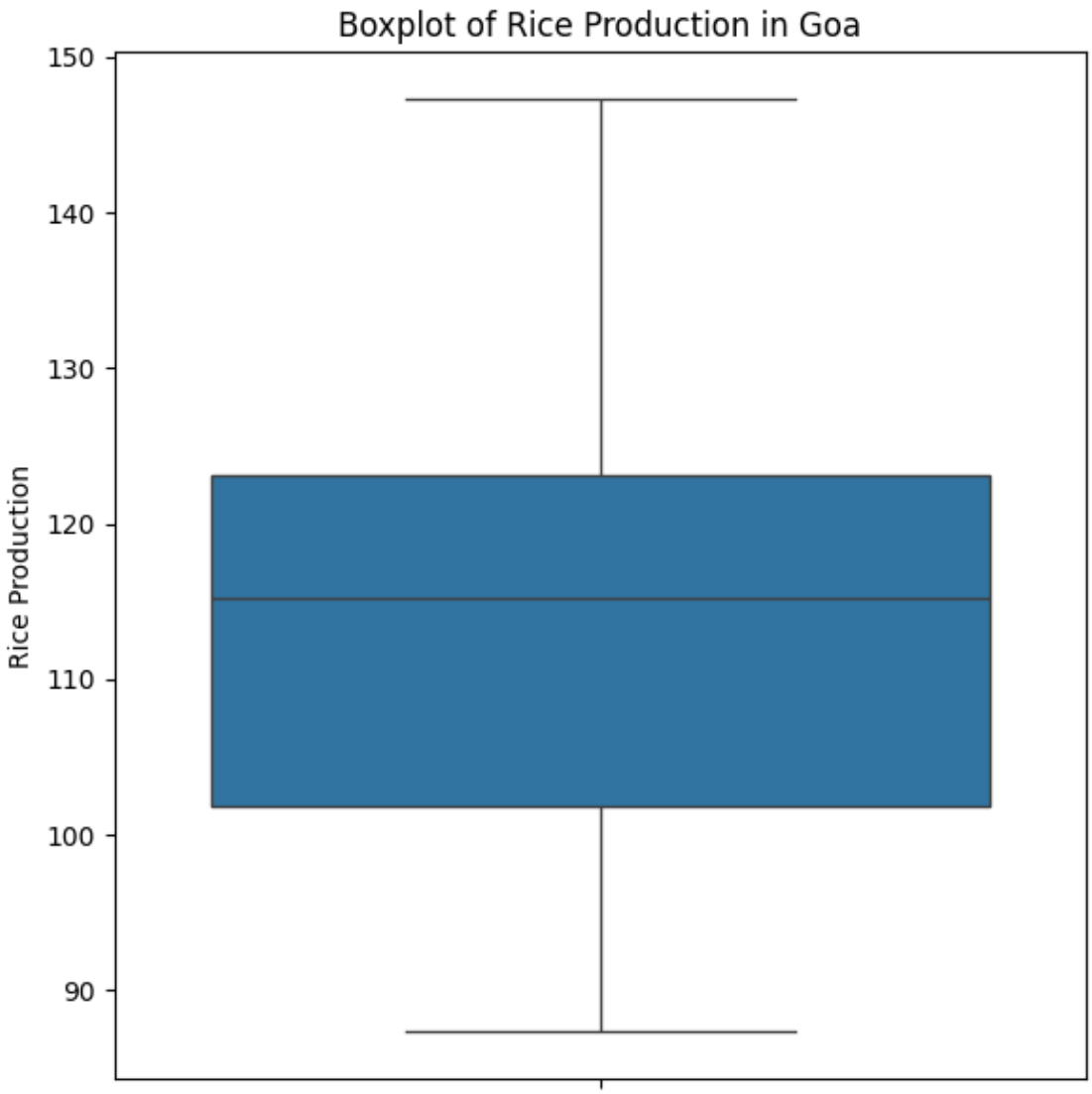

Boxplot of Rice Production in Arunachal Pradesh
Rice Production
280
260
240
220
200
180
160
140

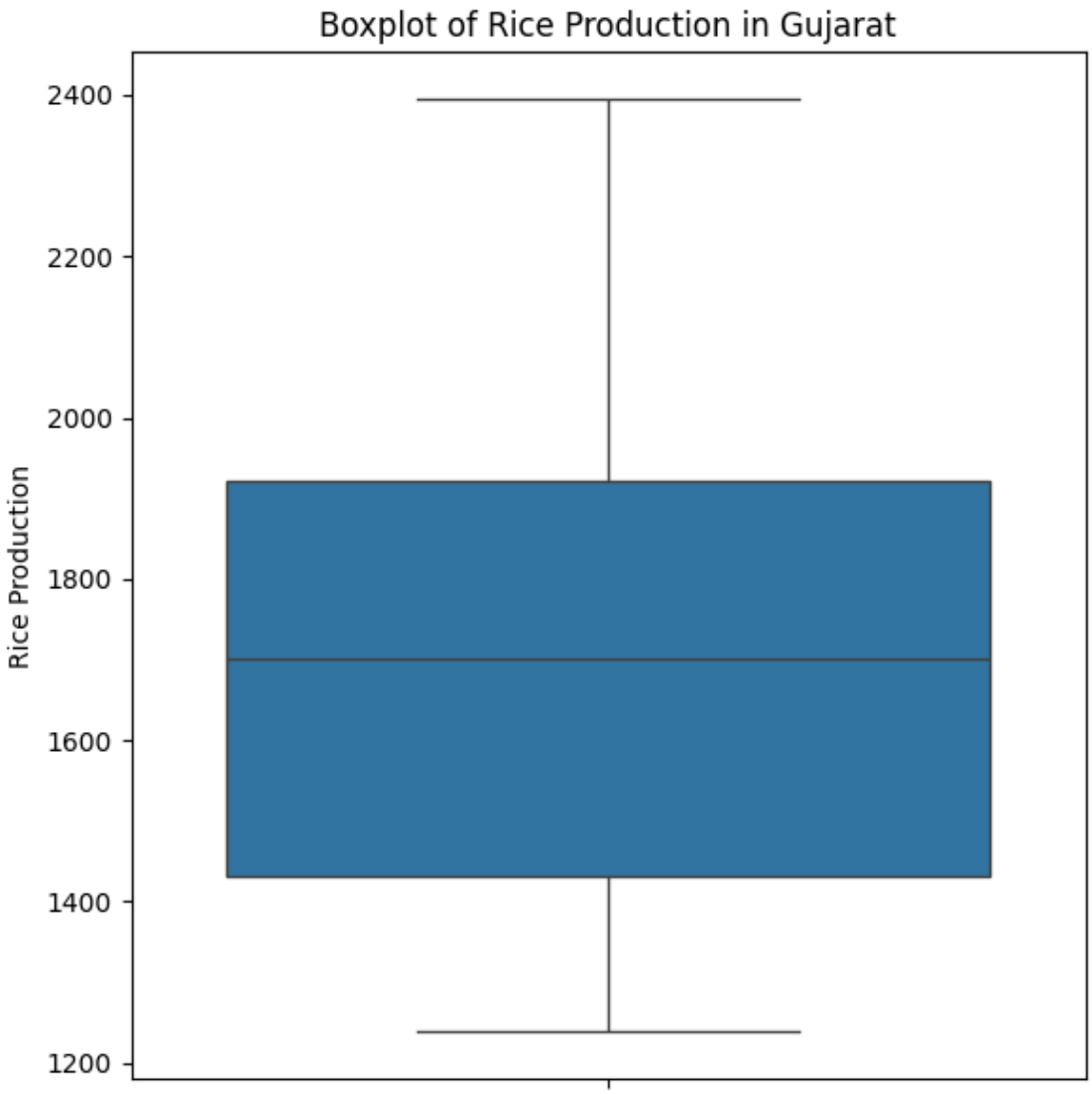

Boxplot of Rice Production in Assam
Rice Production
5000
4500
4000
3500
3000

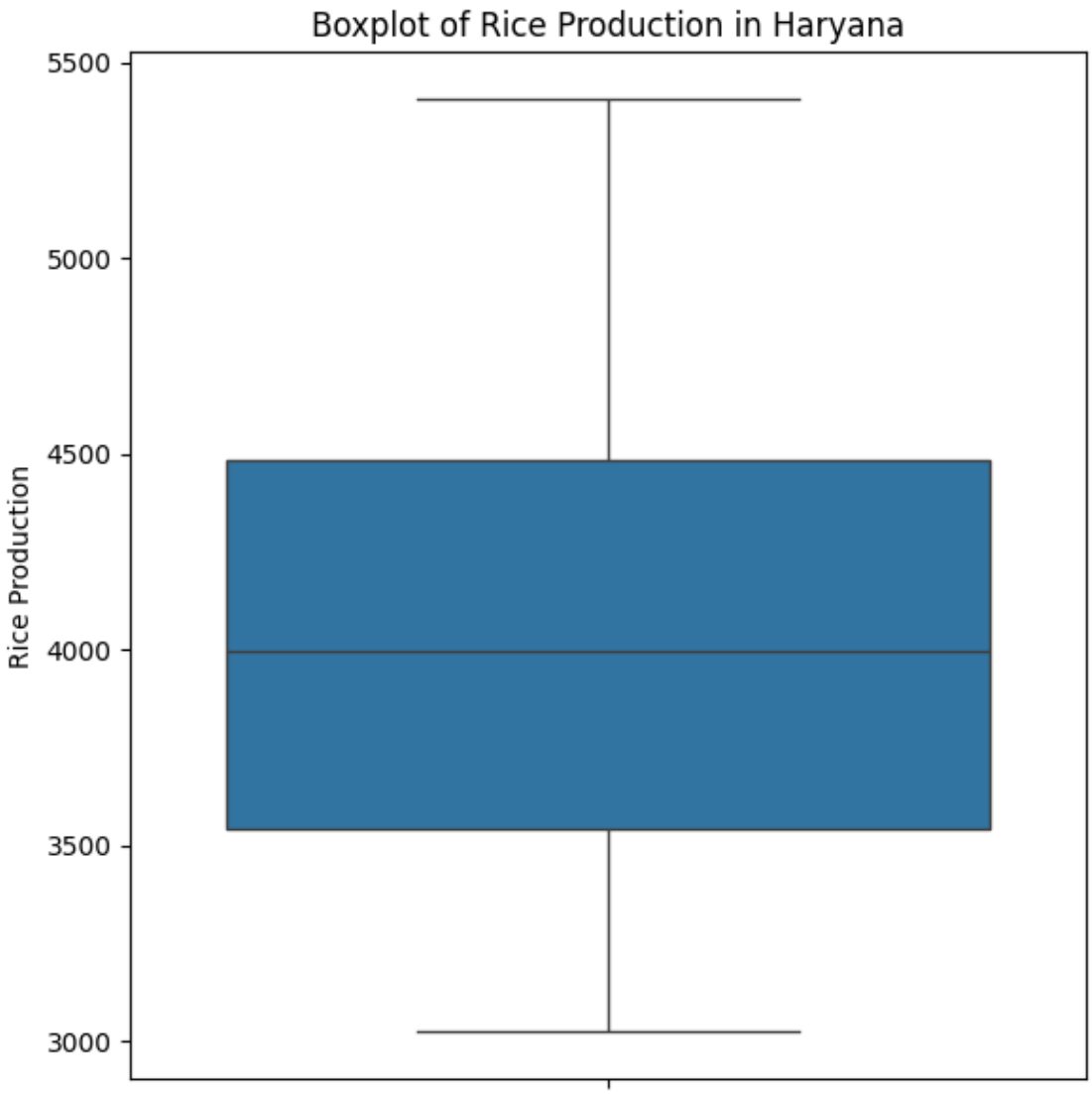

Boxplot of Rice Production in Bihar
Rice Production
8000
7000
6000
5000
4000
3000

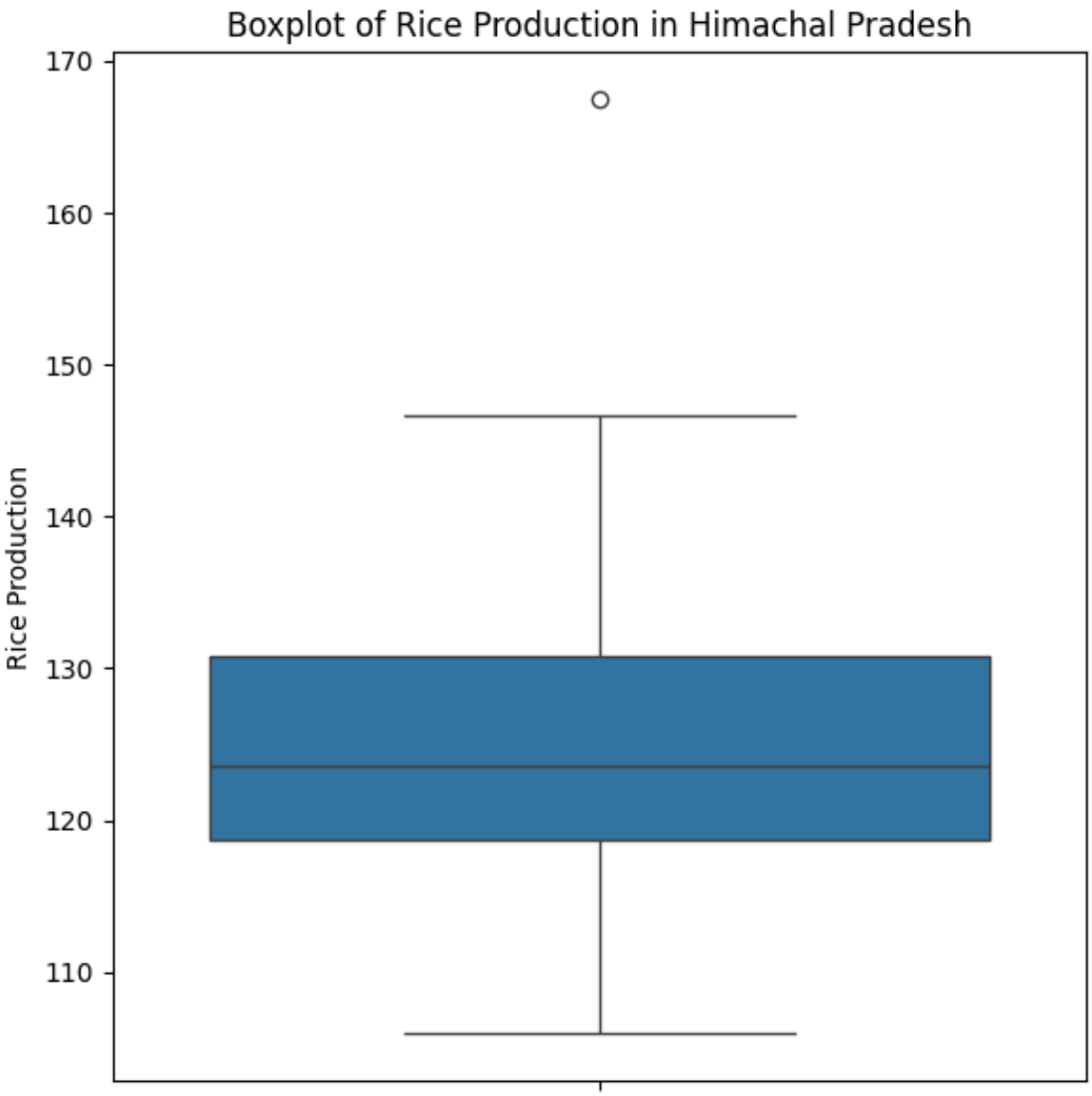

Boxplot of Rice Production in Chhattisgarh
Rice Production
8000
7000
6000
5000
4000

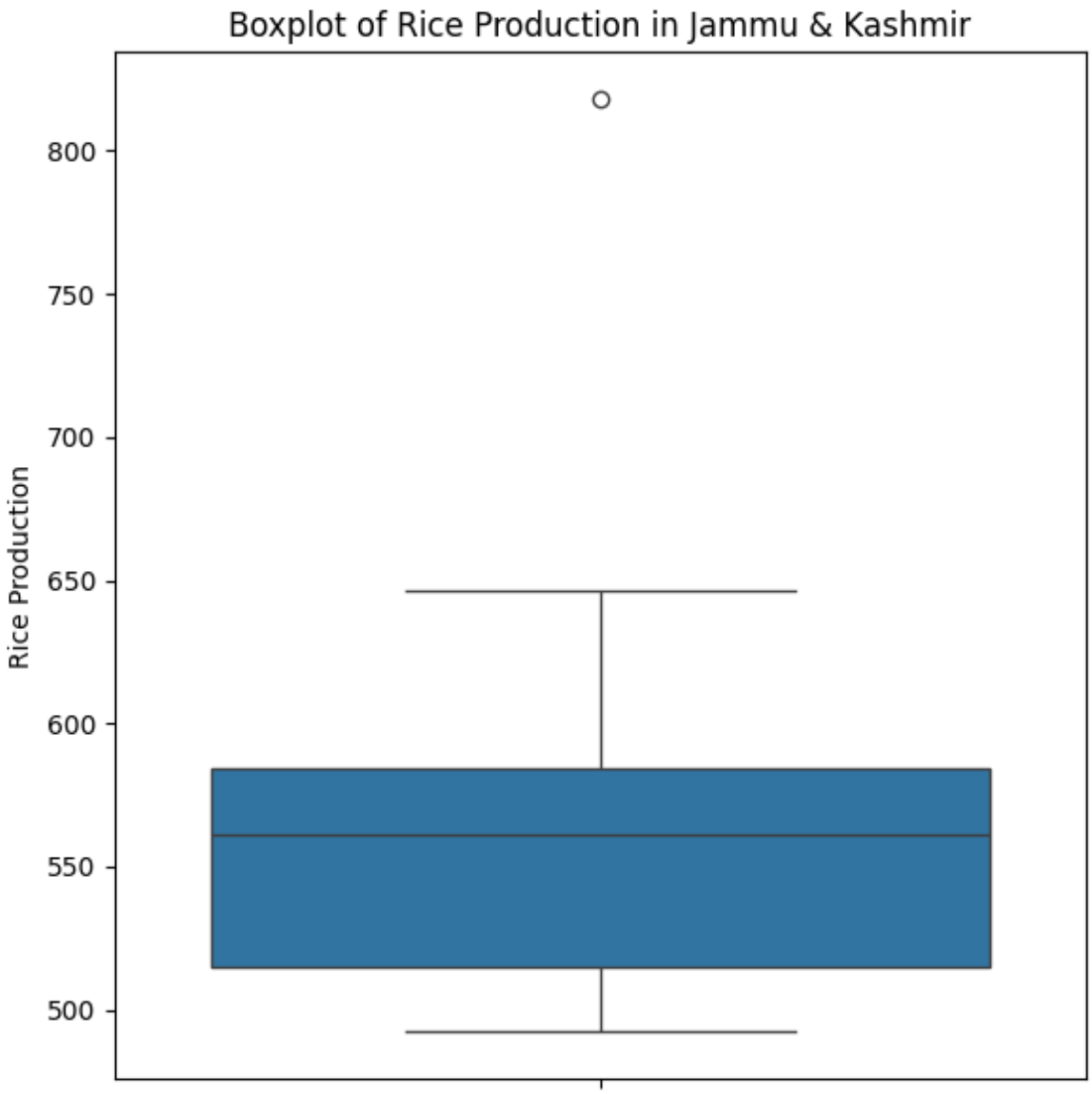

Boxplot of Rice Production in NCT of Delhi
Rice Production
30.0
27.5
25.0
22.5
20.0
17.5
15.0

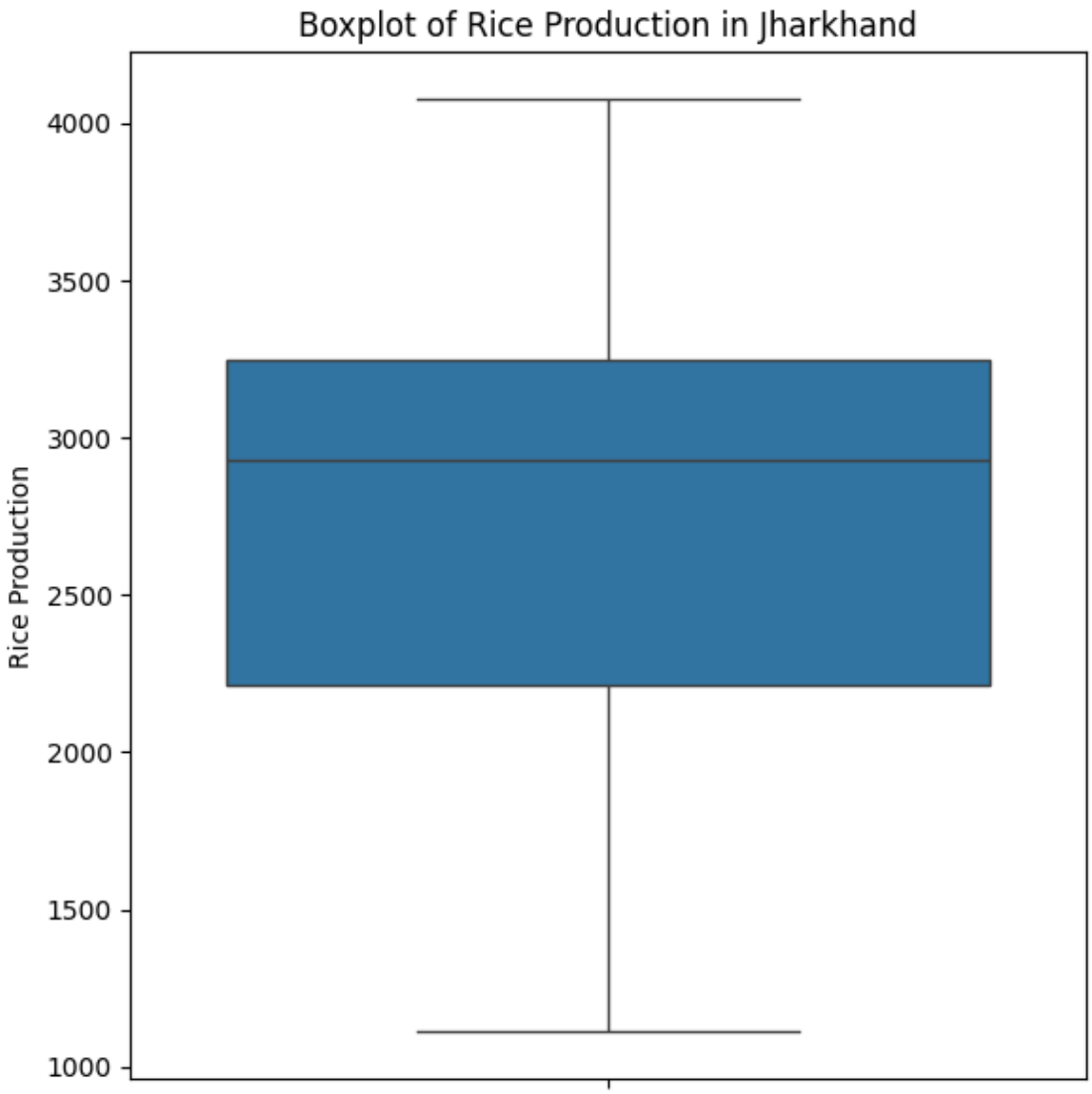

Boxplot of Rice Production in Goa
Rice Production
150
140
130
120
110
100
90

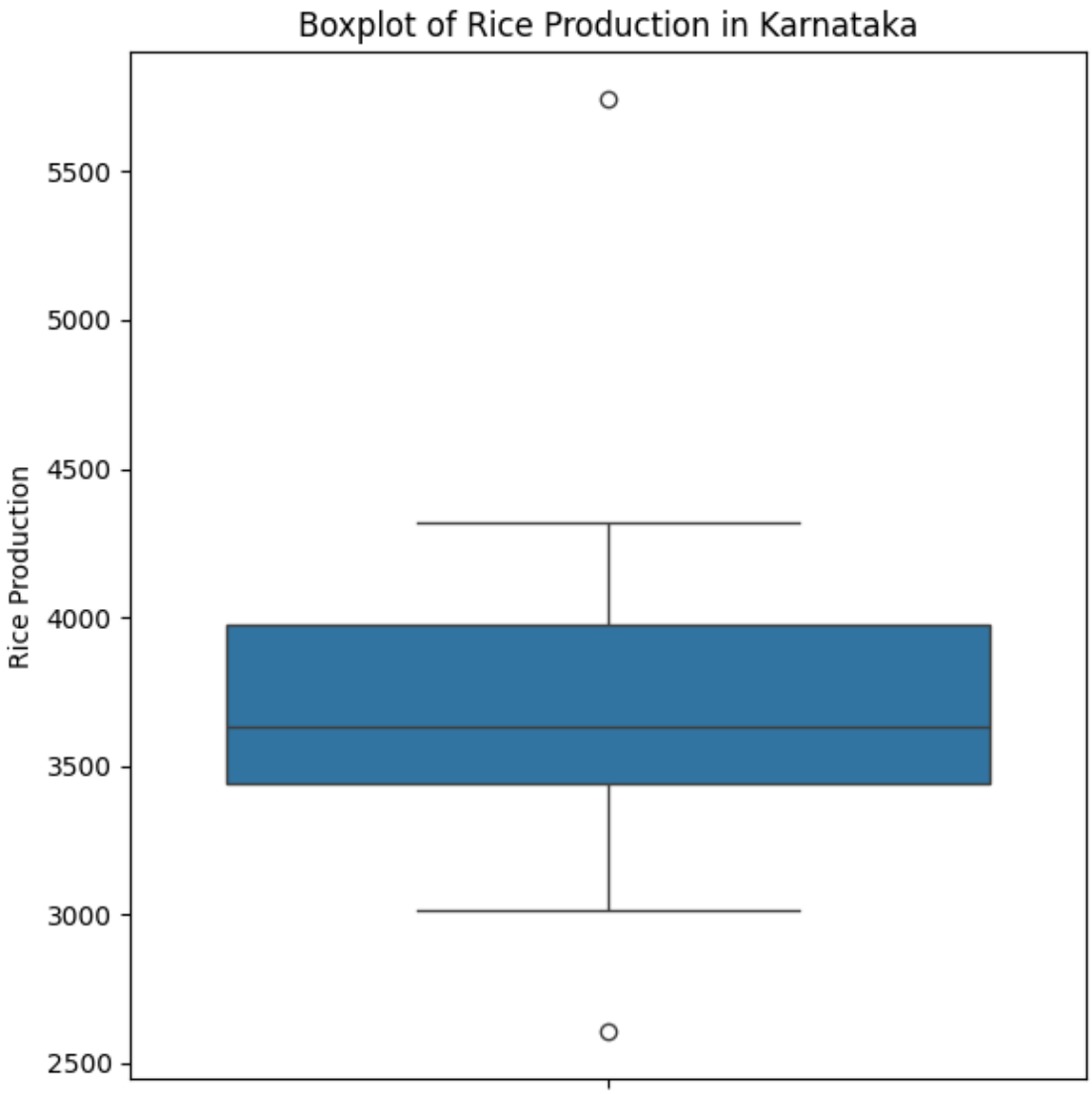

Boxplot of Rice Production in Gujarat
Rice Production
2400
2200
2000
1800
1600
1400
1200

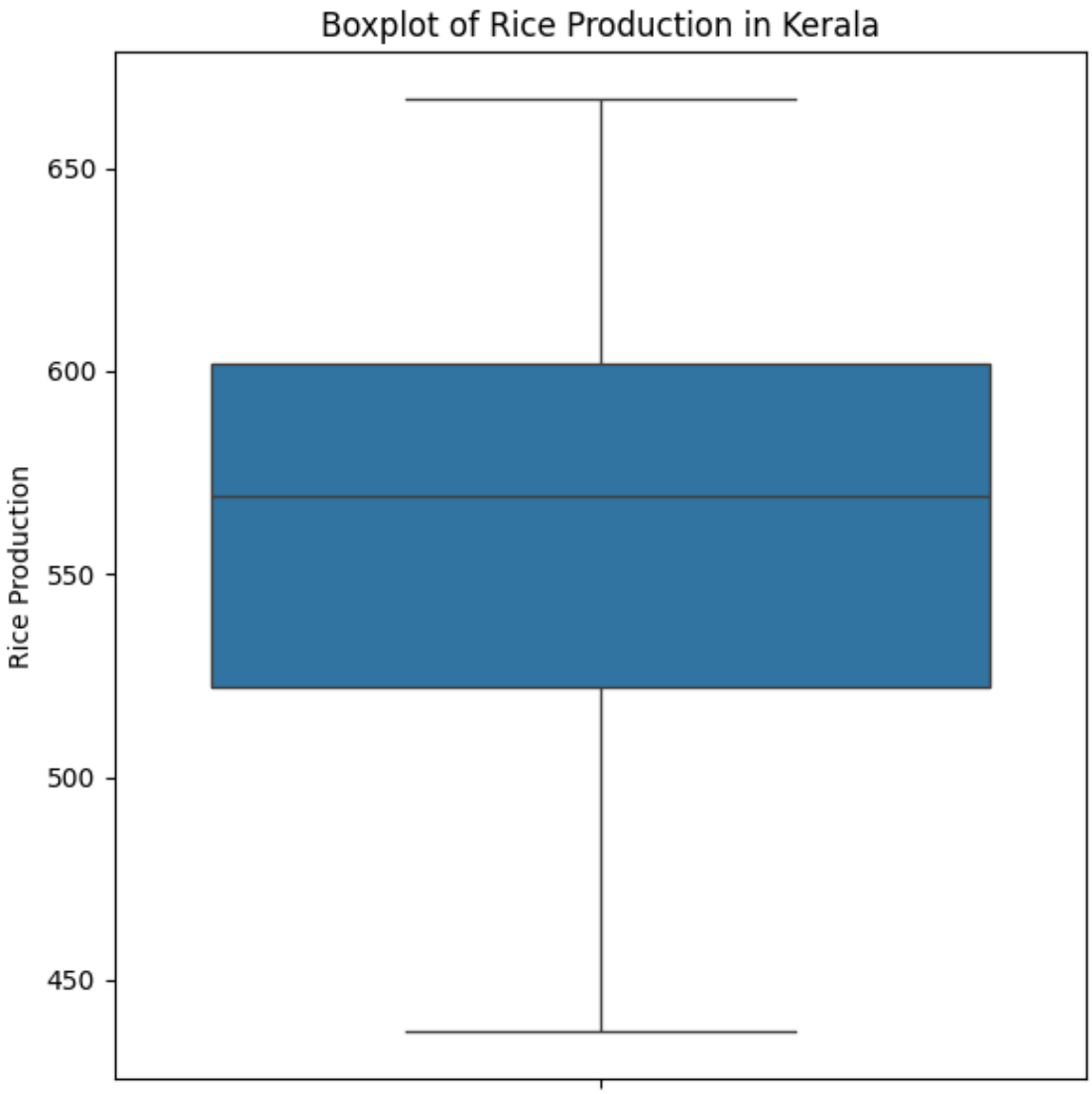

Boxplot of Rice Production in Haryana
Rice Production
5500
5000
4500
4000
3500
3000

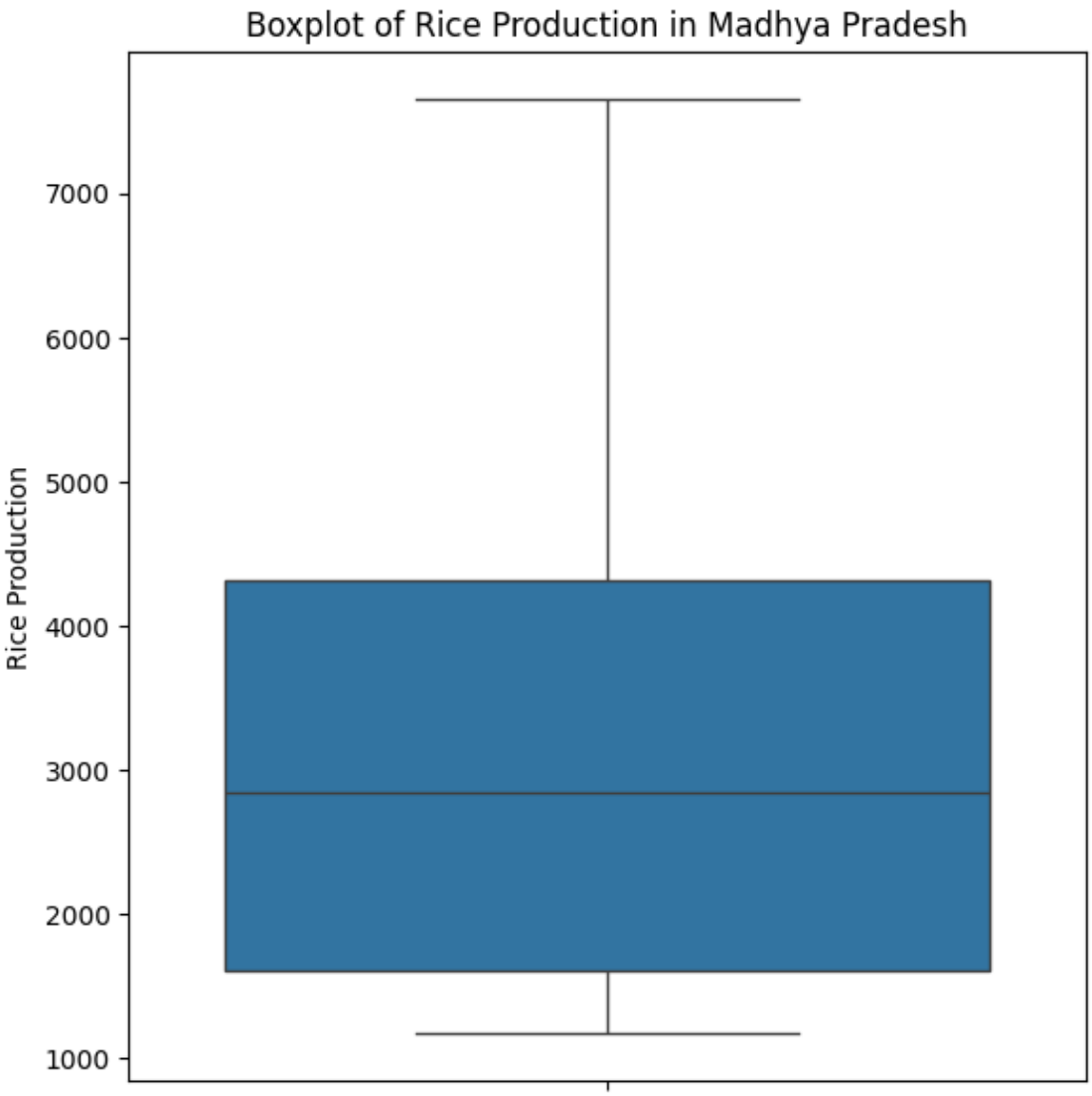

Boxplot of Rice Production in Himachal Pradesh
Rice Production
170
160
150
140
130
120
110

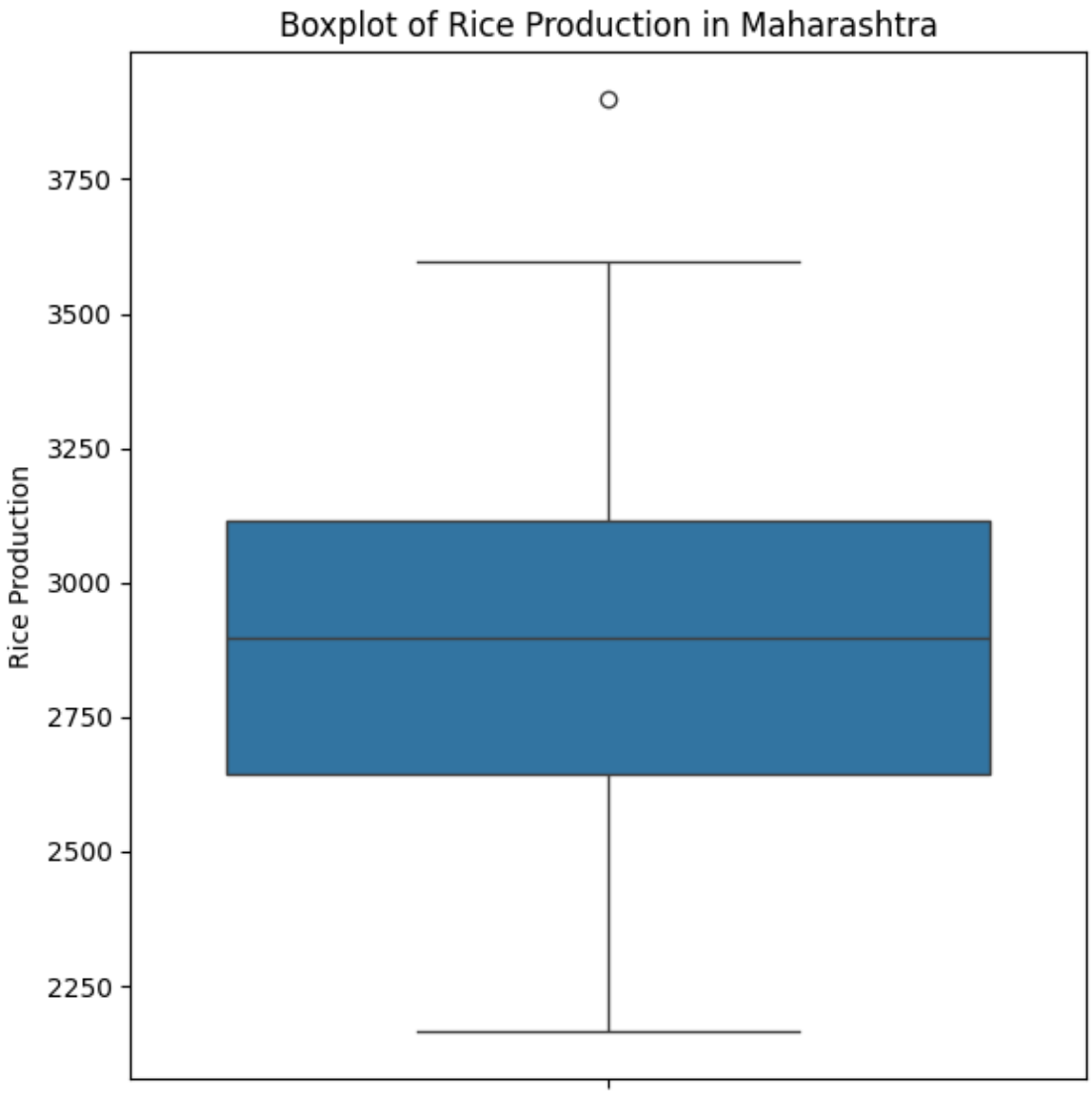

Boxplot of Rice Production in Jammu & Kashmir
Rice Production
800
750
700
650
600
550
500

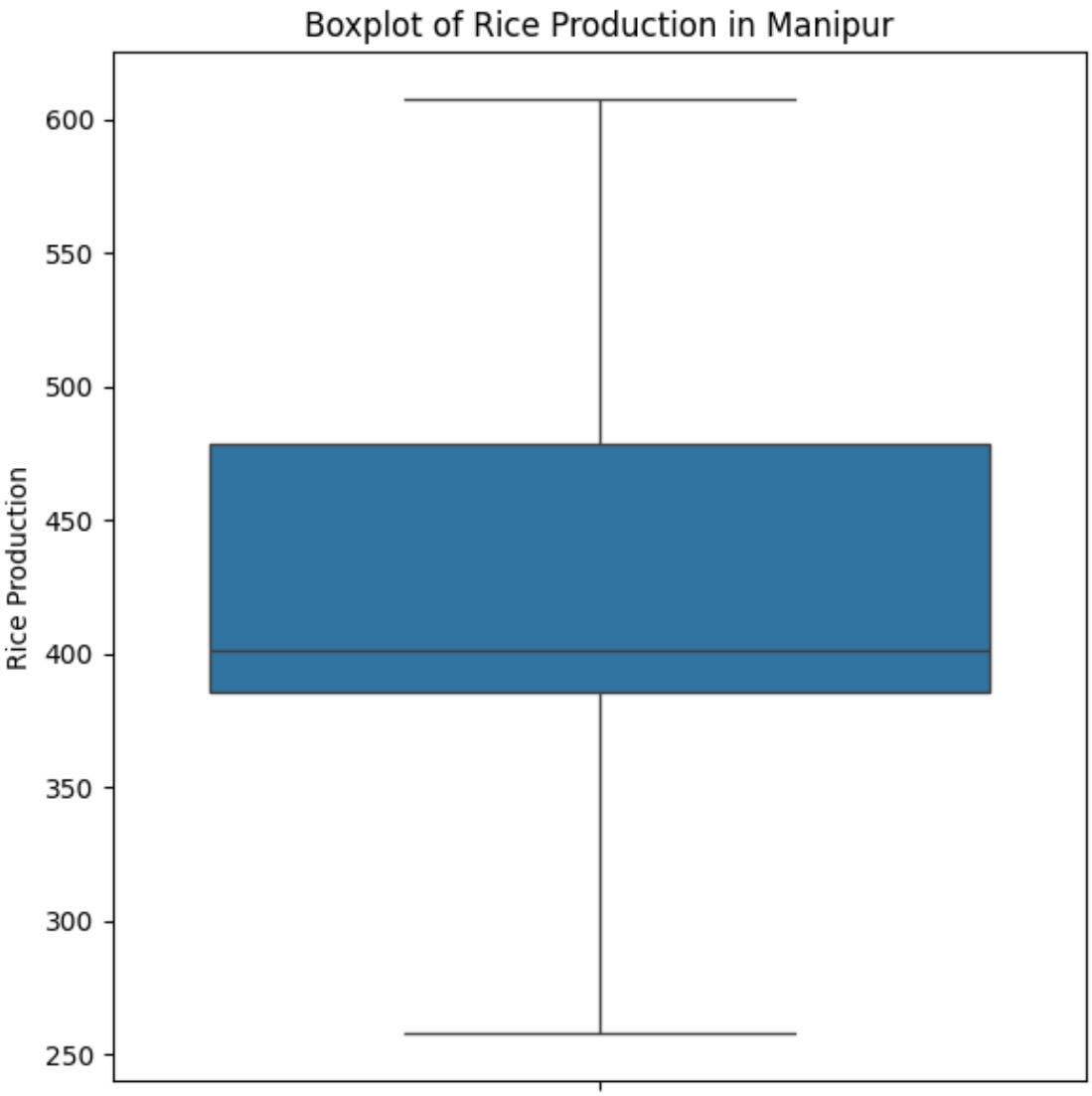

Boxplot of Rice Production in Jharkhand
Rice Production
4000
3500
3000
2500
2000
1500
1000

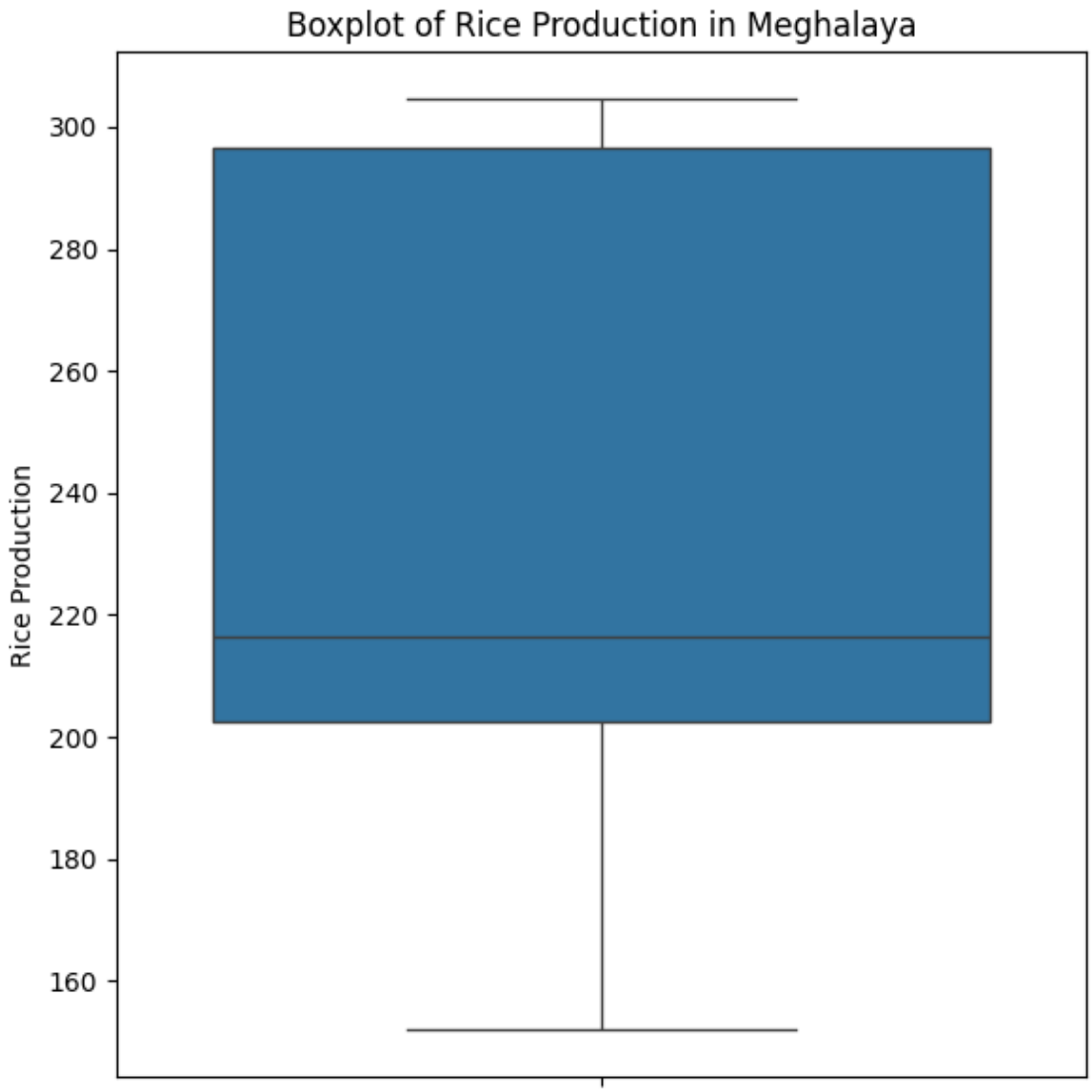

Boxplot of Rice Production in Karnataka
Rice Production
5500
5000
4500
4000
3500
3000
2500

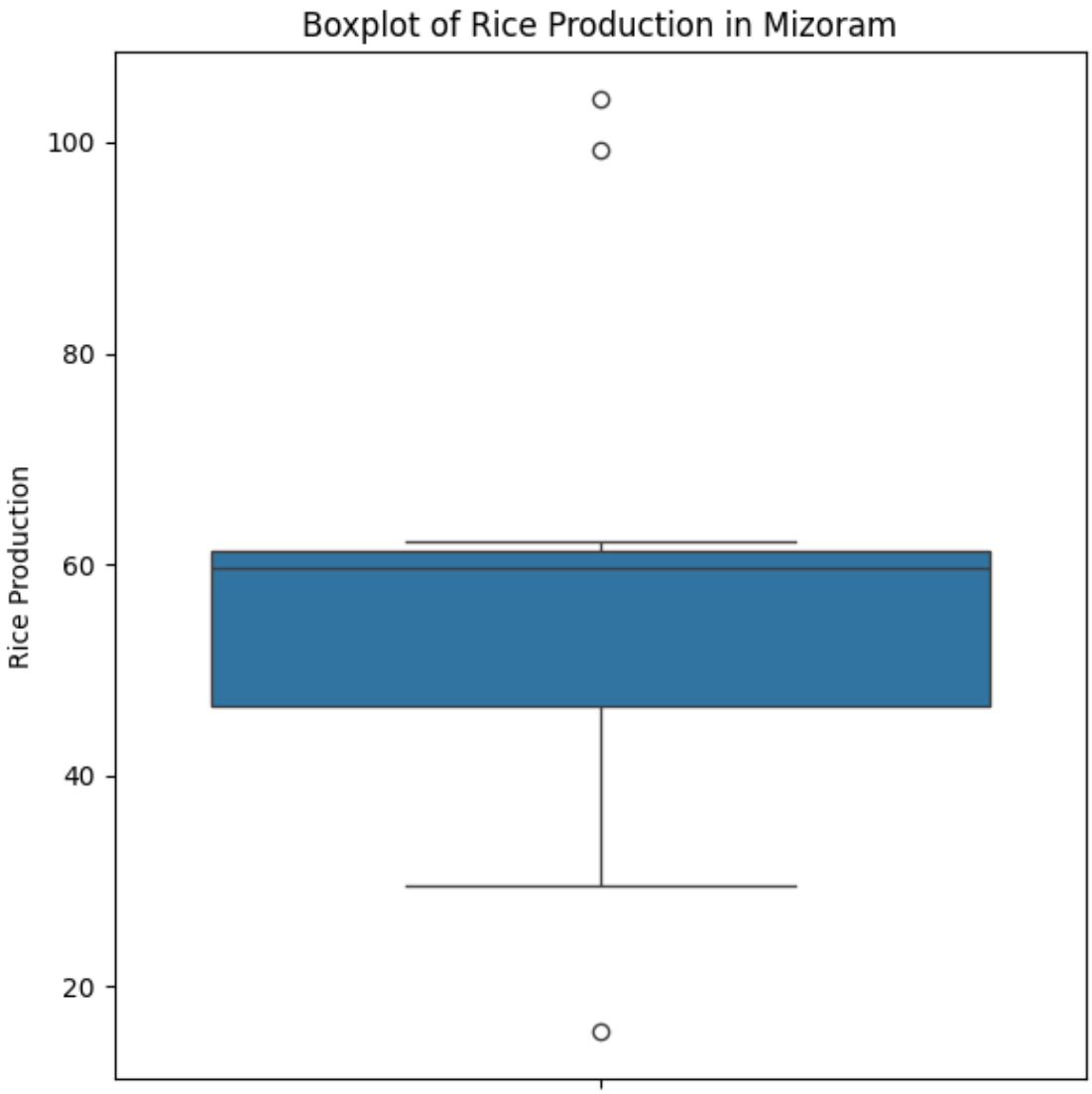

Boxplot of Rice Production in Kerala
Rice Production
650
600
550
500
450

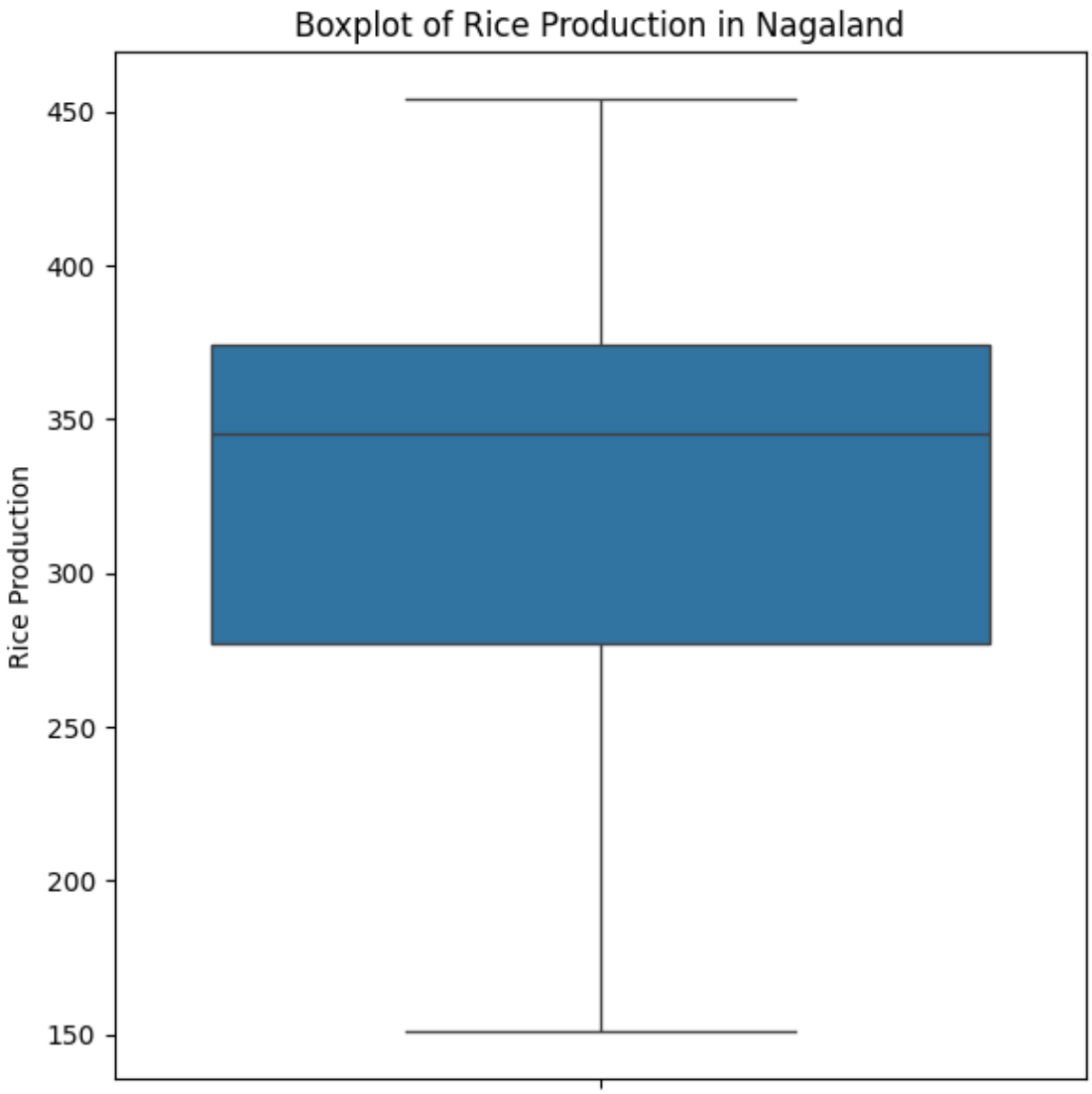

Boxplot of Rice Production in Madhya Pradesh
Rice Production
7000
6000
5000
4000
3000
2000
1000

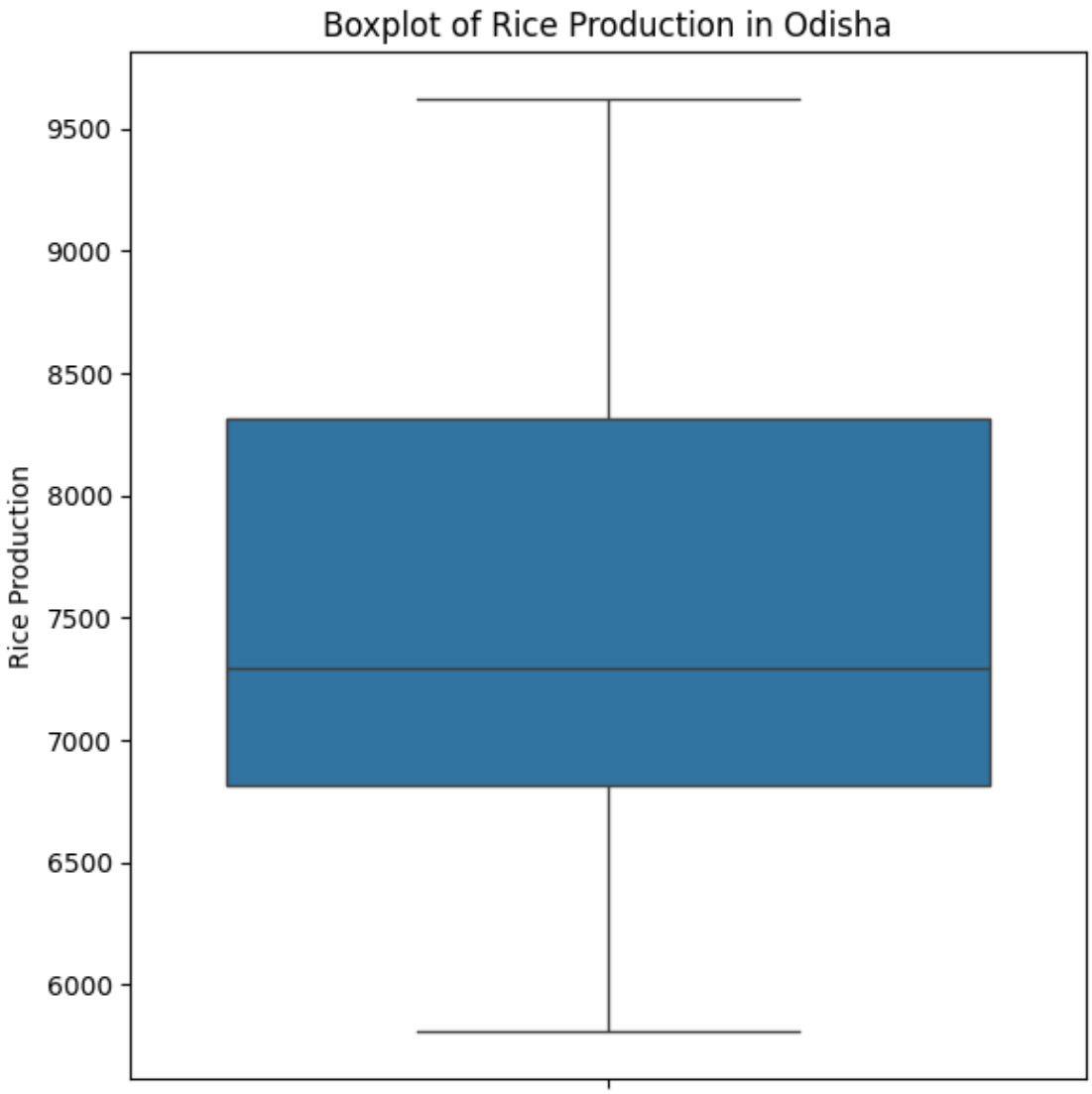

Boxplot of Rice Production in Maharashtra
Rice Production
3750
3500
3250
3000
2750
2500
2250

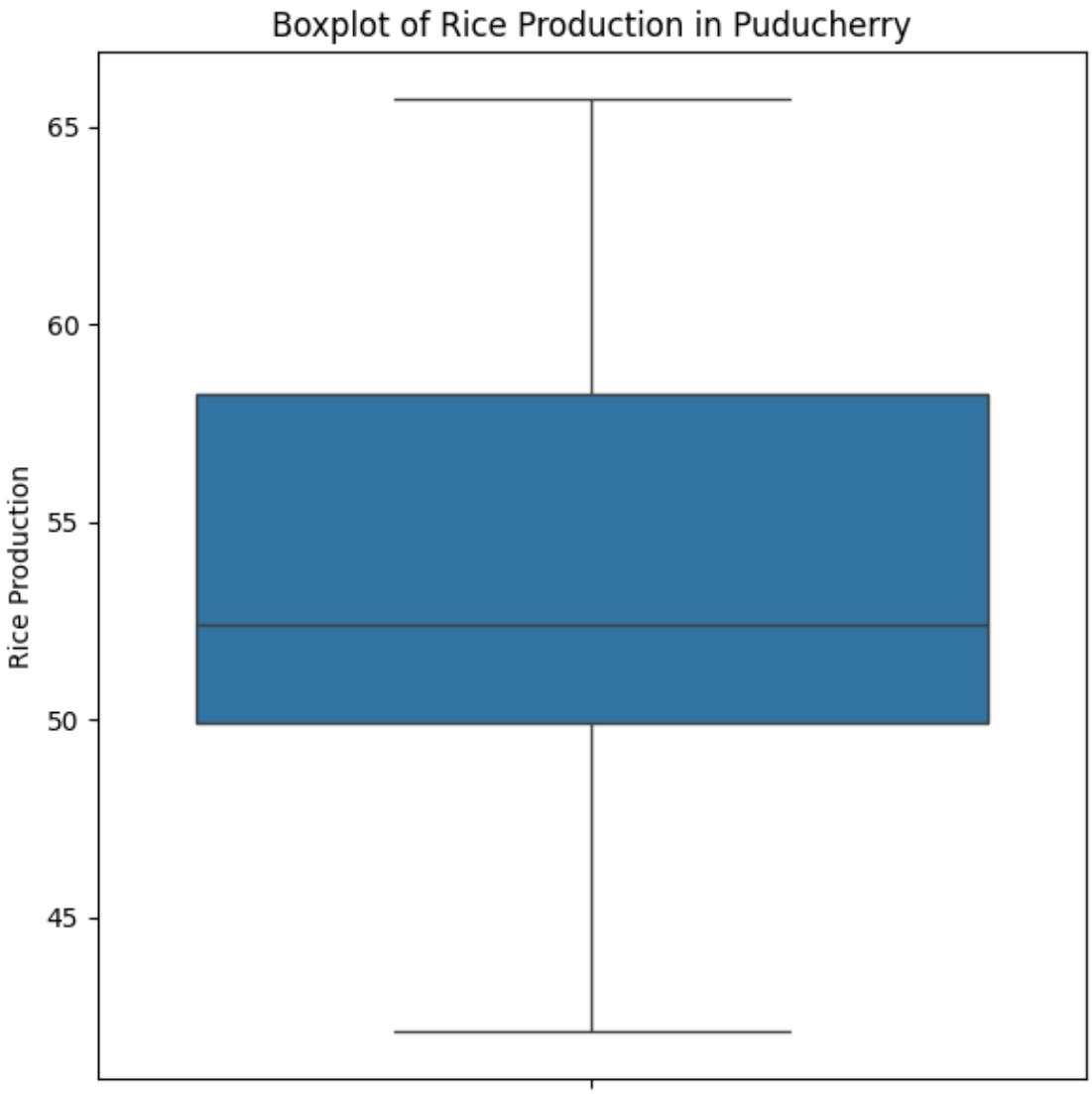

Boxplot of Rice Production in Manipur
Rice Production
600
550
500
450
400
350
300
250

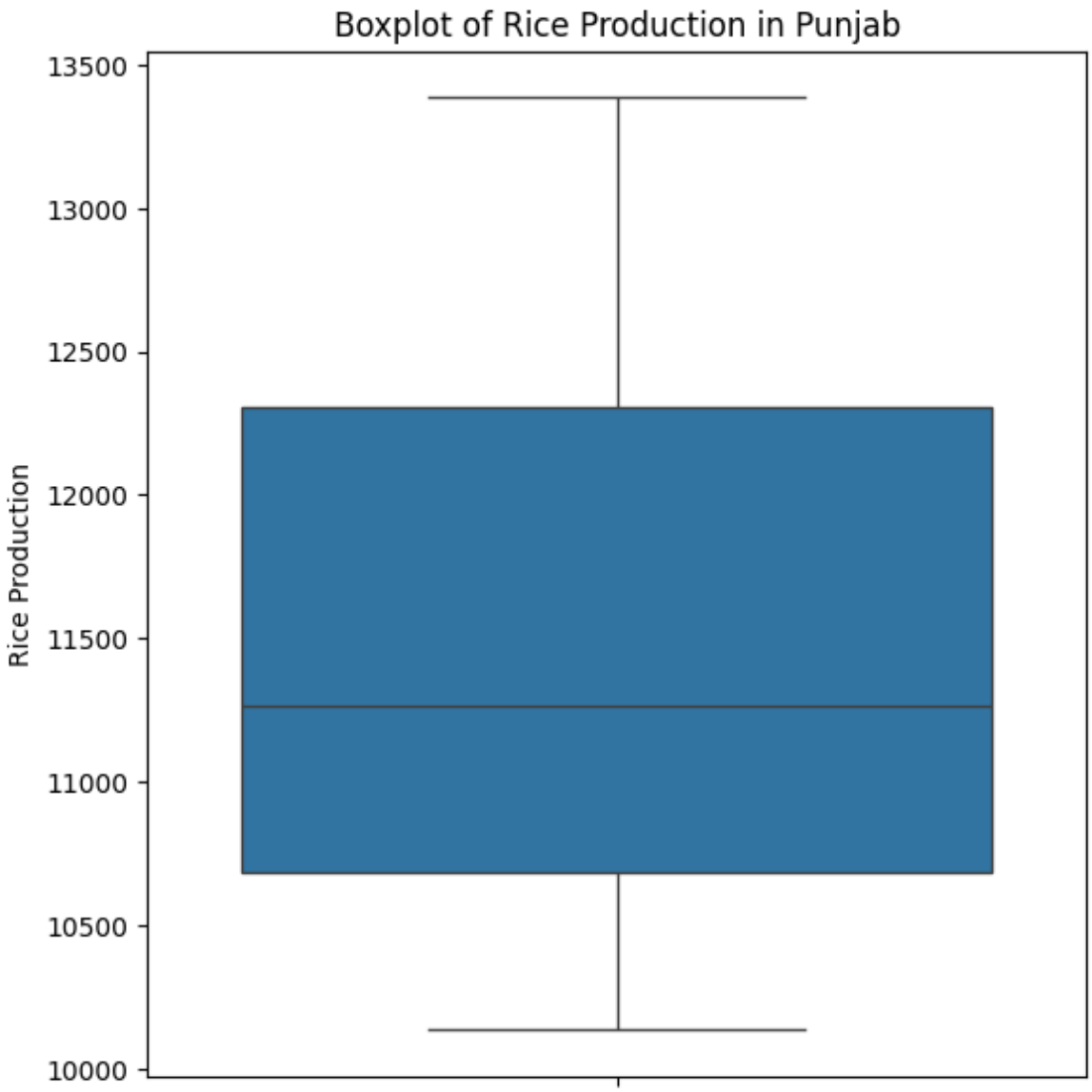

Boxplot of Rice Production in Meghalaya
Rice Production
300
280
260
240
220
200
180
160

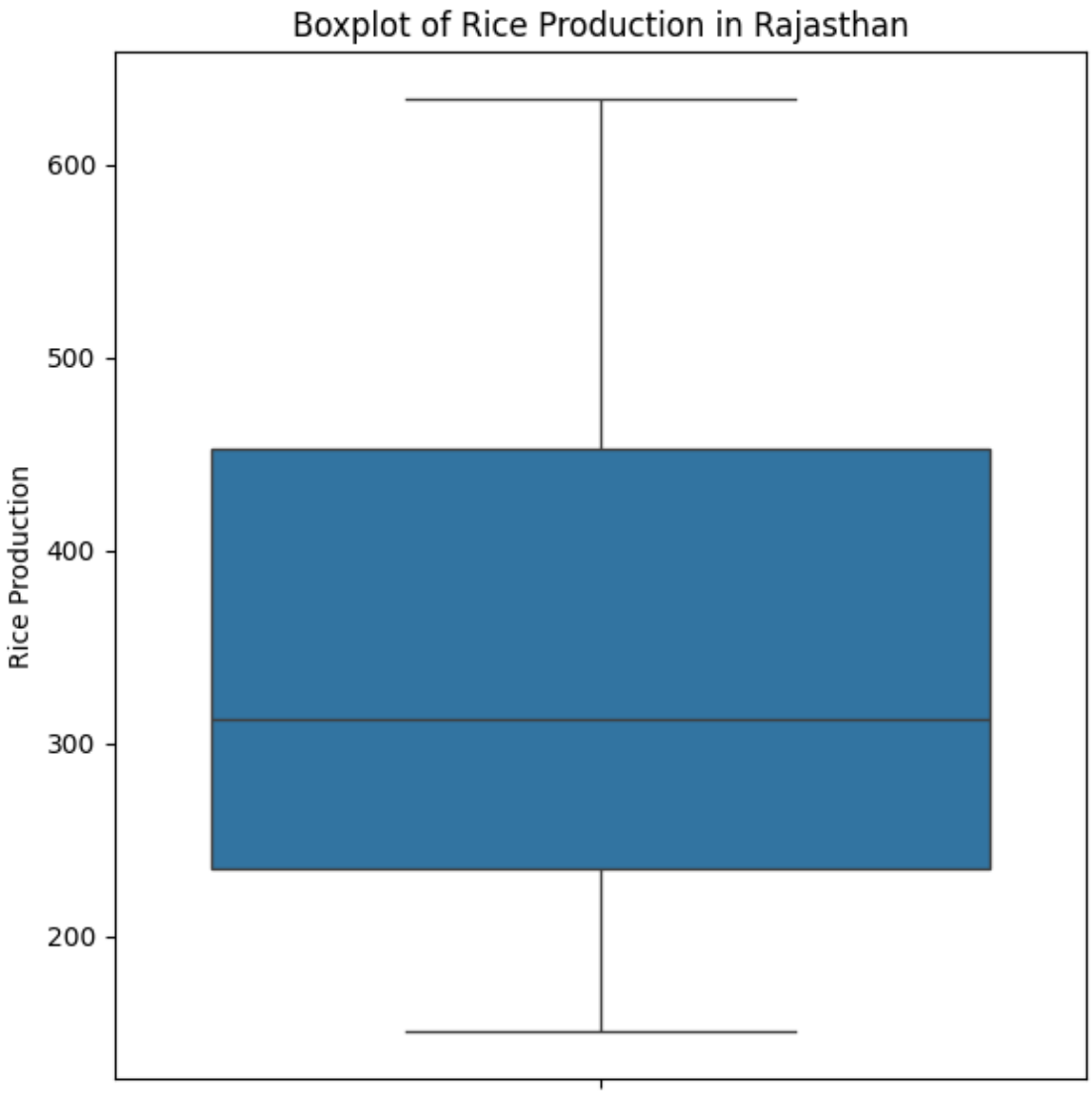

Boxplot of Rice Production in Mizoram
Rice Production
100
80
60
40
20

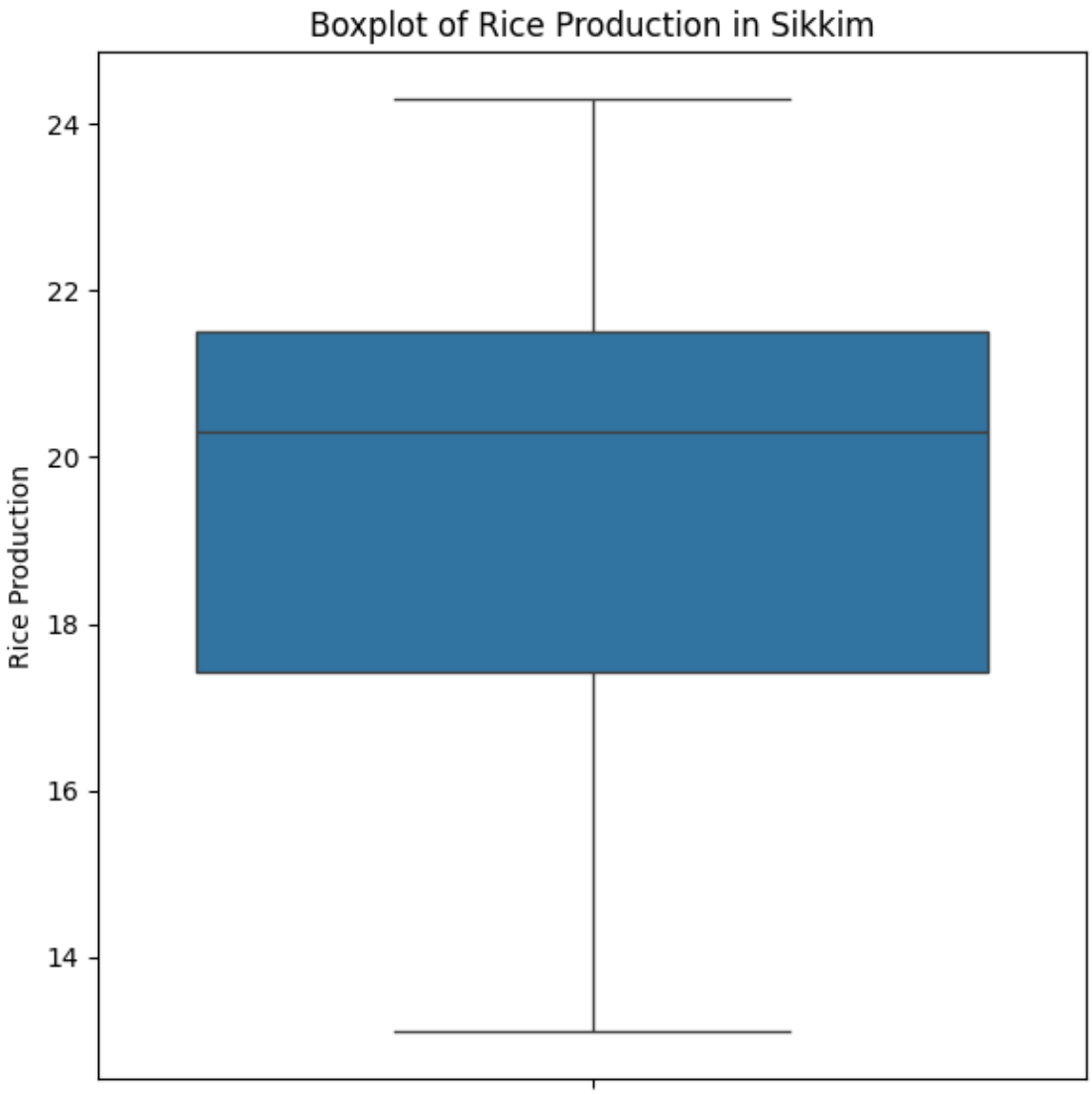

Boxplot of Rice Production in Nagaland
Rice Production
450
400
350
300
250
200
150

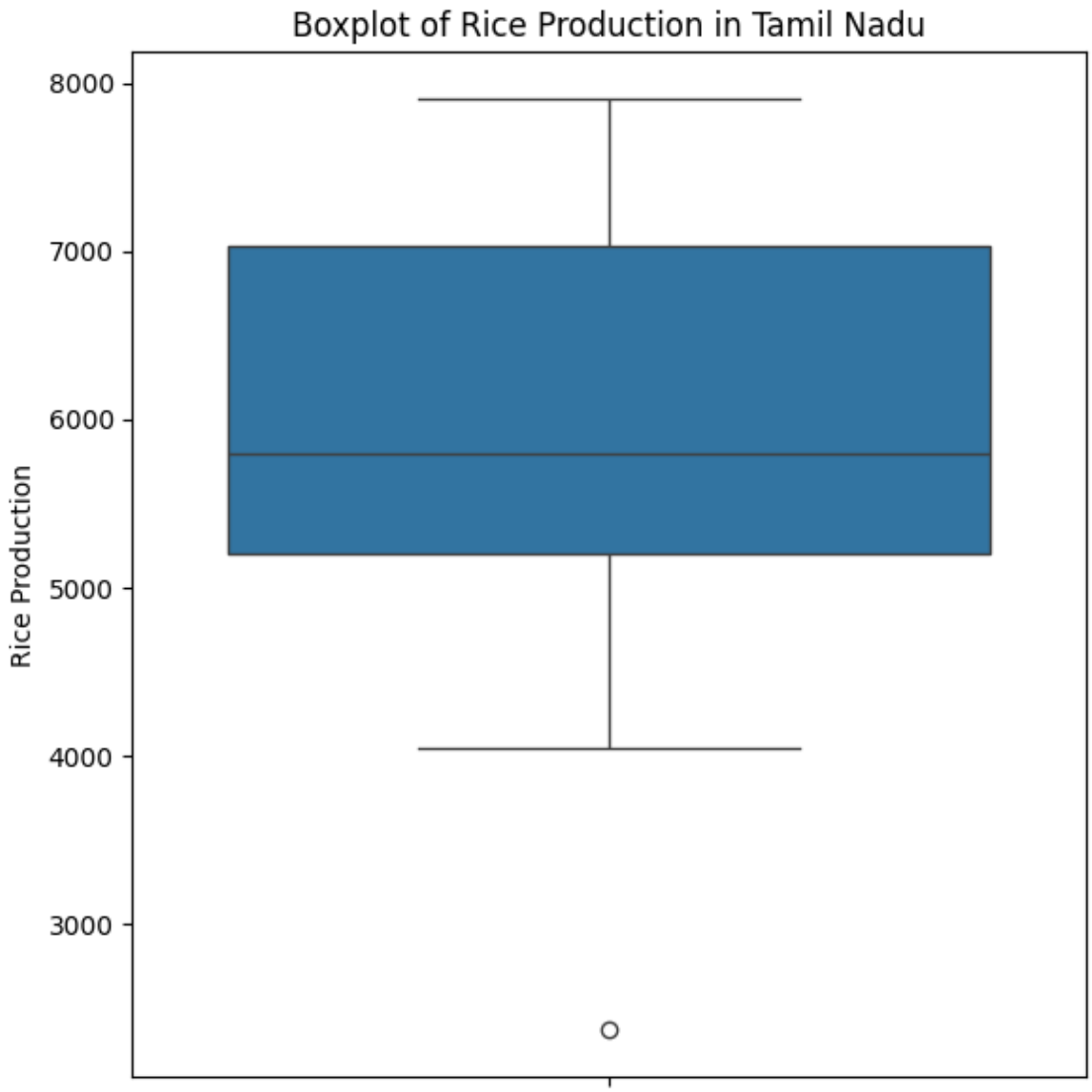

Boxplot of Rice Production in Odisha
Rice Production
9500
9000
8500
8000
7500
7000
6500
6000

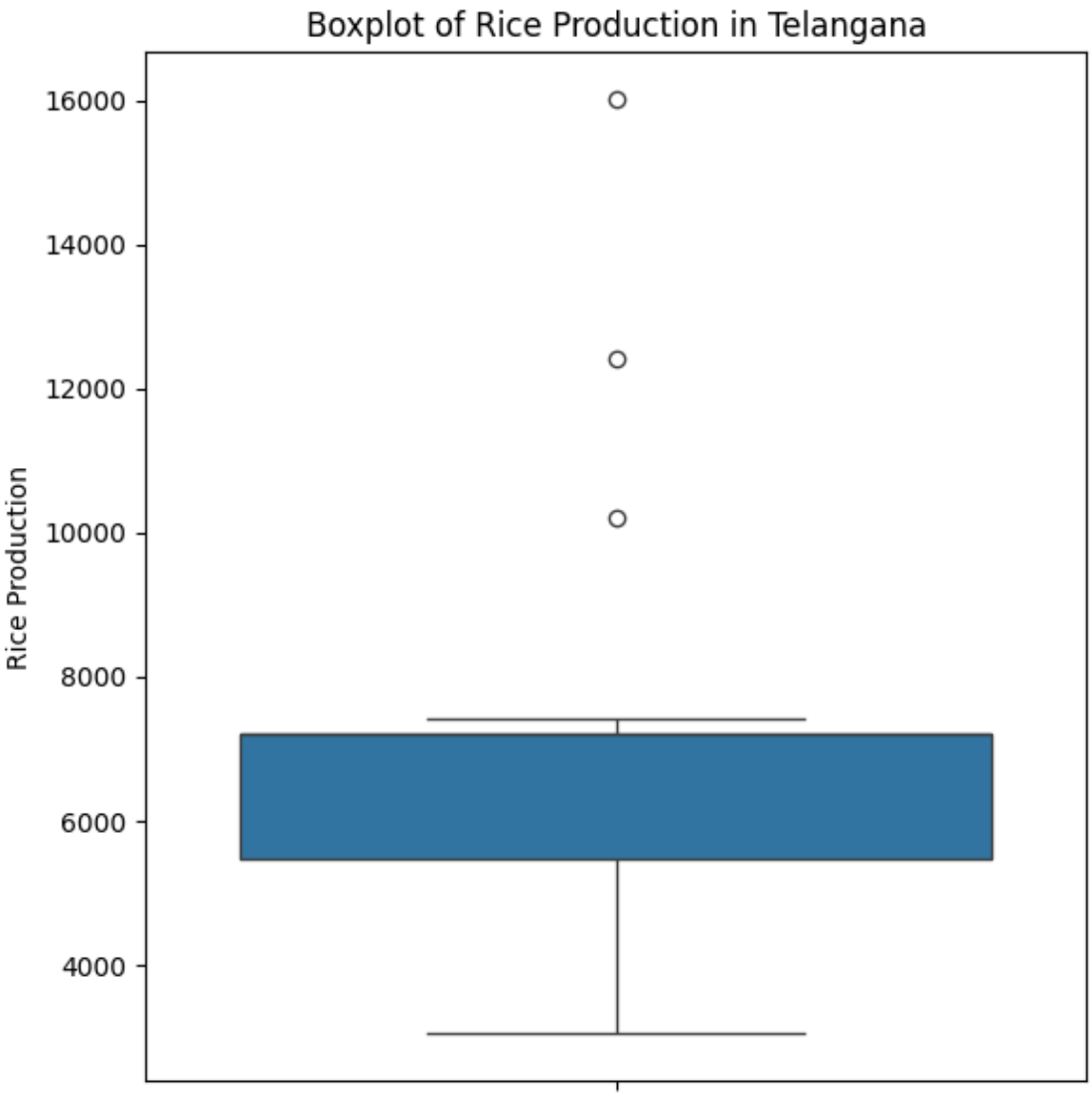

Boxplot of Rice Production in Puducherry
Rice Production
65
60
55
50
45

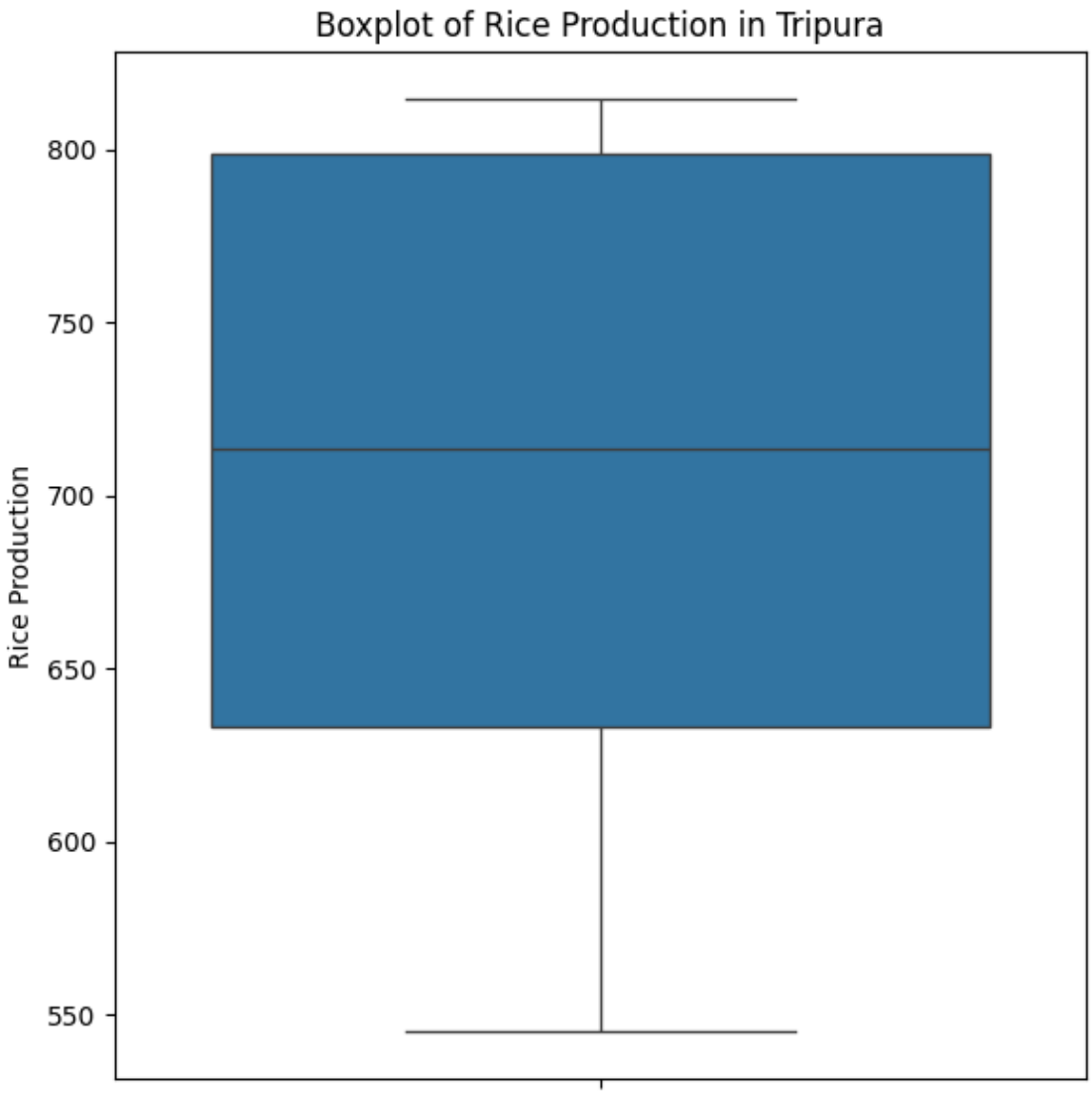

Boxplot of Rice Production in Punjab
Rice Production
13500
13000
12500
12000
11500
11000
10500
10000

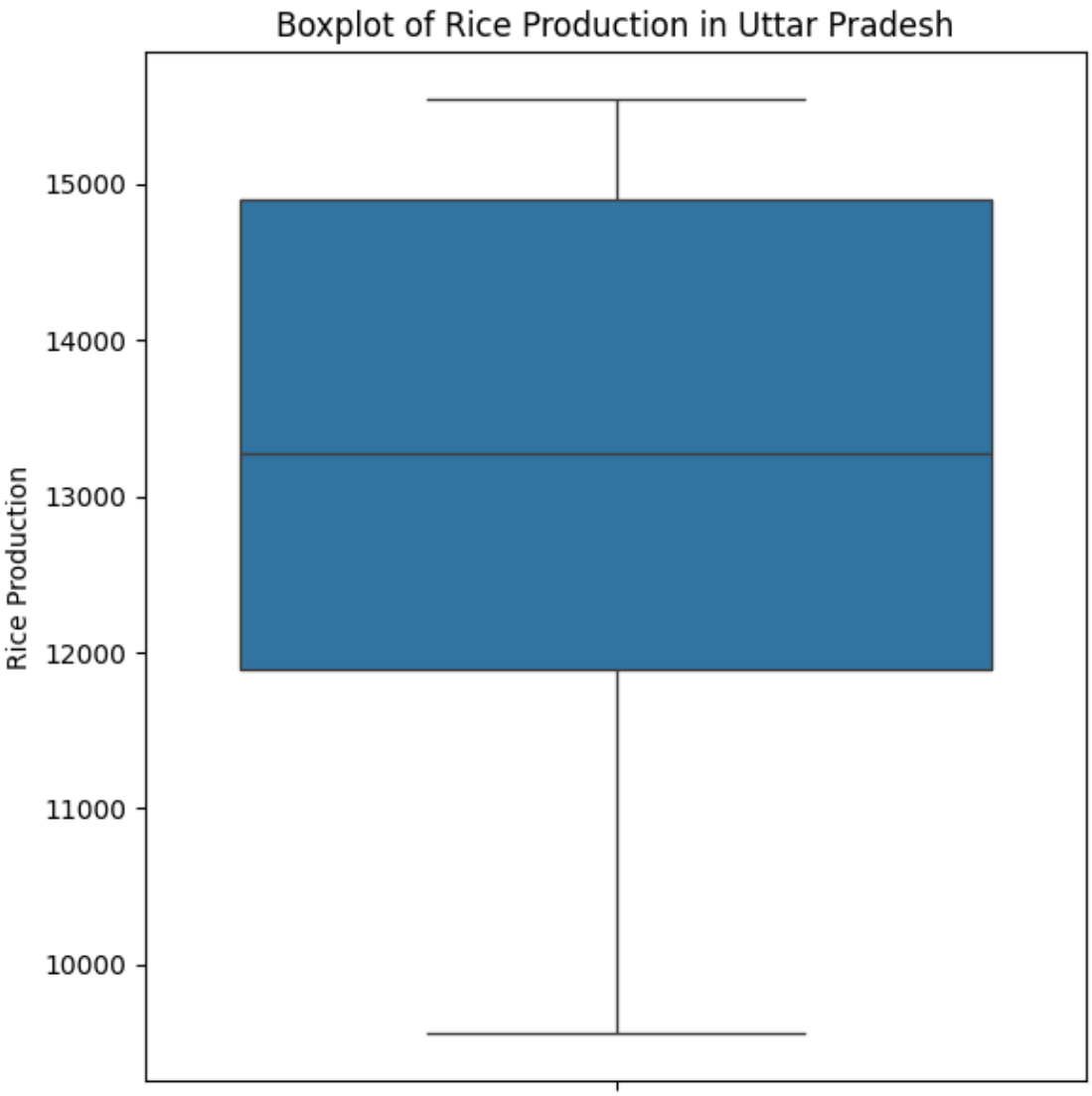

Boxplot of Rice Production in Rajasthan
Rice Production
600
500
400
300
200

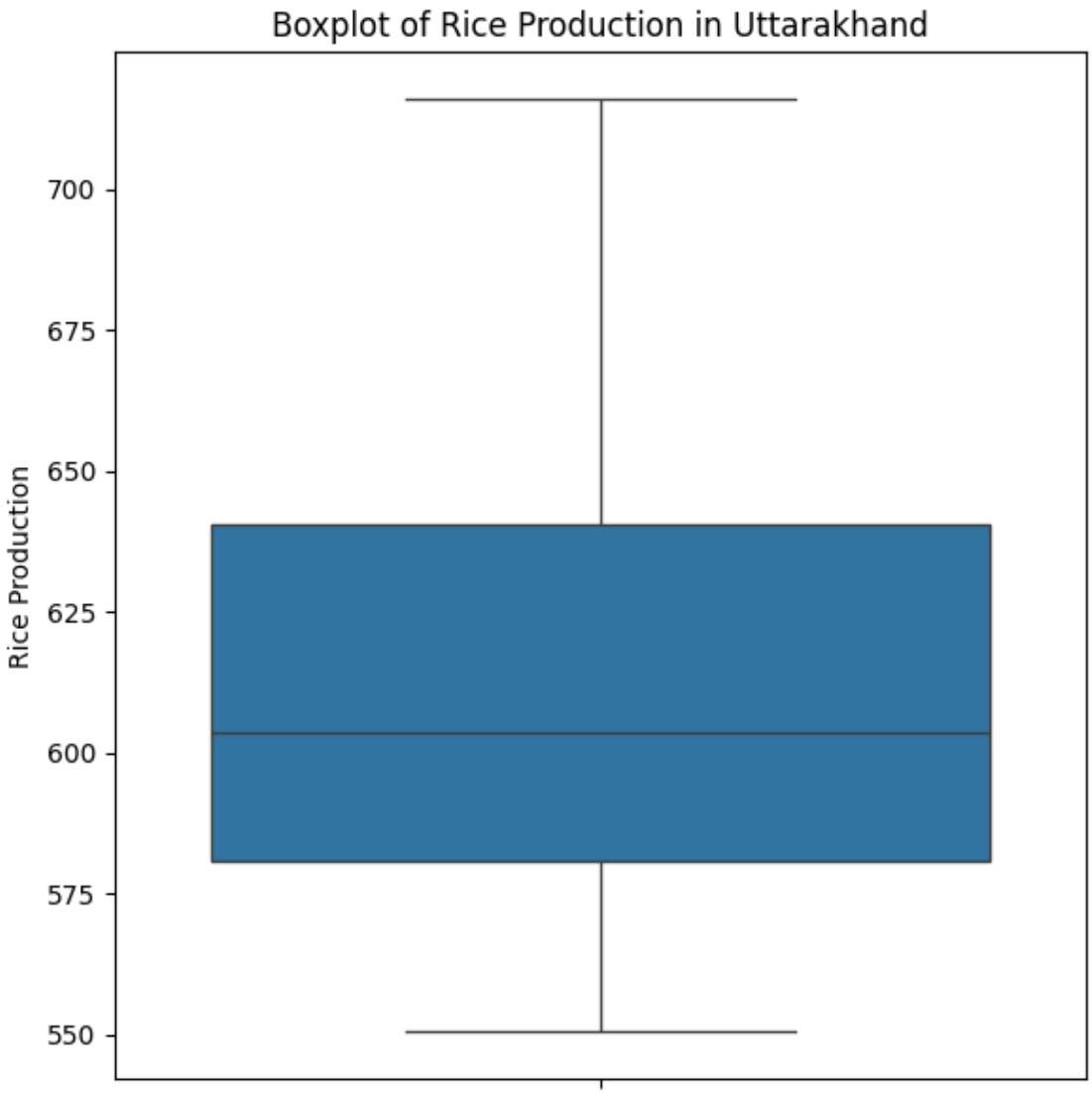

Boxplot of Rice Production in Sikkim
Rice Production
24
22
20
18
16
14

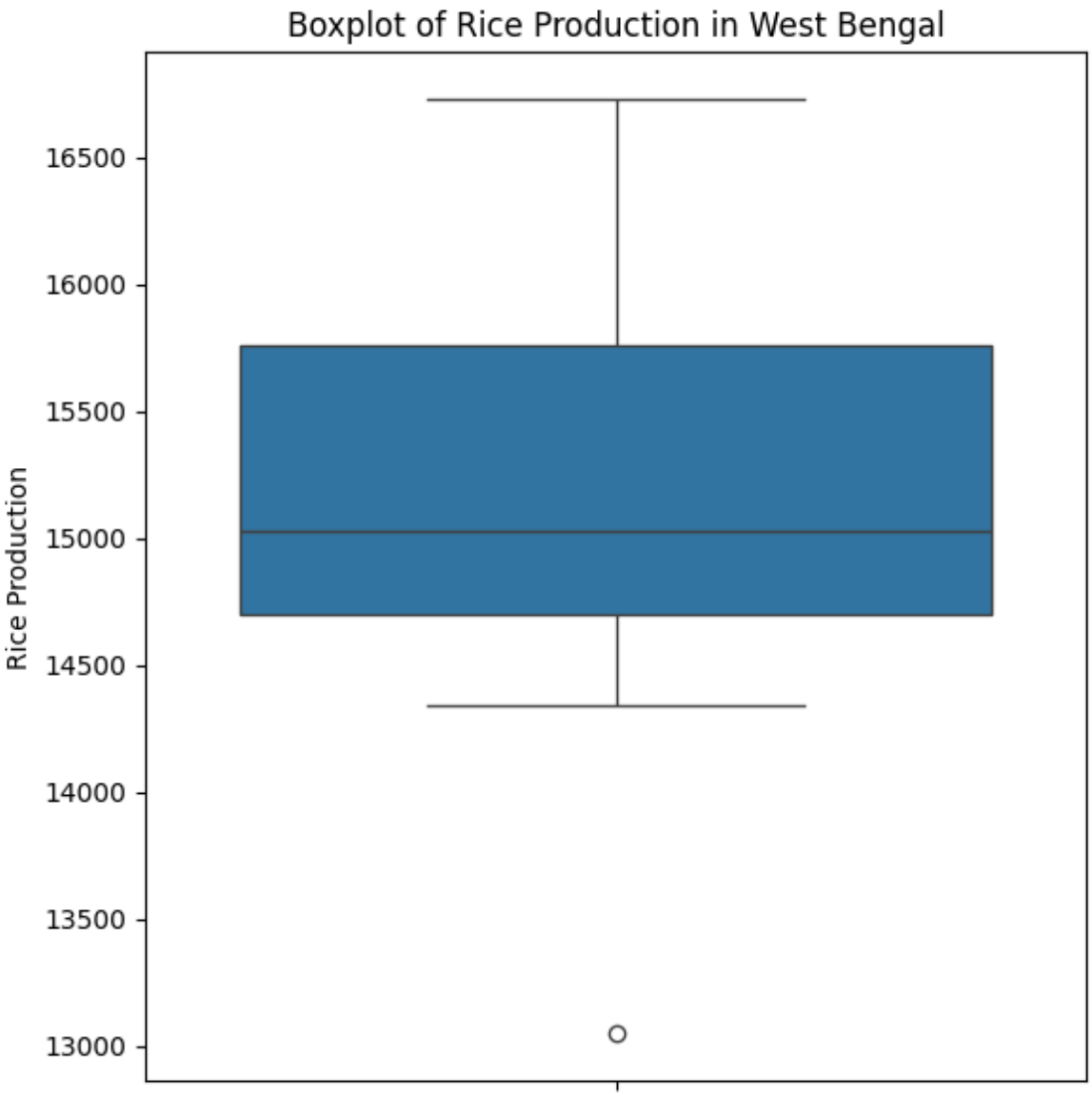

Boxplot of Rice Production in Tamil Nadu
Rice Production
8000
7000
6000
5000
4000
3000

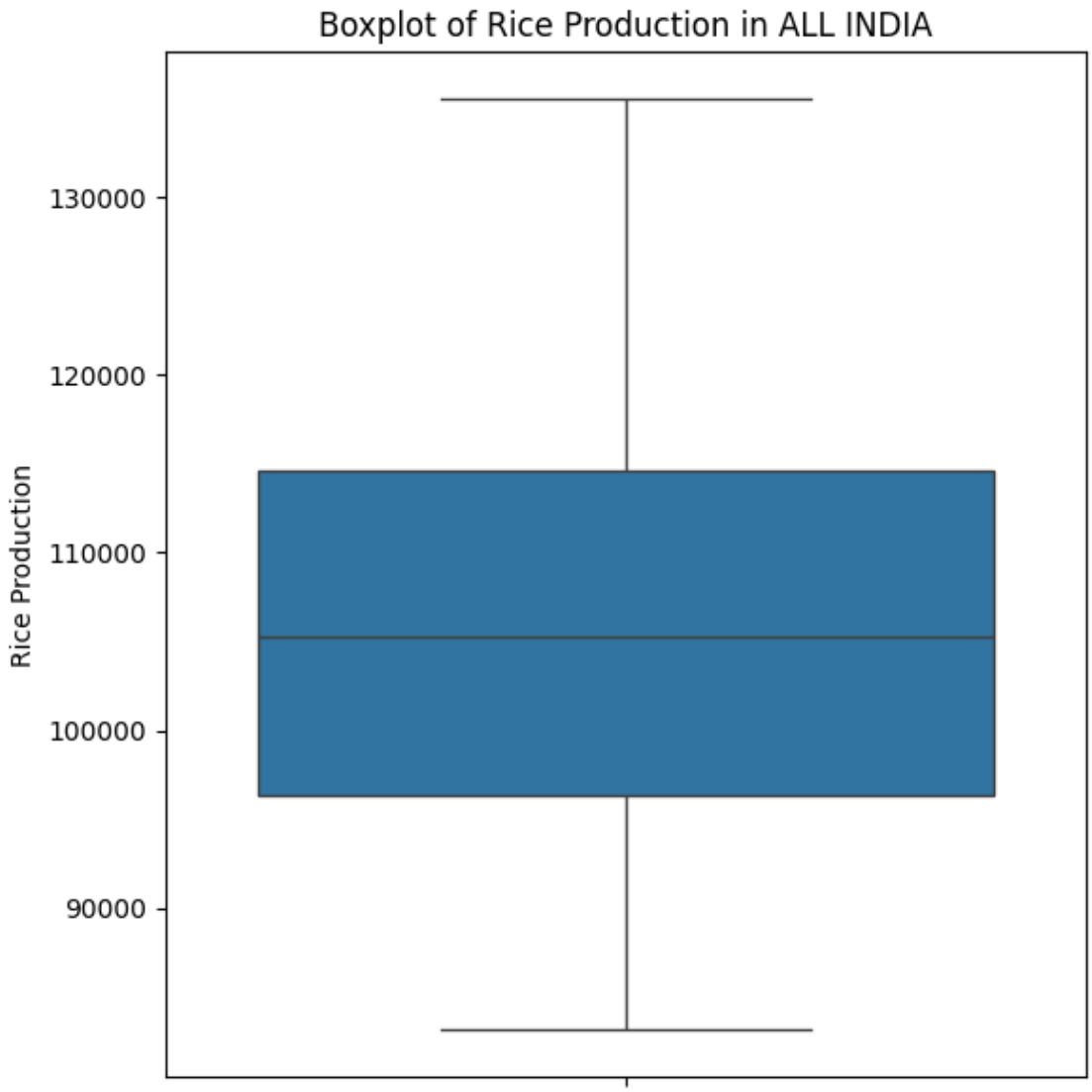

Boxplot of Rice Production in Telangana
Rice Production
16000
14000
12000
10000
8000
6000
4000


Boxplot of Rice Production in Tripura
Rice Production
800
750
700
650
600
550


Boxplot of Rice Production in Uttar Pradesh
Rice Production
15000
14000
13000
12000
11000
10000

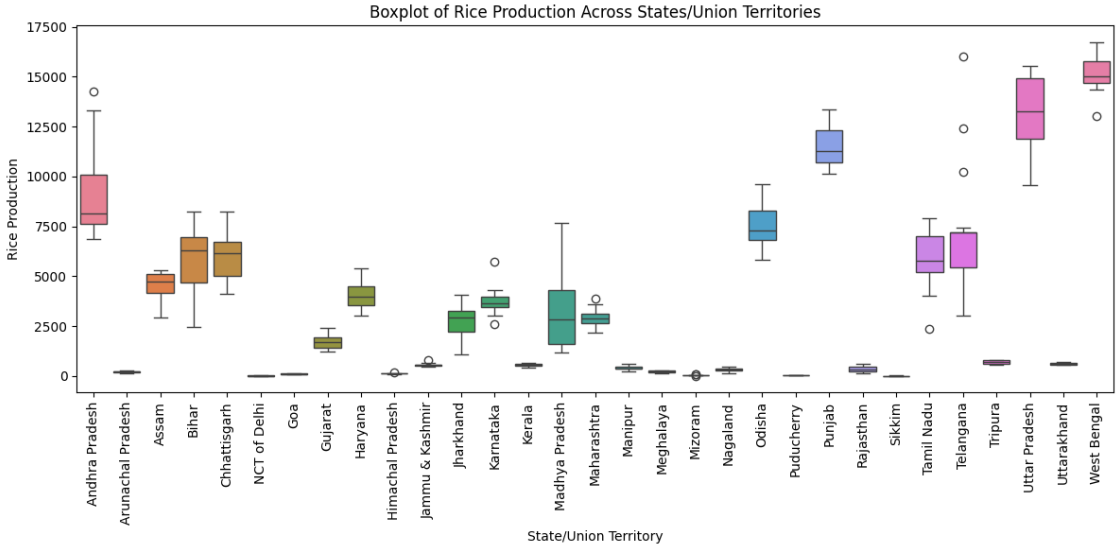

Boxplot of Rice Production in Uttarakhand
Rice Production
700
675
650
625
600
575
550


Boxplot of Rice Production in West Bengal
Rice Production
16500
16000
15500
15000
14500
14000
13500
13000



[ ]:
```
fig, ax = plt.subplots(figsize=(12, 6))

#
sns.boxplot(data=df_T_A, ax=ax)


ax.set_xlabel('State/Union Territory')
ax.set_ylabel('Rice Production')
ax.set_title('Boxplot of Rice Production Across States/Union Territories')


plt.xticks(rotation=90)
```

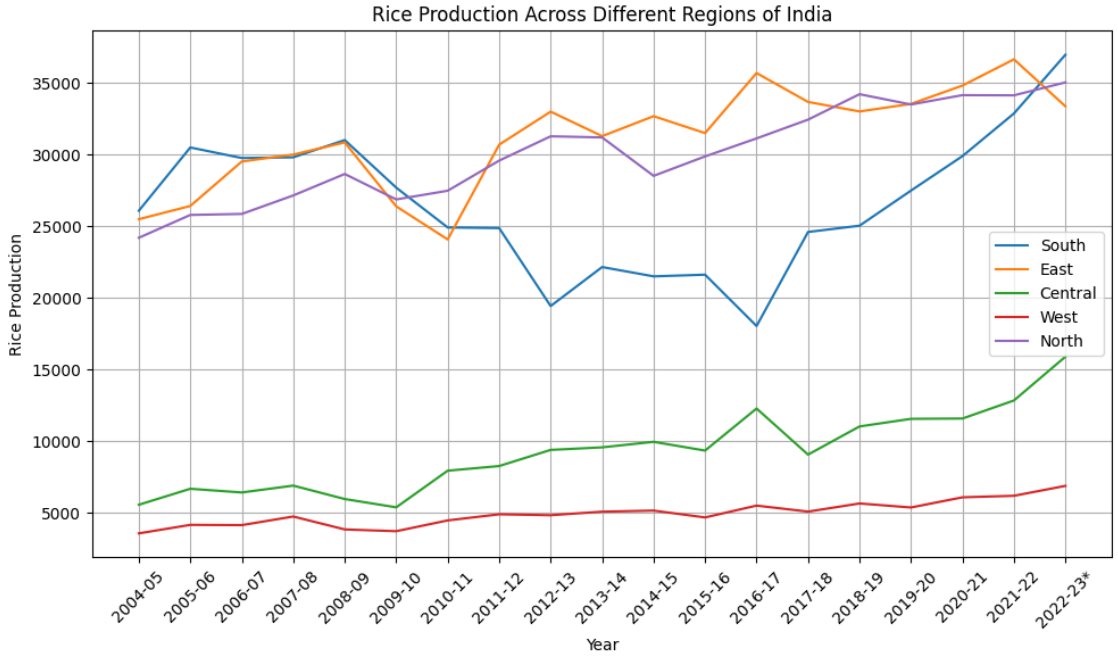
```
plt.tight_layout()
plt.show()
```



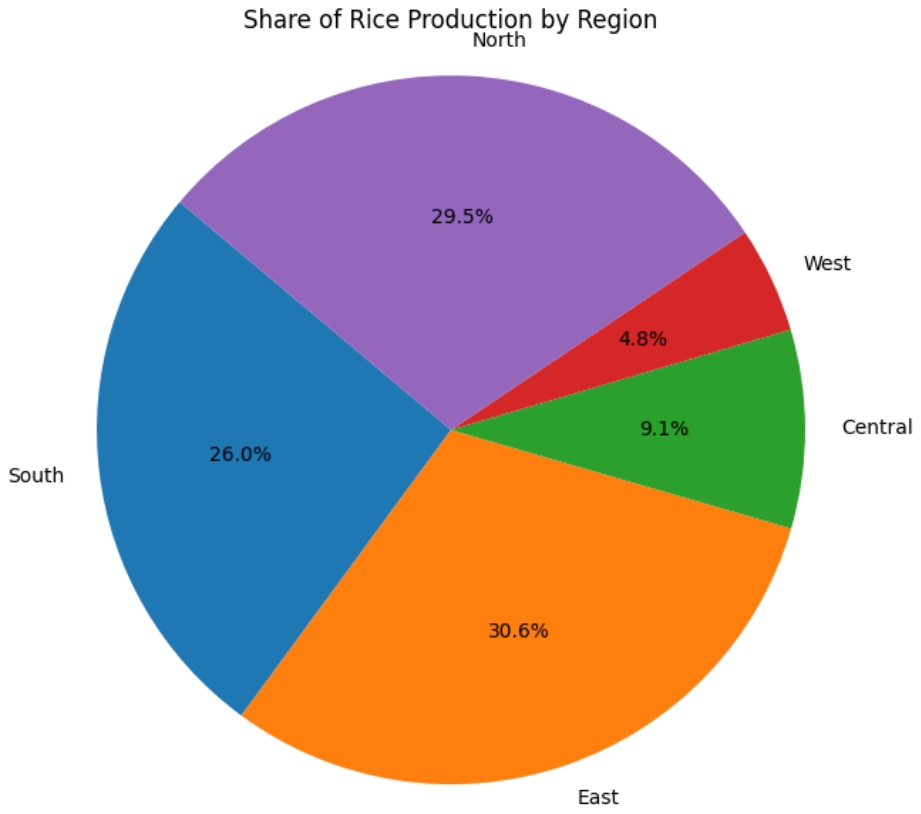
3 Regional Comparisons

[ ]:
```
north_states = ['Delhi', 'Haryana', 'Himachal Pradesh', 'Jammu & Kashmir',␣
 ↪'Punjab', 'Uttarakhand', 'Uttar Pradesh']
south_states = ['Andhra Pradesh', 'Karnataka', 'Kerala', 'Tamil Nadu',␣
 ↪'Telangana']
east_states = ['Bihar', 'Jharkhand', 'Odisha', 'West Bengal']
west_states = ['Gujarat', 'Maharashtra', 'Rajasthan']
central_states = ['Chhattisgarh', 'Madhya Pradesh']


state_to_region = {}
for state in df_T.columns:
    if state in north_states:
        state_to_region[state] = 'North'
    elif state in south_states:
        state_to_region[state] = 'South'
    elif state in east_states:
        state_to_region[state] = 'East'
    elif state in west_states:
        state_to_region[state] = 'West'
    elif state in central_states:
        state_to_region[state] = 'Central'
```

```
region_production = {}
for state, region in state_to_region.items():
    if region not in region_production:
        region_production[region] = df_T[state]
    else:
        region_production[region] += df_T[state]


plt.figure(figsize=(10, 6))
for region, production in region_production.items():
    plt.plot(df_T.index, production, label=region)


plt.xlabel('Year')
plt.ylabel('Rice Production')
plt.title('Rice Production Across Different Regions of India')
plt.legend()
plt.xticks(rotation=45)
plt.grid(True)

plt.tight_layout()
plt.show()
```

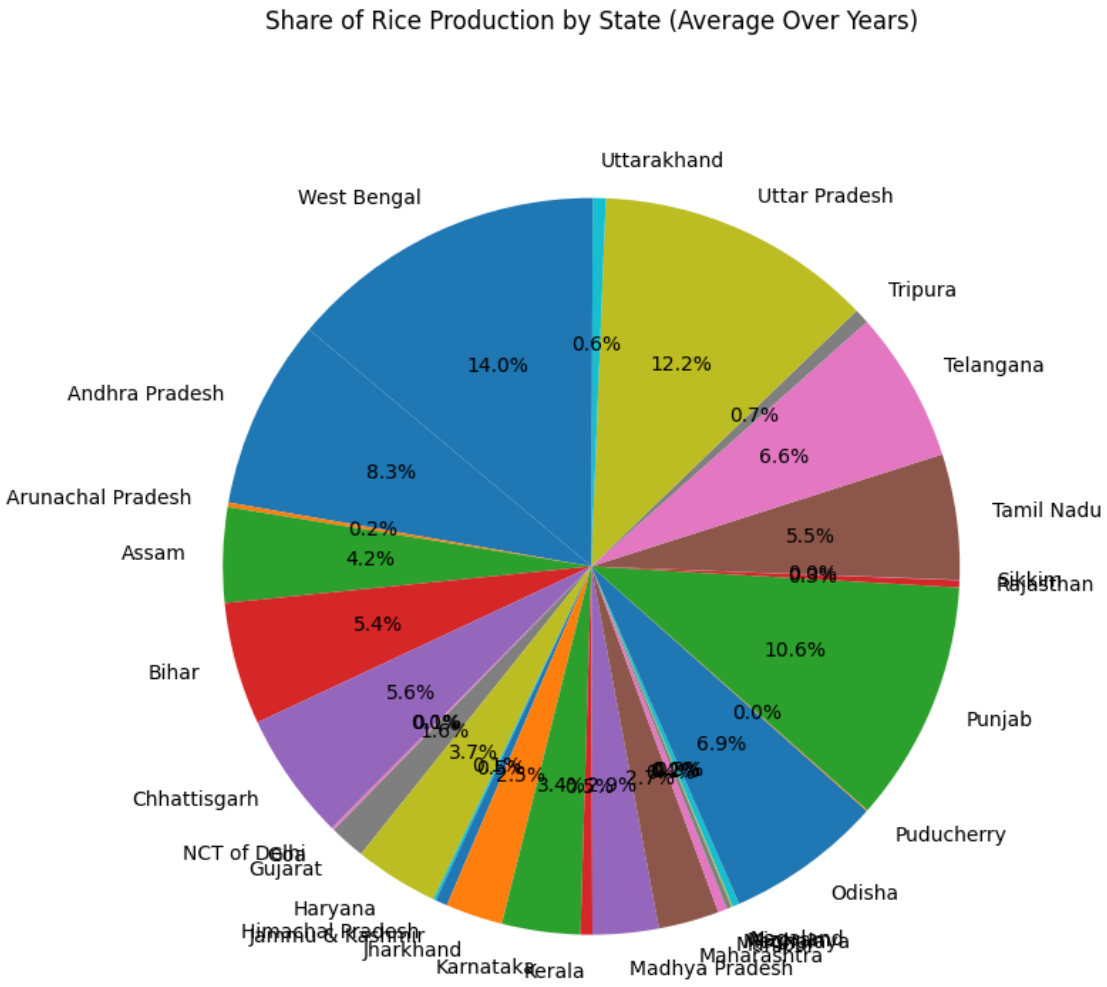


[ ]:
```
total_production = {region: production.sum() for region, production in␣
↪region_production.items()}


plt.figure(figsize=(8, 6))
plt.pie(total_production.values(), labels=total_production.keys(), autopct='%1.
↪1f%%', startangle=140)
plt.title('Share of Rice Production by Region')
plt.axis('equal')

plt.tight_layout()
plt.show()
```



[ ]:
```
average_production = df_T_A.mean()


plt.figure(figsize=(8, 8))
plt.pie(average_production, labels=average_production.index, autopct='%1.1f%%',␣
↪startangle=140)
plt.title('Share of Rice Production by State (Average Over Years)')
```

```
plt.axis('equal')
plt.tight_layout()
plt.show()
```



[ ]:
```
average_production = df_T_A.mean()


highest_state = average_production.idxmax()
lowest_state = average_production.idxmin()


highest_production = average_production[highest_state]
lowest_production = average_production[lowest_state]
```

```
print(f"Highest Producing State: {highest_state}, Production:␣
 ↪{highest_production:.2f} (Average Over Years)")
print(f"Lowest Producing State: {lowest_state}, Production: {lowest_production:.
 ↪2f} (Average Over Years)")
```

```
Highest Producing State: West Bengal, Production: 15168.38 (Average Over Years)
Lowest Producing State: Sikkim, Production: 19.61 (Average Over Years)
```

4 Seasonality

[ ]:
```
rainfall_data = {
    'Year': ['2004-05', '2005-06', '2006-07', '2007-08', '2008-09', '2009-10',␣
 ↪'2010-11', '2011-12', '2012-13', '2013-14', '2014-15', '2015-16', '2016-17',␣
 ↪'2017-18', '2018-19', '2019-20', '2021-22', '2022-23'],
    'Annual Rainfall': [790, 875.2, 926.8, 970.9, 902.8, 714.2, 910.7, 915.4,␣
 ↪841.7, 945.8, 784.2, 765.4, 863.7, 843.7, 802.4, 969.4, 863.8, 868.5]
}
rainfall_df = pd.DataFrame(rainfall_data)

rainfall_df.set_index('Year', inplace=True)

df_T_with_rainfall = pd.merge(df_T, rainfall_df, left_index=True,␣
 ↪right_index=True, how='left')


print(df_T_with_rainfall)
```

```
         Andhra Pradesh  Arunachal Pradesh   Assam     Bihar  Chhattisgarh  \
2004-05     26088.746154         135.000000  3470.7  25500.00        5552.3
2005-06     30509.346154         146.200000  3552.5  26423.30        6667.9
2006-07     29771.046154         146.200000  2916.0  29527.70        6409.8
2007-08     29821.146154         158.100000  3319.0  30014.70        6888.5
2008-09     31027.446154         163.900000  4008.5  30860.50        5951.5
2009-10     27703.946154         215.800000  4335.9  26395.90        5371.0
2010-11     24921.100000         234.000000  4736.6  24085.70        7931.1
2011-12     24877.700000         255.000000  4516.3  30706.00        8255.7
2012-13     19432.200000         263.000000  5128.5  33013.40        9383.8
2013-14     22156.300000         276.200000  4927.1  31300.50        9561.2
2014-15     21505.600000         285.000000  5222.7  32694.00        9947.4
2015-16     21623.100000         204.000000  5125.1  31513.70        9336.1
2016-17     18037.100000         220.000000  4727.4  35709.50       12275.2
2017-18     24605.700000         233.300000  5283.7  33689.44        9054.7
2018-19     25044.900000         240.000000  5220.6  33025.30       11021.6
2019-20     27497.900000         244.700000  4984.6  33552.60       11553.0
```

2020-21	29906.800000	247.100000	5214.8	34834.60	11575.0
2021-22	32885.200000	252.400000	4382.1	36667.00	12836.6
2022-23*	36989.500000	217.772222	4979.8	33383.10	15895.5

	NCT of Delhi	Goa	Gujarat	Haryana	Himachal Pradesh	\
2004-05	14.300000	145.200000	3552.60	24201.800000	122.00	
2005-06	24.000000	147.300000	4146.00	25795.600000	112.10	
2006-07	31.100000	130.300000	4128.80	25866.500000	123.50	
2007-08	31.400000	121.600000	4729.60	27157.800000	121.50	
2008-09	31.400000	123.300000	3828.10	28658.400000	118.30	
2009-10	19.300000	100.600000	3703.30	26879.400000	105.90	
2010-11	19.600000	115.000000	4458.10	27488.000000	128.90	
2011-12	19.800000	121.800000	4884.40	29593.300000	131.60	
2012-13	19.700000	122.800000	4820.50	31289.200000	125.30	
2013-14	29.600000	126.500000	5068.60	31211.300000	120.80	
2014-15	25.900000	120.500000	5143.60	28527.000000	125.20	
2015-16	17.300000	115.100000	4664.80	29884.400000	129.90	
2016-17	17.300000	113.200000	5492.20	31142.000000	146.60	
2017-18	16.800000	103.000000	5072.57	32453.800000	114.79	
2018-19	16.800000	98.800000	5641.00	34231.300000	114.90	
2019-20	16.800000	90.400000	5361.20	33510.600000	143.80	
2020-21	19.800000	87.300000	6071.40	34165.500000	140.50	
2021-22	19.000000	90.400000	6177.80	34151.500000	167.50	
2022-23*	21.661111	115.172222	6871.70	35054.263333	119.20	

	…	Rajasthan	Sikkim	Tamil Nadu	Telangana	Tripura	\
2004-05	…	150.40	21.600000	5062.2	7211.446154	545.100000	
2005-06	…	153.00	21.500000	5220.0	7211.446154	552.900000	
2006-07	…	169.80	21.500000	6610.6	7211.446154	620.500000	
2007-08	…	259.60	22.900000	5040.2	7211.446154	624.600000	
2008-09	…	241.10	21.700000	5182.7	7211.446154	627.100000	
2009-10	…	228.30	24.300000	5665.2	7211.446154	640.000000	
2010-11	…	265.50	21.000000	5792.4	6535.600000	702.500000	
2011-12	…	253.40	20.900000	7458.7	5148.800000	718.300000	
2012-13	…	222.50	21.300000	4049.9	4647.600000	713.200000	
2013-14	…	312.60	20.300000	5349.8	5755.000000	711.800000	
2014-15	…	366.70	20.100000	5727.8	4440.800000	747.000000	
2015-16	…	369.80	13.100000	7517.1	3047.000000	794.800000	
2016-17	…	452.70	19.700000	2369.4	5173.400000	814.600000	
2017-18	…	450.87	17.630000	6638.9	6262.200000	812.100000	
2018-19	…	453.20	17.200000	6130.9	6670.000000	793.200000	
2019-20	…	480.50	16.100000	7171.1	7427.800000	810.200000	
2020-21	…	634.00	16.200000	6881.2	10217.100000	803.100000	
2021-22	…	478.60	16.000000	7906.6	12409.600000	811.000000	
2022-23*	…	577.40	19.612778	7850.6	16013.900000	713.444444	

	Uttar Pradesh	Uttarakhand	West Bengal	ALL INDIA	Annual Rainfall
2004-05	9555.6	572.0	14884.8	83131.7	790.0

```
2005-06         11133.7        590.0       14510.8     91793.4             875.2
2006-07         11124.0        556.0       14745.9     93355.3             926.8
2007-08         11780.0        593.0       14719.5     96692.9             970.9
2008-09         13097.0        582.0       15037.3     99182.5             902.8
2009-10         10807.1        608.0       14340.7     89092.9             714.2
2010-11         11992.0        550.4       13045.9     95979.8             910.7
2011-12         14022.0        594.0       14605.8    105310.9             915.4
2012-13         14416.0        579.8       15023.7    105231.6             841.7
2013-14         14636.0        578.6       15370.7    106645.5             945.8
2014-15         12167.9        603.7       14677.2    104798.5             784.2
2015-16         12501.0        639.1       15953.9    104408.2             765.4
2016-17         13754.0        630.0       15302.5    109698.4             863.7
2017-18         13274.0        646.7       14967.0    112757.6             843.7
2018-19         15545.3        617.6       16242.2    116477.8             802.4
2019-20         15517.8        658.4       15881.4    118870.3             969.4
2020-21         15520.0        714.9       16524.4    124368.3               NaN
2021-22         15271.5        716.1       16728.7    129471.4             863.8
2022-23*        15171.3        641.7       15636.9    135542.0               NaN

[19 rows x 33 columns]
```

[ ]:
```
df_T_with_rainfall['Annual Rainfall'] = df_T_with_rainfall['Annual Rainfall'].
↪fillna(df_T_with_rainfall['Annual Rainfall'].mean())
```

[ ]:
```
df_T_with_rainfall
```

[ ]:
```
          Andhra Pradesh  Arunachal Pradesh   Assam     Bihar  Chhattisgarh  \
2004-05     26088.746154         135.000000  3470.7  25500.00        5552.3
2005-06     30509.346154         146.200000  3552.5  26423.30        6667.9
2006-07     29771.046154         146.200000  2916.0  29527.70        6409.8
2007-08     29821.146154         158.100000  3319.0  30014.70        6888.5
2008-09     31027.446154         163.900000  4008.5  30860.50        5951.5
2009-10     27703.946154         215.800000  4335.9  26395.90        5371.0
2010-11     24921.100000         234.000000  4736.6  24085.70        7931.1
2011-12     24877.700000         255.000000  4516.3  30706.00        8255.7
2012-13     19432.200000         263.000000  5128.5  33013.40        9383.8
2013-14     22156.300000         276.200000  4927.1  31300.50        9561.2
2014-15     21505.600000         285.000000  5222.7  32694.00        9947.4
2015-16     21623.100000         204.000000  5125.1  31513.70        9336.1
2016-17     18037.100000         220.000000  4727.4  35709.50       12275.2
2017-18     24605.700000         233.300000  5283.7  33689.44        9054.7
2018-19     25044.900000         240.000000  5220.6  33025.30       11021.6
2019-20     27497.900000         244.700000  4984.6  33552.60       11553.0
2020-21     29906.800000         247.100000  5214.8  34834.60       11575.0
2021-22     32885.200000         252.400000  4382.1  36667.00       12836.6
2022-23*    36989.500000         217.772222  4979.8  33383.10       15895.5
```

	NCT of Delhi	Goa	Gujarat	Haryana	Himachal Pradesh	\
2004-05	14.300000	145.200000	3552.60	24201.800000	122.00	
2005-06	24.000000	147.300000	4146.00	25795.600000	112.10	
2006-07	31.100000	130.300000	4128.80	25866.500000	123.50	
2007-08	31.400000	121.600000	4729.60	27157.800000	121.50	
2008-09	31.400000	123.300000	3828.10	28658.400000	118.30	
2009-10	19.300000	100.600000	3703.30	26879.400000	105.90	
2010-11	19.600000	115.000000	4458.10	27488.000000	128.90	
2011-12	19.800000	121.800000	4884.40	29593.300000	131.60	
2012-13	19.700000	122.800000	4820.50	31289.200000	125.30	
2013-14	29.600000	126.500000	5068.60	31211.300000	120.80	
2014-15	25.900000	120.500000	5143.60	28527.000000	125.20	
2015-16	17.300000	115.100000	4664.80	29884.400000	129.90	
2016-17	17.300000	113.200000	5492.20	31142.000000	146.60	
2017-18	16.800000	103.000000	5072.57	32453.800000	114.79	
2018-19	16.800000	98.800000	5641.00	34231.300000	114.90	
2019-20	16.800000	90.400000	5361.20	33510.600000	143.80	
2020-21	19.800000	87.300000	6071.40	34165.500000	140.50	
2021-22	19.000000	90.400000	6177.80	34151.500000	167.50	
2022-23*	21.661111	115.172222	6871.70	35054.263333	119.20	

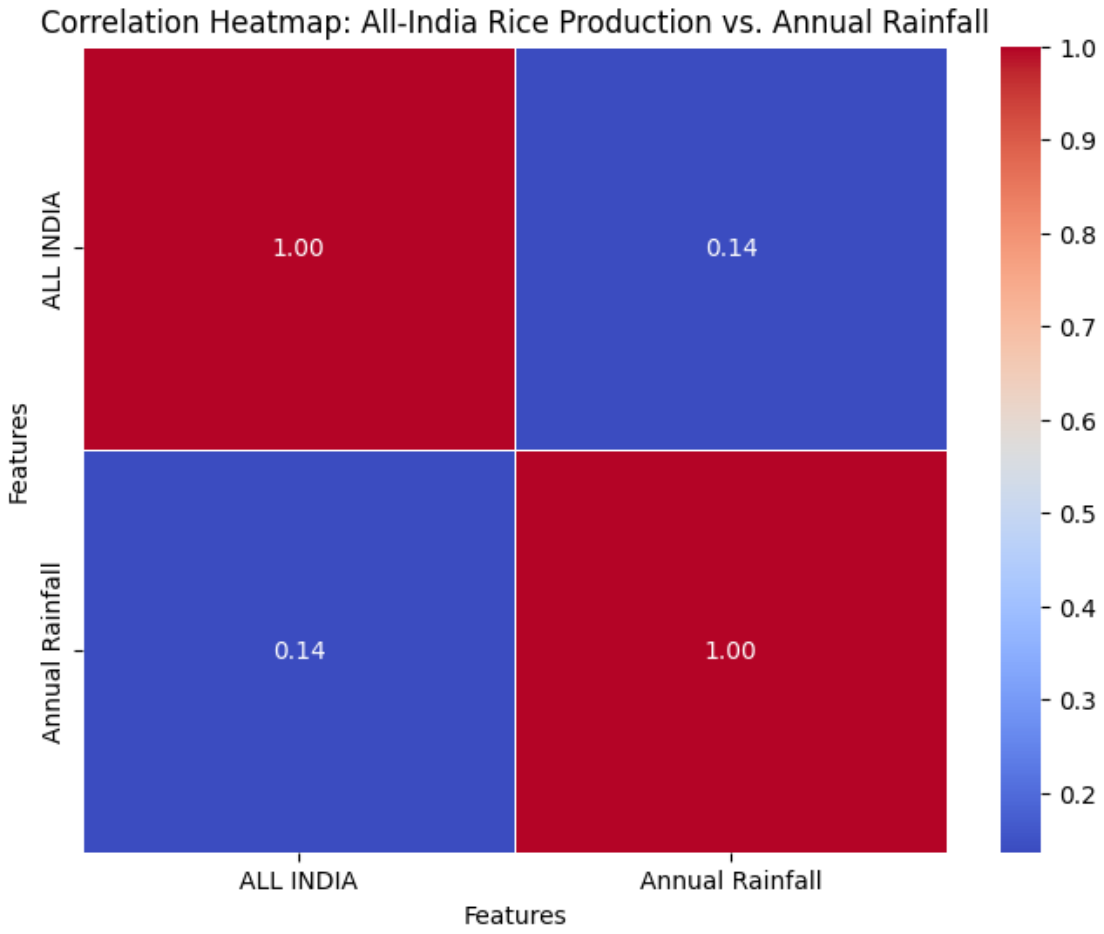
	…	Rajasthan	Sikkim	Tamil Nadu	Telangana	Tripura	\
2004-05	…	150.40	21.600000	5062.2	7211.446154	545.100000	
2005-06	…	153.00	21.500000	5220.0	7211.446154	552.900000	
2006-07	…	169.80	21.500000	6610.6	7211.446154	620.500000	
2007-08	…	259.60	22.900000	5040.2	7211.446154	624.600000	
2008-09	…	241.10	21.700000	5182.7	7211.446154	627.100000	
2009-10	…	228.30	24.300000	5665.2	7211.446154	640.000000	
2010-11	…	265.50	21.000000	5792.4	6535.600000	702.500000	
2011-12	…	253.40	20.900000	7458.7	5148.800000	718.300000	
2012-13	…	222.50	21.300000	4049.9	4647.600000	713.200000	
2013-14	…	312.60	20.300000	5349.8	5755.000000	711.800000	
2014-15	…	366.70	20.100000	5727.8	4440.800000	747.000000	
2015-16	…	369.80	13.100000	7517.1	3047.000000	794.800000	
2016-17	…	452.70	19.700000	2369.4	5173.400000	814.600000	
2017-18	…	450.87	17.630000	6638.9	6262.200000	812.100000	
2018-19	…	453.20	17.200000	6130.9	6670.000000	793.200000	
2019-20	…	480.50	16.100000	7171.1	7427.800000	810.200000	
2020-21	…	634.00	16.200000	6881.2	10217.100000	803.100000	
2021-22	…	478.60	16.000000	7906.6	12409.600000	811.000000	
2022-23*	…	577.40	19.612778	7850.6	16013.900000	713.444444	

	Uttar Pradesh	Uttarakhand	West Bengal	ALL INDIA	Annual Rainfall
2004-05	9555.6	572.0	14884.8	83131.7	790.000000
2005-06	11133.7	590.0	14510.8	91793.4	875.200000
2006-07	11124.0	556.0	14745.9	93355.3	926.800000
2007-08	11780.0	593.0	14719.5	96692.9	970.900000

2008-09	13097.0	582.0	15037.3	99182.5	902.800000
2009-10	10807.1	608.0	14340.7	89092.9	714.200000
2010-11	11992.0	550.4	13045.9	95979.8	910.700000
2011-12	14022.0	594.0	14605.8	105310.9	915.400000
2012-13	14416.0	579.8	15023.7	105231.6	841.700000
2013-14	14636.0	578.6	15370.7	106645.5	945.800000
2014-15	12167.9	603.7	14677.2	104798.5	784.200000
2015-16	12501.0	639.1	15953.9	104408.2	765.400000
2016-17	13754.0	630.0	15302.5	109698.4	863.700000
2017-18	13274.0	646.7	14967.0	112757.6	843.700000
2018-19	15545.3	617.6	16242.2	116477.8	802.400000
2019-20	15517.8	658.4	15881.4	118870.3	969.400000
2020-21	15520.0	714.9	16524.4	124368.3	863.888235
2021-22	15271.5	716.1	16728.7	129471.4	863.800000
2022-23*	15171.3	641.7	15636.9	135542.0	863.888235

[19 rows x 33 columns]

[ ]:
```
correlation_matrix = df_T_with_rainfall[['ALL INDIA', 'Annual Rainfall']].corr()

plt.figure(figsize=(8, 6))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f",␣
 ↪linewidths=0.5)
plt.title('Correlation Heatmap: All-India Rice Production vs. Annual Rainfall')
plt.xlabel('Features')
plt.ylabel('Features')
plt.show()
```



[ ]:
```
# Imports
import numpy as np
import pandas as pd

import sklearn
import seaborn as sns
import matplotlib.pyplot as plt
```

[ ]:
```
df_table1 = pd.read_excel("rice_production_modified.xlsx", sheet_name="Table␣
↪1", header=1)
df_table1.head()
```

[ ]:

	State/Union Territory	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	\
0	Andhra Pradesh	9601	11704	11872	13324	14241	10538	
1	Arunachal Pradesh	135	146.2	146.2	158.1	163.9	215.8	
2	Assam	3470.7	3552.5	2916	3319	4008.5	4335.9	
3	Bihar	2472.2	3495.5	4989.3	4418.1	5590.3	3599.3	

```
4          Chhattisgarh  4383.3  5011.6  5041.4  5426.6  4391.8  4110.4

   2010-11  2011-12  2012-13
0   7882.4   7746.2   6862.4
1    234.0    255.0    263.0
2   4736.6   4516.3   5128.5
3   3102.1   7162.6   7529.3
4   6159.0   6028.4   6608.8
```

[ ]:
```
df_table2 = pd.read_excel("rice_production_modified.xlsx", sheet_name="Table␣
↪2", header=1).drop(labels = 'State/Union Territory', axis=1)
df_table2.head()
```

[ ]:
```
   2013-14  2014-15  2015-16  2016-17  2017-18  2018-19  2019-20  2020-21  \
0   6969.7   7233.9   7488.7   7452.4   8166.2   8234.7   8658.9   7882.9
1    276.2    285.0    204.0    220.0    233.3    240.0    244.7    247.1
2   4927.1   5222.7   5125.1   4727.4   5283.7   5220.6   4984.6   5214.8
3   5505.8   6356.7   6802.2   8239.3   8093.1   6155.5   6298.0   6747.0
4   6716.4   6322.1   5789.4   8048.4   4930.8   6526.9   6774.8   7161.2

   2021-22 2022-23*
0   7763.6   8542.3
1    252.4        -
2   4382.1   4979.8
3   7717.0   6725.2
4   8021.7   8238.3
```

[ ]:
```
# Load data

rainfall_data = pd.read_csv('/content/Monthly_Rainfall_From_1901_to_2017.csv')

yield_data = pd.concat([df_table1, df_table2], axis=1)
```

[ ]:
```
# # Load data

# rainfall_data = pd.read_csv('Monthly_Rainfall_From_1901_to_2017.csv')

# yield_data = pd.read_excel('State_wise_rice_production_in_India.
↪xlsx',header=1)
```

[ ]:
```
yield_data
```

[ ]:
```
   State/Union Territory  2004-05  2005-06  2006-07  2007-08  2008-09  \
0         Andhra Pradesh     9601    11704    11872    13324    14241
1      Arunachal Pradesh      135    146.2    146.2    158.1    163.9
2                  Assam   3470.7   3552.5     2916     3319   4008.5
3                  Bihar   2472.2   3495.5   4989.3   4418.1   5590.3
```

4	Chhattisgarh	4383.3	5011.6	5041.4	5426.6	4391.8
5	NCT of Delhi	14.3	24	31.1	31.4	31.4
6	Goa	145.2	147.3	130.3	121.6	123.3
7	Gujarat	1238.2	1298	1390	1474	1303
8	Haryana	3023	3210	3371	3613	3298
9	Himachal Pradesh	122	112.1	123.5	121.5	118.3
10	Jammu & Kashmir	492.2	556.8	554	561.3	563.1
11	Jharkhand	1677	1558	2967.8	3336.4	3420.2
12	Karnataka	3547	5744	3446	3717	3802
13	Kerala	667.1	629.9	631	528.5	590.3
14	Madhya Pradesh	1169	1656.3	1368.4	1461.9	1559.7
15	Maharashtra	2164	2695	2569	2996	2284
16	Manipur	435.9	386.1	386.1	406.2	397
17	Meghalaya	193.7	151.9	200.2	200	203.9
18	Mizoram	104.1	99.2	29.5	15.7	46
19	Nagaland	259.8	263.1	263.5	290.6	345.1
20	Odisha	6466	6859	6824.7	7540.7	6812.7
21	Puducherry	65.7	59.9	59.9	53.4	50.8
22	Punjab	10437	10193	10138	10489	11000
23	Rajasthan	150.4	153	169.8	259.6	241.1
24	Sikkim	21.6	21.5	21.5	22.9	21.7
25	Tamil Nadu	5062.2	5220	6610.6	5040.2	5182.7
26	Telangana	.	.	.	.	.
27	Tripura	545.1	552.9	620.5	624.6	627.1
28	Uttar Pradesh	9555.6	11133.7	11124	11780	13097
29	Uttarakhand	572	590	556	593	582
30	West Bengal	14884.8	14510.8	14745.9	14719.5	15037.3
31	ALL INDIA	83131.7	91793.4	93355.3	96692.9	99182.5

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	\
0	10538	7882.4	7746.2	6862.4	6969.7	7233.9	7488.7	
1	215.8	234.0	255.0	263.0	276.2	285.0	204.0	
2	4335.9	4736.6	4516.3	5128.5	4927.1	5222.7	5125.1	
3	3599.3	3102.1	7162.6	7529.3	5505.8	6356.7	6802.2	
4	4110.4	6159.0	6028.4	6608.8	6716.4	6322.1	5789.4	
5	19.3	19.6	19.8	19.7	29.6	25.9	17.3	
6	100.6	115.0	121.8	122.8	126.5	120.5	115.1	
7	1292	1496.6	1790.0	1541.0	1636.0	1830.9	1702.0	
8	3625	3472.0	3759.0	3976.0	3998.0	4006.0	4145.0	
9	105.9	128.9	131.6	125.3	120.8	125.2	129.9	
10	497.4	507.7	544.7	818.1	610.9	517.2	646.4	
11	1538.4	1110.0	3130.6	3164.9	2810.6	3361.9	2882.2	
12	3691	4188.0	3955.0	3364.0	3572.6	3541.0	3021.0	
13	598.3	522.7	569.0	508.3	509.2	562.1	549.3	
14	1260.6	1772.1	2227.3	2775.0	2844.8	3625.3	3546.7	
15	2183	2696.0	2841.0	3057.0	3120.0	2946.0	2593.0	
16	319.9	521.7	591.0	257.6	398.5	334.1	338.8	

17	206.7	207.0	216.5	232.0	273.9	298.2	301.1
18	44.3	47.2	54.3	30.5	59.0	60.7	62.1
19	240.3	381.4	382.4	405.2	429.6	454.2	318.8
20	6917.5	6827.7	5807.0	7295.5	7613.4	8298.2	5875.4
21	52.4	52.0	42.1	46.5	49.8	52.7	43.9
22	11236	10837.0	10542.0	11374.0	11267.0	11107.0	11823.0
23	228.3	265.5	253.4	222.5	312.6	366.7	369.8
24	24.3	21.0	20.9	21.3	20.3	20.1	13.1
25	5665.2	5792.4	7458.7	4049.9	5349.8	5727.8	7517.1
26	.	6535.6	5148.8	4647.6	5755.0	4440.8	3047.0
27	640	702.5	718.3	713.2	711.8	747.0	794.8
28	10807.1	11992.0	14022.0	14416.0	14636.0	12167.9	12501.0
29	608	550.4	594.0	579.8	578.6	603.7	639.1
30	14340.7	13045.9	14605.8	15023.7	15370.7	14677.2	15953.9
31	89092.9	95979.8	105310.9	105231.6	106645.5	104798.5	104408.2

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23*
0	7452.4	8166.20	8234.7	8658.9	7882.9	7763.6	8542.3
1	220.0	233.30	240.0	244.7	247.1	252.4	-
2	4727.4	5283.70	5220.6	4984.6	5214.8	4382.1	4979.8
3	8239.3	8093.10	6155.5	6298.0	6747.0	7717.0	6725.2
4	8048.4	4930.80	6526.9	6774.8	7161.2	8021.7	8238.3
5	17.3	16.80	16.8	16.8	19.8	19.0	-
6	113.2	103.00	98.8	90.4	87.3	90.4	-
7	1930.0	1890.90	1912.1	1983.1	2145.7	2101.1	2395.2
8	4453.0	4523.38	4516.1	4824.3	4424.9	4618.0	5406.9
9	146.6	114.79	114.9	143.8	140.5	167.5	119.2
10	572.2	513.14	615.8	587.0	581.5	492.9	-
11	3841.8	4078.04	2893.9	3012.8	2752.9	2930.5	1399.8
12	2604.8	3017.10	3431.0	3634.5	4291.8	4318.4	4001.3
13	437.1	521.30	578.3	605.6	633.8	487.0	581.4
14	4226.8	4123.90	4494.7	4778.2	4413.8	4814.9	7657.2
15	3109.5	2730.80	3275.7	2897.6	3291.7	3598.1	3899.1
16	430.4	607.80	401.6	385.5	602.2	567.4	-
17	203.0	304.60	202.0	303.4	295.9	297.3	-
18	61.5	59.60	60.0	60.0	62.2	60.9	-
19	336.7	349.60	356.7	363.3	367.4	150.7	-
20	8325.9	6551.30	7733.7	8360.4	8810.3	9290.8	9621.2
21	52.2	42.50	63.3	59.4	50.0	57.1	-
22	11586.2	13381.79	12821.6	11779.3	12783.7	12885.5	13146.7
23	452.7	450.87	453.2	480.5	634.0	478.6	577.4
24	19.7	17.63	17.2	16.1	16.2	16.0	-
25	2369.4	6638.90	6130.9	7171.1	6881.2	7906.6	7850.6
26	5173.4	6262.20	6670.0	7427.8	10217.1	12409.6	16013.9
27	814.6	812.10	793.2	810.2	803.1	811.0	-
28	13754.0	13274.00	15545.3	15517.8	15520.0	15271.5	15171.3
29	630.0	646.70	617.6	658.4	714.9	716.1	641.7

```
30   15302.5   14967.00   16242.2   15881.4   16524.4   16728.7  15636.9
31  109698.4  112757.60  116477.8  118870.3  124368.3  129471.4   135542
```

[ ]:
```
yield_data.columns
```

[ ]:
```
Index(['State/Union Territory', '2004-05', '2005-06', '2006-07', '2007-08',
       '2008-09', '2009-10', '2010-11', '2011-12', '2012-13', '2013-14',
       '2014-15', '2015-16', '2016-17', '2017-18', '2018-19', '2019-20',
       '2020-21', '2021-22', '2022-23*'],
      dtype='object')
```

[ ]:
```
# melted_df['YEAR'] = melted_df['YEAR'].str.split('-').str[0].astype(int)
```

[ ]:
```
# # convert all cols except 'State/Union Territory' to float type,␣
 ↪errors=coerce and replace those NaN values which cannot be converted with␣
 ↪the average values of respective columns

# import pandas as pd
# cols_to_convert = yield_data.columns.difference(['State/Union Territory'])
# yield_data[cols_to_convert] = yield_data[cols_to_convert].apply(pd.
 ↪to_numeric, errors='coerce')
# for state in cols_to_convert:
#   if yield_data.loc[state].isnull().sum() != 0:
#     yield_data.loc[state] = yield_data.loc[state].fillna(yield_data.
 ↪loc[state].mean())
```

[ ]:
```
yield_data.dtypes
```

[ ]:
```
State/Union Territory     object
2004-05                   object
2005-06                   object
2006-07                   object
2007-08                   object
2008-09                   object
2009-10                   object
2010-11                  float64
2011-12                  float64
2012-13                  float64
2013-14                  float64
2014-15                  float64
2015-16                  float64
2016-17                  float64
2017-18                  float64
2018-19                  float64
2019-20                  float64
2020-21                  float64
2021-22                  float64
```

```
2022-23*                  object
dtype: object
```

[ ]:
```
yield_data.isnull().sum().sum()
```

[ ]:
```
0
```

[ ]:
```
rainfall_data
```

[ ]:
```
      Unnamed: 0                States/UTs  YEAR   JAN    FEB   MAR    APR  \
0              0  Andaman & Nicobar Islands  1901  49.2   87.1  29.2    2.3
1              1  Andaman & Nicobar Islands  1902   0.0  159.8  12.2    0.0
2              2  Andaman & Nicobar Islands  1903  12.7  144.0   0.0    1.0
3              3  Andaman & Nicobar Islands  1904   9.4   14.7   0.0  202.4
4              4  Andaman & Nicobar Islands  1905   1.3    0.0   3.3   26.9
…            …                          …     …    …      …     …      …
4182        4182                Lakshadweep  2012  19.2    0.1   1.6   76.8
4183        4183                Lakshadweep  2013  26.2   34.4  37.5    5.3
4184        4184                Lakshadweep  2014  53.2   16.1   4.4   14.9
4185        4185                Lakshadweep  2015   2.2    0.5   3.7   87.1
4186        4186                Lakshadweep  2016  59.6   12.1   3.2    2.6

        MAY    JUN    JUL    AUG    SEP    OCT    NOV    DEC  ANNUAL
0     528.8  517.5  365.1  481.1  332.6  388.5  558.2   33.6  3373.2
1     446.1  537.1  228.9  753.7  666.2  197.2  359.0  160.5  3520.7
2     235.1  479.9  728.4  326.7  339.0  181.2  284.4  225.0  2957.4
3     304.5  495.1  502.0  160.1  820.4  222.2  308.7   40.1  3079.6
4     279.5  628.7  368.7  330.5  297.0  260.7   25.4  344.7  2566.7
…     …    …    …    …    …    …    …    …    …
4182   21.2  327.0  231.5  381.2  179.8  145.9   12.4    8.8  1405.5
4183   88.3  426.2  296.4  154.4  180.0   72.8   78.1   26.7  1426.3
4184   57.4  244.1  116.1  466.1  132.2  169.2   59.0   62.3  1395.0
4185  133.1  296.6  257.5  146.4  160.4  165.4  231.0  159.0  1642.9
4186   77.4  321.1  262.6   86.2   75.6   58.6   32.0   74.7  1065.7

[4187 rows x 16 columns]
```

[ ]:
```
rainfall_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4187 entries, 0 to 4186
Data columns (total 16 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   Unnamed: 0  4187 non-null   int64
 1   States/UTs  4187 non-null   object
 2   YEAR        4187 non-null   int64
```

```
 3   JAN         4183 non-null   float64
 4   FEB         4184 non-null   float64
 5   MAR         4181 non-null   float64
 6   APR         4183 non-null   float64
 7   MAY         4184 non-null   float64
 8   JUN         4182 non-null   float64
 9   JUL         4180 non-null   float64
 10  AUG         4183 non-null   float64
 11  SEP         4181 non-null   float64
 12  OCT         4180 non-null   float64
 13  NOV         4176 non-null   float64
 14  DEC         4177 non-null   float64
 15  ANNUAL      4161 non-null   float64
dtypes: float64(13), int64(2), object(1)
memory usage: 523.5+ KB
```

[ ]:
```
rainfall_data.drop(['Unnamed: 0'],axis = 1,inplace=True)
```

[ ]:
```
rainfall_data.head()
```

[ ]:
```
                  States/UTs  YEAR   JAN    FEB   MAR    APR    MAY    JUN  \
0  Andaman & Nicobar Islands  1901  49.2   87.1  29.2    2.3  528.8  517.5
1  Andaman & Nicobar Islands  1902   0.0  159.8  12.2    0.0  446.1  537.1
2  Andaman & Nicobar Islands  1903  12.7  144.0   0.0    1.0  235.1  479.9
3  Andaman & Nicobar Islands  1904   9.4   14.7   0.0  202.4  304.5  495.1
4  Andaman & Nicobar Islands  1905   1.3    0.0   3.3   26.9  279.5  628.7

     JUL    AUG    SEP    OCT    NOV    DEC  ANNUAL
0  365.1  481.1  332.6  388.5  558.2   33.6  3373.2
1  228.9  753.7  666.2  197.2  359.0  160.5  3520.7
2  728.4  326.7  339.0  181.2  284.4  225.0  2957.4
3  502.0  160.1  820.4  222.2  308.7   40.1  3079.6
4  368.7  330.5  297.0  260.7   25.4  344.7  2566.7
```

[ ]:
```
rainfall_data.describe()
```

[ ]:
```
              YEAR          JAN          FEB          MAR          APR  \
count  4187.000000  4183.000000  4184.000000  4181.000000  4183.000000
mean   1959.206831    18.937772    21.604374    27.395503    43.081712
std      33.709294    33.797148    35.734572    46.920068    68.156144
min    1901.000000     0.000000     0.000000     0.000000     0.000000
25%    1930.000000     0.600000     0.500000     1.000000     3.000000
50%    1959.000000     5.900000     6.500000     7.900000    15.500000
75%    1988.000000    22.000000    26.600000    31.300000    49.700000
max    2017.000000   583.700000   403.500000   605.600000   595.100000

               MAY          JUN          JUL          AUG          SEP  \
```

```
count  4184.000000  4182.000000  4180.000000  4183.000000  4181.000000
mean     85.646511   230.047704   347.063780   289.762156   197.311863
std     122.706290   234.276638   268.867991   188.444169   135.563551
min       0.000000     0.400000     0.000000     0.000000     0.100000
25%       8.600000    70.800000   175.825000   155.800000   100.400000
50%      36.850000   138.750000   285.050000   258.500000   173.600000
75%      97.725000   304.700000   418.525000   377.650000   266.200000
max    1168.600000  1609.900000  2362.800000  1664.600000  1222.000000

                OCT          NOV          DEC       ANNUAL
count  4180.000000  4176.000000  4177.000000  4161.000000
mean     95.314713    39.490685    18.934858  1409.370031
std      99.204613    68.365883    43.003479   902.693445
min       0.000000     0.000000     0.000000    62.300000
25%      14.600000     0.600000     0.100000   803.000000
50%      65.100000     9.400000     3.000000  1120.200000
75%     148.300000    45.300000    17.500000  1642.900000
max     948.300000   648.900000   617.500000  6331.100000
```

[ ]:
```
len(rainfall_data['YEAR'].unique())
```

[ ]:
```
117
```

[ ]:
```
rainfall_data.head(12)
```

[ ]:
```
                   States/UTs  YEAR    JAN    FEB    MAR    APR    MAY    JUN  \
0   Andaman & Nicobar Islands  1901   49.2   87.1   29.2    2.3  528.8  517.5
1   Andaman & Nicobar Islands  1902    0.0  159.8   12.2    0.0  446.1  537.1
2   Andaman & Nicobar Islands  1903   12.7  144.0    0.0    1.0  235.1  479.9
3   Andaman & Nicobar Islands  1904    9.4   14.7    0.0  202.4  304.5  495.1
4   Andaman & Nicobar Islands  1905    1.3    0.0    3.3   26.9  279.5  628.7
5   Andaman & Nicobar Islands  1906   36.6    0.0    0.0    0.0  556.1  733.3
6   Andaman & Nicobar Islands  1907  110.7    0.0  113.3   21.6  616.3  305.2
7   Andaman & Nicobar Islands  1908   20.9   85.1    0.0   29.0  562.0  693.6
8   Andaman & Nicobar Islands  1910   26.6   22.7  206.3   89.3  224.5  472.7
9   Andaman & Nicobar Islands  1911    0.0    8.4    0.0  122.5  327.3  649.0
10  Andaman & Nicobar Islands  1912  583.7    0.8    0.0   21.9  140.7  549.8
11  Andaman & Nicobar Islands  1913   84.8    0.5    1.3    2.5  190.7  530.0

      JUL    AUG    SEP    OCT    NOV    DEC  ANNUAL
0   365.1  481.1  332.6  388.5  558.2   33.6  3373.2
1   228.9  753.7  666.2  197.2  359.0  160.5  3520.7
2   728.4  326.7  339.0  181.2  284.4  225.0  2957.4
3   502.0  160.1  820.4  222.2  308.7   40.1  3079.6
4   368.7  330.5  297.0  260.7   25.4  344.7  2566.7
5   247.7  320.5  164.3  267.8  128.9   79.2  2534.4
6   443.9  377.6  200.4  264.4  648.9  245.6  3347.9
```

```
7   481.4  699.9  428.8  170.7  208.1  196.9  3576.4
8   264.3  337.4  626.6  208.2  267.3  153.5  2899.4
9   253.0  187.1  464.5  333.8   94.5  247.1  2687.2
10  468.9  370.3  386.2  318.7  117.2    2.3  2960.5
11  280.8  205.8  580.1  288.8  133.0   67.5  2365.8
```

[ ]:
```
rainfall_df = rainfall_data.groupby(['YEAR'],as_index = False,axis = 0)
```

[ ]:
```
rainfall_df.head()
```

[ ]:
```
                    States/UTs  YEAR   JAN    FEB   MAR    APR    MAY    JUN  \
0    Andaman & Nicobar Islands  1901  49.2   87.1  29.2    2.3  528.8  517.5
1    Andaman & Nicobar Islands  1902   0.0  159.8  12.2    0.0  446.1  537.1
2    Andaman & Nicobar Islands  1903  12.7  144.0   0.0    1.0  235.1  479.9
3    Andaman & Nicobar Islands  1904   9.4   14.7   0.0  202.4  304.5  495.1
4    Andaman & Nicobar Islands  1905   1.3    0.0   3.3   26.9  279.5  628.7
..                         …   …   …    …   …    …    …    …
609       Gangetic West Bengal  1948  13.2   44.9  48.4   52.6  135.9  200.4
615       Gangetic West Bengal  1954  12.3    5.9   0.3   11.6   88.6  211.1
616       Gangetic West Bengal  1955   2.9    2.3  11.4   24.3   48.0  174.7
617       Gangetic West Bengal  1956   4.5   33.9  50.7   25.6  141.6  343.3
687                     Orissa  1909   5.7   11.9   4.8  148.4   53.1  288.2

       JUL    AUG    SEP    OCT    NOV    DEC  ANNUAL
0    365.1  481.1  332.6  388.5  558.2   33.6  3373.2
1    228.9  753.7  666.2  197.2  359.0  160.5  3520.7
2    728.4  326.7  339.0  181.2  284.4  225.0  2957.4
3    502.0  160.1  820.4  222.2  308.7   40.1  3079.6
4    368.7  330.5  297.0  260.7   25.4  344.7  2566.7
..     …    …    …    …    …    …    …
609  268.4  323.6  214.3  116.7  113.6    0.0  1532.1
615  201.7  215.1  247.1   56.8    1.5   28.0  1080.0
616  338.8  251.9  188.1  151.9   73.9    0.1  1268.2
617  253.9  295.4  391.1  157.6   12.7    3.9  1714.2
687  452.7  234.3  234.0   42.3    1.8   58.1  1535.5

[585 rows x 15 columns]
```

[ ]:
```
rainfall_data.
 ↪drop(['JAN'        ,'FEB',        'MAR',        'APR',        'MAY',        'JUN'        ,'
 ↪= 1,inplace=True)
```

[ ]:
```
rainfall_data.head()
```

[ ]:
```
                   States/UTs  YEAR  ANNUAL
0  Andaman & Nicobar Islands  1901  3373.2
1  Andaman & Nicobar Islands  1902  3520.7
```

```
2  Andaman & Nicobar Islands  1903  2957.4
3  Andaman & Nicobar Islands  1904  3079.6
4  Andaman & Nicobar Islands  1905  2566.7
```

[ ]:
```
rainfall_data = rainfall_data[rainfall_data['YEAR']>=2004]
```

[ ]:
```
rainfall_data
```

[ ]:
```
                     States/UTs  YEAR  ANNUAL
98    Andaman & Nicobar Islands  2004  2460.1
99    Andaman & Nicobar Islands  2005  2954.7
100   Andaman & Nicobar Islands  2006  2404.7
101   Andaman & Nicobar Islands  2007  2748.0
102   Andaman & Nicobar Islands  2008  3374.8
…                           …     …       …
4182                Lakshadweep  2012  1405.5
4183                Lakshadweep  2013  1426.3
4184                Lakshadweep  2014  1395.0
4185                Lakshadweep  2015  1642.9
4186                Lakshadweep  2016  1065.7

[503 rows x 3 columns]
```

[ ]:
```
rainfall_data.columns
```

[ ]:
```
Index(['States/UTs', 'YEAR', 'ANNUAL'], dtype='object')
```

[ ]:
```
yield_data.head()
```

[ ]:
```
  State/Union Territory 2004-05 2005-06 2006-07 2007-08 2008-09 2009-10  \
0        Andhra Pradesh    9601   11704   11872   13324   14241   10538
1     Arunachal Pradesh     135   146.2   146.2   158.1   163.9   215.8
2                 Assam  3470.7  3552.5    2916    3319  4008.5  4335.9
3                 Bihar  2472.2  3495.5  4989.3  4418.1  5590.3  3599.3
4          Chhattisgarh  4383.3  5011.6  5041.4  5426.6  4391.8  4110.4

   2010-11  2011-12  2012-13  2013-14  2014-15  2015-16  2016-17  2017-18  \
0   7882.4   7746.2   6862.4   6969.7   7233.9   7488.7   7452.4   8166.2
1    234.0    255.0    263.0    276.2    285.0    204.0    220.0    233.3
2   4736.6   4516.3   5128.5   4927.1   5222.7   5125.1   4727.4   5283.7
3   3102.1   7162.6   7529.3   5505.8   6356.7   6802.2   8239.3   8093.1
4   6159.0   6028.4   6608.8   6716.4   6322.1   5789.4   8048.4   4930.8

   2018-19  2019-20  2020-21  2021-22 2022-23*
0   8234.7   8658.9   7882.9   7763.6   8542.3
1    240.0    244.7    247.1    252.4        -
2   5220.6   4984.6   5214.8   4382.1   4979.8
```

```
3   6155.5   6298.0   6747.0   7717.0   6725.2
4   6526.9   6774.8   7161.2   8021.7   8238.3
```

[ ]:
```
yield_data.columns
```

[ ]:
```
Index(['State/Union Territory', '2004-05', '2005-06', '2006-07', '2007-08',
       '2008-09', '2009-10', '2010-11', '2011-12', '2012-13', '2013-14',
       '2014-15', '2015-16', '2016-17', '2017-18', '2018-19', '2019-20',
       '2020-21', '2021-22', '2022-23*'],
      dtype='object')
```

[ ]:
```
df = yield_data
```

[ ]:
```
df.dtypes
```

[ ]:
```
State/Union Territory     object
2004-05                   object
2005-06                   object
2006-07                   object
2007-08                   object
2008-09                   object
2009-10                   object
2010-11                  float64
2011-12                  float64
2012-13                  float64
2013-14                  float64
2014-15                  float64
2015-16                  float64
2016-17                  float64
2017-18                  float64
2018-19                  float64
2019-20                  float64
2020-21                  float64
2021-22                  float64
2022-23*                  object
dtype: object
```

[ ]:
```
rainfall_data.dtypes
```

[ ]:
```
States/UTs     object
YEAR            int64
ANNUAL        float64
dtype: object
```

[ ]:
```
melted_df = pd.melt(df, id_vars=["State/Union Territory"], var_name="YEAR",␣
↪value_name="PRODUCTION")
```

```
# Print the melted DataFrame
print(melted_df.to_string(index=False))
```

```
State/Union Territory     YEAR PRODUCTION
       Andhra Pradesh  2004-05       9601
    Arunachal Pradesh  2004-05        135
                Assam  2004-05     3470.7
                Bihar  2004-05     2472.2
         Chhattisgarh  2004-05     4383.3
         NCT of Delhi  2004-05       14.3
                  Goa  2004-05      145.2
              Gujarat  2004-05     1238.2
              Haryana  2004-05       3023
     Himachal Pradesh  2004-05        122
      Jammu & Kashmir  2004-05      492.2
            Jharkhand  2004-05       1677
            Karnataka  2004-05       3547
               Kerala  2004-05      667.1
       Madhya Pradesh  2004-05       1169
          Maharashtra  2004-05       2164
              Manipur  2004-05      435.9
            Meghalaya  2004-05      193.7
              Mizoram  2004-05      104.1
             Nagaland  2004-05      259.8
               Odisha  2004-05       6466
           Puducherry  2004-05       65.7
               Punjab  2004-05      10437
            Rajasthan  2004-05      150.4
               Sikkim  2004-05       21.6
           Tamil Nadu  2004-05     5062.2
            Telangana  2004-05          .
              Tripura  2004-05      545.1
        Uttar Pradesh  2004-05     9555.6
          Uttarakhand  2004-05        572
          West Bengal  2004-05    14884.8
            ALL INDIA  2004-05    83131.7
       Andhra Pradesh  2005-06      11704
    Arunachal Pradesh  2005-06      146.2
                Assam  2005-06     3552.5
                Bihar  2005-06     3495.5
         Chhattisgarh  2005-06     5011.6
         NCT of Delhi  2005-06         24
                  Goa  2005-06      147.3
              Gujarat  2005-06       1298
              Haryana  2005-06       3210
     Himachal Pradesh  2005-06      112.1
      Jammu & Kashmir  2005-06      556.8
```

Jharkhand	2005-06	1558
Karnataka	2005-06	5744
Kerala	2005-06	629.9
Madhya Pradesh	2005-06	1656.3
Maharashtra	2005-06	2695
Manipur	2005-06	386.1
Meghalaya	2005-06	151.9
Mizoram	2005-06	99.2
Nagaland	2005-06	263.1
Odisha	2005-06	6859
Puducherry	2005-06	59.9
Punjab	2005-06	10193
Rajasthan	2005-06	153
Sikkim	2005-06	21.5
Tamil Nadu	2005-06	5220
Telangana	2005-06	.
Tripura	2005-06	552.9
Uttar Pradesh	2005-06	11133.7
Uttarakhand	2005-06	590
West Bengal	2005-06	14510.8
ALL INDIA	2005-06	91793.4
Andhra Pradesh	2006-07	11872
Arunachal Pradesh	2006-07	146.2
Assam	2006-07	2916
Bihar	2006-07	4989.3
Chhattisgarh	2006-07	5041.4
NCT of Delhi	2006-07	31.1
Goa	2006-07	130.3
Gujarat	2006-07	1390
Haryana	2006-07	3371
Himachal Pradesh	2006-07	123.5
Jammu & Kashmir	2006-07	554
Jharkhand	2006-07	2967.8
Karnataka	2006-07	3446
Kerala	2006-07	631
Madhya Pradesh	2006-07	1368.4
Maharashtra	2006-07	2569
Manipur	2006-07	386.1
Meghalaya	2006-07	200.2
Mizoram	2006-07	29.5
Nagaland	2006-07	263.5
Odisha	2006-07	6824.7
Puducherry	2006-07	59.9
Punjab	2006-07	10138
Rajasthan	2006-07	169.8
Sikkim	2006-07	21.5
Tamil Nadu	2006-07	6610.6
Telangana	2006-07	.

Tripura	2006-07	620.5
Uttar Pradesh	2006-07	11124
Uttarakhand	2006-07	556
West Bengal	2006-07	14745.9
ALL INDIA	2006-07	93355.3
Andhra Pradesh	2007-08	13324
Arunachal Pradesh	2007-08	158.1
Assam	2007-08	3319
Bihar	2007-08	4418.1
Chhattisgarh	2007-08	5426.6
NCT of Delhi	2007-08	31.4
Goa	2007-08	121.6
Gujarat	2007-08	1474
Haryana	2007-08	3613
Himachal Pradesh	2007-08	121.5
Jammu & Kashmir	2007-08	561.3
Jharkhand	2007-08	3336.4
Karnataka	2007-08	3717
Kerala	2007-08	528.5
Madhya Pradesh	2007-08	1461.9
Maharashtra	2007-08	2996
Manipur	2007-08	406.2
Meghalaya	2007-08	200
Mizoram	2007-08	15.7
Nagaland	2007-08	290.6
Odisha	2007-08	7540.7
Puducherry	2007-08	53.4
Punjab	2007-08	10489
Rajasthan	2007-08	259.6
Sikkim	2007-08	22.9
Tamil Nadu	2007-08	5040.2
Telangana	2007-08	.
Tripura	2007-08	624.6
Uttar Pradesh	2007-08	11780
Uttarakhand	2007-08	593
West Bengal	2007-08	14719.5
ALL INDIA	2007-08	96692.9
Andhra Pradesh	2008-09	14241
Arunachal Pradesh	2008-09	163.9
Assam	2008-09	4008.5
Bihar	2008-09	5590.3
Chhattisgarh	2008-09	4391.8
NCT of Delhi	2008-09	31.4
Goa	2008-09	123.3
Gujarat	2008-09	1303
Haryana	2008-09	3298
Himachal Pradesh	2008-09	118.3
Jammu & Kashmir	2008-09	563.1

Jharkhand	2008-09	3420.2
Karnataka	2008-09	3802
Kerala	2008-09	590.3
Madhya Pradesh	2008-09	1559.7
Maharashtra	2008-09	2284
Manipur	2008-09	397
Meghalaya	2008-09	203.9
Mizoram	2008-09	46
Nagaland	2008-09	345.1
Odisha	2008-09	6812.7
Puducherry	2008-09	50.8
Punjab	2008-09	11000
Rajasthan	2008-09	241.1
Sikkim	2008-09	21.7
Tamil Nadu	2008-09	5182.7
Telangana	2008-09	.
Tripura	2008-09	627.1
Uttar Pradesh	2008-09	13097
Uttarakhand	2008-09	582
West Bengal	2008-09	15037.3
ALL INDIA	2008-09	99182.5
Andhra Pradesh	2009-10	10538
Arunachal Pradesh	2009-10	215.8
Assam	2009-10	4335.9
Bihar	2009-10	3599.3
Chhattisgarh	2009-10	4110.4
NCT of Delhi	2009-10	19.3
Goa	2009-10	100.6
Gujarat	2009-10	1292
Haryana	2009-10	3625
Himachal Pradesh	2009-10	105.9
Jammu & Kashmir	2009-10	497.4
Jharkhand	2009-10	1538.4
Karnataka	2009-10	3691
Kerala	2009-10	598.3
Madhya Pradesh	2009-10	1260.6
Maharashtra	2009-10	2183
Manipur	2009-10	319.9
Meghalaya	2009-10	206.7
Mizoram	2009-10	44.3
Nagaland	2009-10	240.3
Odisha	2009-10	6917.5
Puducherry	2009-10	52.4
Punjab	2009-10	11236
Rajasthan	2009-10	228.3
Sikkim	2009-10	24.3
Tamil Nadu	2009-10	5665.2
Telangana	2009-10	.

Tripura	2009-10	640
Uttar Pradesh	2009-10	10807.1
Uttarakhand	2009-10	608
West Bengal	2009-10	14340.7
ALL INDIA	2009-10	89092.9
Andhra Pradesh	2010-11	7882.4
Arunachal Pradesh	2010-11	234.0
Assam	2010-11	4736.6
Bihar	2010-11	3102.1
Chhattisgarh	2010-11	6159.0
NCT of Delhi	2010-11	19.6
Goa	2010-11	115.0
Gujarat	2010-11	1496.6
Haryana	2010-11	3472.0
Himachal Pradesh	2010-11	128.9
Jammu & Kashmir	2010-11	507.7
Jharkhand	2010-11	1110.0
Karnataka	2010-11	4188.0
Kerala	2010-11	522.7
Madhya Pradesh	2010-11	1772.1
Maharashtra	2010-11	2696.0
Manipur	2010-11	521.7
Meghalaya	2010-11	207.0
Mizoram	2010-11	47.2
Nagaland	2010-11	381.4
Odisha	2010-11	6827.7
Puducherry	2010-11	52.0
Punjab	2010-11	10837.0
Rajasthan	2010-11	265.5
Sikkim	2010-11	21.0
Tamil Nadu	2010-11	5792.4
Telangana	2010-11	6535.6
Tripura	2010-11	702.5
Uttar Pradesh	2010-11	11992.0
Uttarakhand	2010-11	550.4
West Bengal	2010-11	13045.9
ALL INDIA	2010-11	95979.8
Andhra Pradesh	2011-12	7746.2
Arunachal Pradesh	2011-12	255.0
Assam	2011-12	4516.3
Bihar	2011-12	7162.6
Chhattisgarh	2011-12	6028.4
NCT of Delhi	2011-12	19.8
Goa	2011-12	121.8
Gujarat	2011-12	1790.0
Haryana	2011-12	3759.0
Himachal Pradesh	2011-12	131.6
Jammu & Kashmir	2011-12	544.7

Jharkhand	2011-12	3130.6
Karnataka	2011-12	3955.0
Kerala	2011-12	569.0
Madhya Pradesh	2011-12	2227.3
Maharashtra	2011-12	2841.0
Manipur	2011-12	591.0
Meghalaya	2011-12	216.5
Mizoram	2011-12	54.3
Nagaland	2011-12	382.4
Odisha	2011-12	5807.0
Puducherry	2011-12	42.1
Punjab	2011-12	10542.0
Rajasthan	2011-12	253.4
Sikkim	2011-12	20.9
Tamil Nadu	2011-12	7458.7
Telangana	2011-12	5148.8
Tripura	2011-12	718.3
Uttar Pradesh	2011-12	14022.0
Uttarakhand	2011-12	594.0
West Bengal	2011-12	14605.8
ALL INDIA	2011-12	105310.9
Andhra Pradesh	2012-13	6862.4
Arunachal Pradesh	2012-13	263.0
Assam	2012-13	5128.5
Bihar	2012-13	7529.3
Chhattisgarh	2012-13	6608.8
NCT of Delhi	2012-13	19.7
Goa	2012-13	122.8
Gujarat	2012-13	1541.0
Haryana	2012-13	3976.0
Himachal Pradesh	2012-13	125.3
Jammu & Kashmir	2012-13	818.1
Jharkhand	2012-13	3164.9
Karnataka	2012-13	3364.0
Kerala	2012-13	508.3
Madhya Pradesh	2012-13	2775.0
Maharashtra	2012-13	3057.0
Manipur	2012-13	257.6
Meghalaya	2012-13	232.0
Mizoram	2012-13	30.5
Nagaland	2012-13	405.2
Odisha	2012-13	7295.5
Puducherry	2012-13	46.5
Punjab	2012-13	11374.0
Rajasthan	2012-13	222.5
Sikkim	2012-13	21.3
Tamil Nadu	2012-13	4049.9
Telangana	2012-13	4647.6

Tripura	2012-13	713.2
Uttar Pradesh	2012-13	14416.0
Uttarakhand	2012-13	579.8
West Bengal	2012-13	15023.7
ALL INDIA	2012-13	105231.6
Andhra Pradesh	2013-14	6969.7
Arunachal Pradesh	2013-14	276.2
Assam	2013-14	4927.1
Bihar	2013-14	5505.8
Chhattisgarh	2013-14	6716.4
NCT of Delhi	2013-14	29.6
Goa	2013-14	126.5
Gujarat	2013-14	1636.0
Haryana	2013-14	3998.0
Himachal Pradesh	2013-14	120.8
Jammu & Kashmir	2013-14	610.9
Jharkhand	2013-14	2810.6
Karnataka	2013-14	3572.6
Kerala	2013-14	509.2
Madhya Pradesh	2013-14	2844.8
Maharashtra	2013-14	3120.0
Manipur	2013-14	398.5
Meghalaya	2013-14	273.9
Mizoram	2013-14	59.0
Nagaland	2013-14	429.6
Odisha	2013-14	7613.4
Puducherry	2013-14	49.8
Punjab	2013-14	11267.0
Rajasthan	2013-14	312.6
Sikkim	2013-14	20.3
Tamil Nadu	2013-14	5349.8
Telangana	2013-14	5755.0
Tripura	2013-14	711.8
Uttar Pradesh	2013-14	14636.0
Uttarakhand	2013-14	578.6
West Bengal	2013-14	15370.7
ALL INDIA	2013-14	106645.5
Andhra Pradesh	2014-15	7233.9
Arunachal Pradesh	2014-15	285.0
Assam	2014-15	5222.7
Bihar	2014-15	6356.7
Chhattisgarh	2014-15	6322.1
NCT of Delhi	2014-15	25.9
Goa	2014-15	120.5
Gujarat	2014-15	1830.9
Haryana	2014-15	4006.0
Himachal Pradesh	2014-15	125.2
Jammu & Kashmir	2014-15	517.2

Jharkhand	2014-15	3361.9
Karnataka	2014-15	3541.0
Kerala	2014-15	562.1
Madhya Pradesh	2014-15	3625.3
Maharashtra	2014-15	2946.0
Manipur	2014-15	334.1
Meghalaya	2014-15	298.2
Mizoram	2014-15	60.7
Nagaland	2014-15	454.2
Odisha	2014-15	8298.2
Puducherry	2014-15	52.7
Punjab	2014-15	11107.0
Rajasthan	2014-15	366.7
Sikkim	2014-15	20.1
Tamil Nadu	2014-15	5727.8
Telangana	2014-15	4440.8
Tripura	2014-15	747.0
Uttar Pradesh	2014-15	12167.9
Uttarakhand	2014-15	603.7
West Bengal	2014-15	14677.2
ALL INDIA	2014-15	104798.5
Andhra Pradesh	2015-16	7488.7
Arunachal Pradesh	2015-16	204.0
Assam	2015-16	5125.1
Bihar	2015-16	6802.2
Chhattisgarh	2015-16	5789.4
NCT of Delhi	2015-16	17.3
Goa	2015-16	115.1
Gujarat	2015-16	1702.0
Haryana	2015-16	4145.0
Himachal Pradesh	2015-16	129.9
Jammu & Kashmir	2015-16	646.4
Jharkhand	2015-16	2882.2
Karnataka	2015-16	3021.0
Kerala	2015-16	549.3
Madhya Pradesh	2015-16	3546.7
Maharashtra	2015-16	2593.0
Manipur	2015-16	338.8
Meghalaya	2015-16	301.1
Mizoram	2015-16	62.1
Nagaland	2015-16	318.8
Odisha	2015-16	5875.4
Puducherry	2015-16	43.9
Punjab	2015-16	11823.0
Rajasthan	2015-16	369.8
Sikkim	2015-16	13.1
Tamil Nadu	2015-16	7517.1
Telangana	2015-16	3047.0

Tripura	2015-16	794.8
Uttar Pradesh	2015-16	12501.0
Uttarakhand	2015-16	639.1
West Bengal	2015-16	15953.9
ALL INDIA	2015-16	104408.2
Andhra Pradesh	2016-17	7452.4
Arunachal Pradesh	2016-17	220.0
Assam	2016-17	4727.4
Bihar	2016-17	8239.3
Chhattisgarh	2016-17	8048.4
NCT of Delhi	2016-17	17.3
Goa	2016-17	113.2
Gujarat	2016-17	1930.0
Haryana	2016-17	4453.0
Himachal Pradesh	2016-17	146.6
Jammu & Kashmir	2016-17	572.2
Jharkhand	2016-17	3841.8
Karnataka	2016-17	2604.8
Kerala	2016-17	437.1
Madhya Pradesh	2016-17	4226.8
Maharashtra	2016-17	3109.5
Manipur	2016-17	430.4
Meghalaya	2016-17	203.0
Mizoram	2016-17	61.5
Nagaland	2016-17	336.7
Odisha	2016-17	8325.9
Puducherry	2016-17	52.2
Punjab	2016-17	11586.2
Rajasthan	2016-17	452.7
Sikkim	2016-17	19.7
Tamil Nadu	2016-17	2369.4
Telangana	2016-17	5173.4
Tripura	2016-17	814.6
Uttar Pradesh	2016-17	13754.0
Uttarakhand	2016-17	630.0
West Bengal	2016-17	15302.5
ALL INDIA	2016-17	109698.4
Andhra Pradesh	2017-18	8166.2
Arunachal Pradesh	2017-18	233.3
Assam	2017-18	5283.7
Bihar	2017-18	8093.1
Chhattisgarh	2017-18	4930.8
NCT of Delhi	2017-18	16.8
Goa	2017-18	103.0
Gujarat	2017-18	1890.9
Haryana	2017-18	4523.38
Himachal Pradesh	2017-18	114.79
Jammu & Kashmir	2017-18	513.14

Jharkhand	2017-18	4078.04
Karnataka	2017-18	3017.1
Kerala	2017-18	521.3
Madhya Pradesh	2017-18	4123.9
Maharashtra	2017-18	2730.8
Manipur	2017-18	607.8
Meghalaya	2017-18	304.6
Mizoram	2017-18	59.6
Nagaland	2017-18	349.6
Odisha	2017-18	6551.3
Puducherry	2017-18	42.5
Punjab	2017-18	13381.79
Rajasthan	2017-18	450.87
Sikkim	2017-18	17.63
Tamil Nadu	2017-18	6638.9
Telangana	2017-18	6262.2
Tripura	2017-18	812.1
Uttar Pradesh	2017-18	13274.0
Uttarakhand	2017-18	646.7
West Bengal	2017-18	14967.0
ALL INDIA	2017-18	112757.6
Andhra Pradesh	2018-19	8234.7
Arunachal Pradesh	2018-19	240.0
Assam	2018-19	5220.6
Bihar	2018-19	6155.5
Chhattisgarh	2018-19	6526.9
NCT of Delhi	2018-19	16.8
Goa	2018-19	98.8
Gujarat	2018-19	1912.1
Haryana	2018-19	4516.1
Himachal Pradesh	2018-19	114.9
Jammu & Kashmir	2018-19	615.8
Jharkhand	2018-19	2893.9
Karnataka	2018-19	3431.0
Kerala	2018-19	578.3
Madhya Pradesh	2018-19	4494.7
Maharashtra	2018-19	3275.7
Manipur	2018-19	401.6
Meghalaya	2018-19	202.0
Mizoram	2018-19	60.0
Nagaland	2018-19	356.7
Odisha	2018-19	7733.7
Puducherry	2018-19	63.3
Punjab	2018-19	12821.6
Rajasthan	2018-19	453.2
Sikkim	2018-19	17.2
Tamil Nadu	2018-19	6130.9
Telangana	2018-19	6670.0

Tripura	2018-19	793.2
Uttar Pradesh	2018-19	15545.3
Uttarakhand	2018-19	617.6
West Bengal	2018-19	16242.2
ALL INDIA	2018-19	116477.8
Andhra Pradesh	2019-20	8658.9
Arunachal Pradesh	2019-20	244.7
Assam	2019-20	4984.6
Bihar	2019-20	6298.0
Chhattisgarh	2019-20	6774.8
NCT of Delhi	2019-20	16.8
Goa	2019-20	90.4
Gujarat	2019-20	1983.1
Haryana	2019-20	4824.3
Himachal Pradesh	2019-20	143.8
Jammu & Kashmir	2019-20	587.0
Jharkhand	2019-20	3012.8
Karnataka	2019-20	3634.5
Kerala	2019-20	605.6
Madhya Pradesh	2019-20	4778.2
Maharashtra	2019-20	2897.6
Manipur	2019-20	385.5
Meghalaya	2019-20	303.4
Mizoram	2019-20	60.0
Nagaland	2019-20	363.3
Odisha	2019-20	8360.4
Puducherry	2019-20	59.4
Punjab	2019-20	11779.3
Rajasthan	2019-20	480.5
Sikkim	2019-20	16.1
Tamil Nadu	2019-20	7171.1
Telangana	2019-20	7427.8
Tripura	2019-20	810.2
Uttar Pradesh	2019-20	15517.8
Uttarakhand	2019-20	658.4
West Bengal	2019-20	15881.4
ALL INDIA	2019-20	118870.3
Andhra Pradesh	2020-21	7882.9
Arunachal Pradesh	2020-21	247.1
Assam	2020-21	5214.8
Bihar	2020-21	6747.0
Chhattisgarh	2020-21	7161.2
NCT of Delhi	2020-21	19.8
Goa	2020-21	87.3
Gujarat	2020-21	2145.7
Haryana	2020-21	4424.9
Himachal Pradesh	2020-21	140.5
Jammu & Kashmir	2020-21	581.5

Jharkhand	2020-21	2752.9
Karnataka	2020-21	4291.8
Kerala	2020-21	633.8
Madhya Pradesh	2020-21	4413.8
Maharashtra	2020-21	3291.7
Manipur	2020-21	602.2
Meghalaya	2020-21	295.9
Mizoram	2020-21	62.2
Nagaland	2020-21	367.4
Odisha	2020-21	8810.3
Puducherry	2020-21	50.0
Punjab	2020-21	12783.7
Rajasthan	2020-21	634.0
Sikkim	2020-21	16.2
Tamil Nadu	2020-21	6881.2
Telangana	2020-21	10217.1
Tripura	2020-21	803.1
Uttar Pradesh	2020-21	15520.0
Uttarakhand	2020-21	714.9
West Bengal	2020-21	16524.4
ALL INDIA	2020-21	124368.3
Andhra Pradesh	2021-22	7763.6
Arunachal Pradesh	2021-22	252.4
Assam	2021-22	4382.1
Bihar	2021-22	7717.0
Chhattisgarh	2021-22	8021.7
NCT of Delhi	2021-22	19.0
Goa	2021-22	90.4
Gujarat	2021-22	2101.1
Haryana	2021-22	4618.0
Himachal Pradesh	2021-22	167.5
Jammu & Kashmir	2021-22	492.9
Jharkhand	2021-22	2930.5
Karnataka	2021-22	4318.4
Kerala	2021-22	487.0
Madhya Pradesh	2021-22	4814.9
Maharashtra	2021-22	3598.1
Manipur	2021-22	567.4
Meghalaya	2021-22	297.3
Mizoram	2021-22	60.9
Nagaland	2021-22	150.7
Odisha	2021-22	9290.8
Puducherry	2021-22	57.1
Punjab	2021-22	12885.5
Rajasthan	2021-22	478.6
Sikkim	2021-22	16.0
Tamil Nadu	2021-22	7906.6
Telangana	2021-22	12409.6

```
                Tripura  2021-22      811.0
          Uttar Pradesh  2021-22    15271.5
            Uttarakhand  2021-22      716.1
            West Bengal  2021-22    16728.7
              ALL INDIA  2021-22   129471.4
         Andhra Pradesh 2022-23*     8542.3
      Arunachal Pradesh 2022-23*          -
                  Assam 2022-23*     4979.8
                  Bihar 2022-23*     6725.2
            Chhattisgarh 2022-23*     8238.3
            NCT of Delhi 2022-23*          -
                     Goa 2022-23*          -
                 Gujarat 2022-23*     2395.2
                 Haryana 2022-23*     5406.9
          Himachal Pradesh 2022-23*      119.2
           Jammu & Kashmir 2022-23*          -
                 Jharkhand 2022-23*     1399.8
                 Karnataka 2022-23*     4001.3
                    Kerala 2022-23*      581.4
           Madhya Pradesh 2022-23*     7657.2
              Maharashtra 2022-23*     3899.1
                  Manipur 2022-23*          -
                Meghalaya 2022-23*          -
                  Mizoram 2022-23*          -
                 Nagaland 2022-23*          -
                    Odisha 2022-23*     9621.2
               Puducherry 2022-23*          -
                   Punjab 2022-23*    13146.7
                Rajasthan 2022-23*      577.4
                   Sikkim 2022-23*          -
               Tamil Nadu 2022-23*     7850.6
                Telangana 2022-23*    16013.9
                  Tripura 2022-23*          -
            Uttar Pradesh 2022-23*    15171.3
              Uttarakhand 2022-23*      641.7
              West Bengal 2022-23*    15636.9
                ALL INDIA 2022-23*     135542
```

[ ]:
```
melted_df
```

[ ]:
```
     State/Union Territory      YEAR PRODUCTION
0           Andhra Pradesh   2004-05       9601
1        Arunachal Pradesh   2004-05        135
2                    Assam   2004-05     3470.7
3                    Bihar   2004-05     2472.2
4             Chhattisgarh   2004-05     4383.3
..                     …       …        …
```

```
603              Tripura  2022-23*          -
604         Uttar Pradesh  2022-23*    15171.3
605           Uttarakhand  2022-23*      641.7
606           West Bengal  2022-23*    15636.9
607             ALL INDIA  2022-23*     135542

[608 rows x 3 columns]
```

[ ]:
```
melted_df.describe()
```

[ ]:
```
       State/Union Territory     YEAR PRODUCTION
count                    608      608        608
unique                    32       19        581
top           Andhra Pradesh  2004-05          -
freq                      19       32         11
```

[ ]:
```
melted_df = melted_df.rename(columns={"State/Union Territory": "State/UTs"})
```

[ ]:
```
melted_df.head()
```

[ ]:
```
           State/UTs     YEAR PRODUCTION
0     Andhra Pradesh  2004-05       9601
1  Arunachal Pradesh  2004-05        135
2              Assam  2004-05     3470.7
3              Bihar  2004-05     2472.2
4       Chhattisgarh  2004-05     4383.3
```

[ ]:
```
melted_df['YEAR'] = melted_df['YEAR'].str.split('-').str[0].astype(int)
```

[ ]:
```
melted_df.head()
```

[ ]:
```
           State/UTs  YEAR PRODUCTION
0     Andhra Pradesh  2004       9601
1  Arunachal Pradesh  2004        135
2              Assam  2004     3470.7
3              Bihar  2004     2472.2
4       Chhattisgarh  2004     4383.3
```

[ ]:
```
melted_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 608 entries, 0 to 607
Data columns (total 3 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   State/UTs   608 non-null    object
 1   YEAR        608 non-null    int64
```

```
 2   PRODUCTION  608 non-null    object
dtypes: int64(1), object(2)
memory usage: 14.4+ KB
```

[ ]:
```
melted_df['State/UTs']
```

[ ]:
```
0         Andhra Pradesh
1      Arunachal Pradesh
2                  Assam
3                  Bihar
4           Chhattisgarh
              ...
603              Tripura
604        Uttar Pradesh
605          Uttarakhand
606          West Bengal
607            ALL INDIA
Name: State/UTs, Length: 608, dtype: object
```

[ ]:
```
melted_df = melted_df.astype({"State/UTs": 'str'})
```

[ ]:
```
merged_df = pd.merge(melted_df, rainfall_data, how='inner', left_on=['State/
↪UTs', 'YEAR'], right_on=['States/UTs', 'YEAR'])
```

[ ]:
```
merged_df.head()
```

[ ]:

	State/UTs	YEAR	PRODUCTION	States/UTs	ANNUAL
0	Arunachal Pradesh	2004	135	Arunachal Pradesh	2545.7
1	Bihar	2004	2472.2	Bihar	1147.8
2	Chhattisgarh	2004	4383.3	Chhattisgarh	1144.5
3	Himachal Pradesh	2004	122	Himachal Pradesh	878.5
4	Jammu & Kashmir	2004	492.2	Jammu & Kashmir	944.9

[ ]:
```
merged_df.drop(columns=['States/UTs'], inplace=True)
```

[ ]:
```
merged_df.head()
```

[ ]:

	State/UTs	YEAR	PRODUCTION	ANNUAL
0	Arunachal Pradesh	2004	135	2545.7
1	Bihar	2004	2472.2	1147.8
2	Chhattisgarh	2004	4383.3	1144.5
3	Himachal Pradesh	2004	122	878.5
4	Jammu & Kashmir	2004	492.2	944.9

[ ]:
```
merged_df = merged_df.rename(columns={"ANNUAL": "ANNUAL RAINFALL (mm)"})
```

[ ]:
```
merged_df.head()
```

[ ]:

	State/UTs	YEAR	PRODUCTION	ANNUAL RAINFALL (mm)
0	Arunachal Pradesh	2004	135	2545.7
1	Bihar	2004	2472.2	1147.8
2	Chhattisgarh	2004	4383.3	1144.5
3	Himachal Pradesh	2004	122	878.5
4	Jammu & Kashmir	2004	492.2	944.9

[ ]:
```
df = merged_df
```

[ ]:
```
df.head()
```

[ ]:

	State/UTs	YEAR	PRODUCTION	ANNUAL RAINFALL (mm)
0	Arunachal Pradesh	2004	135	2545.7
1	Bihar	2004	2472.2	1147.8
2	Chhattisgarh	2004	4383.3	1144.5
3	Himachal Pradesh	2004	122	878.5
4	Jammu & Kashmir	2004	492.2	944.9

[ ]:
```
df.isnull().sum()
```

[ ]:
```
State/UTs               0
YEAR                    0
PRODUCTION              0
ANNUAL RAINFALL (mm)    1
dtype: int64
```

[ ]:
```
replacement_value = 0  # You can replace NaN with any desired value

# Replace NaN values with the specified value
df['ANNUAL RAINFALL (mm)'].fillna(replacement_value, inplace=True)
```

[ ]:
```
df.isnull().sum()
```

[ ]:
```
State/UTs               0
YEAR                    0
PRODUCTION              0
ANNUAL RAINFALL (mm)    0
dtype: int64
```

[ ]:
```
grouped_df = df.groupby(['State/UTs', 'YEAR']).sum()

# Reset index to make the grouped columns into regular columns
grouped_df.reset_index(inplace=True)

# Print the grouped DataFrame
print(grouped_df)
```

```
              State/UTs  YEAR PRODUCTION  ANNUAL RAINFALL (mm)
0    Arunachal Pradesh  2004        135                2545.7
1    Arunachal Pradesh  2005      146.2                2335.5
2    Arunachal Pradesh  2006      146.2                2259.6
3    Arunachal Pradesh  2007      158.1                3020.7
4    Arunachal Pradesh  2008      163.9                2244.4
..                 …   …        …                    …
149        Uttarakhand  2013      578.6                1735.4
150        Uttarakhand  2014      603.7                1287.4
151        Uttarakhand  2015      639.1                1247.6
152        Uttarakhand  2016      630.0                1308.6
153        Uttarakhand  2017      646.7                1476.0

[154 rows x 4 columns]
```

[ ]:
```
grouped_df.head()
```

[ ]:
```
            State/UTs  YEAR PRODUCTION  ANNUAL RAINFALL (mm)
0  Arunachal Pradesh  2004        135                2545.7
1  Arunachal Pradesh  2005      146.2                2335.5
2  Arunachal Pradesh  2006      146.2                2259.6
3  Arunachal Pradesh  2007      158.1                3020.7
4  Arunachal Pradesh  2008      163.9                2244.4
```

[ ]:
```
grouped_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 154 entries, 0 to 153
Data columns (total 4 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   State/UTs             154 non-null    object
 1   YEAR                  154 non-null    int64
 2   PRODUCTION            154 non-null    object
 3   ANNUAL RAINFALL (mm)  154 non-null    float64
dtypes: float64(1), int64(1), object(2)
memory usage: 4.9+ KB
```

[ ]:
```
grouped_df.head(25)
```

[ ]:
```
            State/UTs  YEAR PRODUCTION  ANNUAL RAINFALL (mm)
0  Arunachal Pradesh  2004        135                2545.7
1  Arunachal Pradesh  2005      146.2                2335.5
2  Arunachal Pradesh  2006      146.2                2259.6
3  Arunachal Pradesh  2007      158.1                3020.7
4  Arunachal Pradesh  2008      163.9                2244.4
5  Arunachal Pradesh  2009      215.8                1749.9
6  Arunachal Pradesh  2010      234.0                2855.7
```

```
7   Arunachal Pradesh  2011      255.0              2193.7
8   Arunachal Pradesh  2012      263.0              3440.3
9   Arunachal Pradesh  2013      276.2              2042.9
10  Arunachal Pradesh  2014      285.0              2403.2
11  Arunachal Pradesh  2015      204.0              2767.5
12  Arunachal Pradesh  2016      220.0              2706.9
13  Arunachal Pradesh  2017      233.3              2745.3
14              Bihar  2004     2472.2              1147.8
15              Bihar  2005     3495.5               907.8
16              Bihar  2006     4989.3              1052.8
17              Bihar  2007     4418.1              1600.2
18              Bihar  2008     5590.3              1197.7
19              Bihar  2009     3599.3               889.3
20              Bihar  2010     3102.1               629.2
21              Bihar  2011     7162.6              1097.1
22              Bihar  2012     7529.3              1032.4
23              Bihar  2013     5505.8              1069.9
24              Bihar  2014     6356.7              1061.0
```

[ ]:
```
# import pandas as pd

# non_numeric_rows = grouped_df[~pd.to_numeric(grouped_df['PRODUCTION'],␣
 ↪errors='coerce').notnull()]

# # Print the non-numeric rows
# print(non_numeric_rows)
```

[ ]:
```
# # prompt: convert the datatype of PRODUCTION col in grouped_df to float type␣
 ↪and to print the entire row of the grouped_df for which the PRODUCTION col␣
 ↪couldnt be converted to float

# try:
#     grouped_df['PRODUCTION'] = grouped_df['PRODUCTION'].astype(float)
# except ValueError as e:
#     # Find the row where the conversion failed
#     row_index = grouped_df[grouped_df['PRODUCTION'] == e.args[0]].index[0]

#     # Print the entire row
#     print(grouped_df.iloc[row_index])
```

[ ]:
```
grouped_df.isnull().sum()
```

[ ]:
```
State/UTs              0
YEAR                   0
PRODUCTION             0
ANNUAL RAINFALL (mm)   0
dtype: int64
```

[ ]:
```
replacement_value = 0  # You can replace NaN with any desired value

# Replace NaN values with the specified value
grouped_df['PRODUCTION'].fillna(replacement_value, inplace=True)
```

[ ]:
```
grouped_df.dtypes
```

[ ]:
```
State/UTs                object
YEAR                      int64
PRODUCTION               object
ANNUAL RAINFALL (mm)    float64
dtype: object
```

[ ]:
```
# grouped_df['PRODUCTION'].
```

[ ]:
```
# grouped_df["PRODUCTION"] = [float(str(i).replace(",", "")) for i in␣
 ↪grouped_df["PRODUCTION"]]
```

[ ]:
```
# # do the transfrom
# grouped_df['PRODUCTION'] = grouped_df['PRODUCTION'].astype(float).round(2)
# #
# print(grouped_df)
```

[ ]:
```
import pandas as pd

# Your existing code to create 'grouped_df'

# Remove non-numeric values from the 'PRODUCTION' column
grouped_df['PRODUCTION'] = pd.to_numeric(grouped_df['PRODUCTION'],␣
 ↪errors='coerce')

# Drop rows with NaN values in the 'PRODUCTION' column
grouped_df = grouped_df.dropna(subset=['PRODUCTION'])

# Convert the column to integer type
grouped_df['PRODUCTION'] = grouped_df['PRODUCTION'].astype(int)

# Print the modified DataFrame
print(grouped_df)
```

```
             State/UTs  YEAR  PRODUCTION  ANNUAL RAINFALL (mm)
0    Arunachal Pradesh  2004         135                2545.7
1    Arunachal Pradesh  2005         146                2335.5
2    Arunachal Pradesh  2006         146                2259.6
3    Arunachal Pradesh  2007         158                3020.7
4    Arunachal Pradesh  2008         163                2244.4
..                 …     …          …                     …
```

```
149        Uttarakhand  2013         578                1735.4
150        Uttarakhand  2014         603                1287.4
151        Uttarakhand  2015         639                1247.6
152        Uttarakhand  2016         630                1308.6
153        Uttarakhand  2017         646                1476.0

[148 rows x 4 columns]
```

```
<ipython-input-648-a73f98ad8e8c>:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['PRODUCTION'] = grouped_df['PRODUCTION'].astype(int)
```

[ ]:
```
# Import the necessary libraries
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import OneHotEncoder

# Method 1: Label Encoding
label_encoder = LabelEncoder()
grouped_df['State/UTs_LabelEncoded'] = label_encoder.
 ↪fit_transform(grouped_df['State/UTs'])

# # Method 2: One-Hot Encoding
# one_hot_encoder = OneHotEncoder(sparse=False)
# encoded_states = one_hot_encoder.fit_transform(grouped_df[['State/UTs']])
# encoded_states_df = pd.DataFrame(encoded_states, columns=one_hot_encoder.
 ↪get_feature_names(['State/UTs']))
# grouped_df = pd.concat([grouped_df, encoded_states_df], axis=1)

# Print the DataFrame with encoded columns
print(grouped_df)
```

```
             State/UTs  YEAR  PRODUCTION  ANNUAL RAINFALL (mm)  \
0    Arunachal Pradesh  2004         135                2545.7
1    Arunachal Pradesh  2005         146                2335.5
2    Arunachal Pradesh  2006         146                2259.6
3    Arunachal Pradesh  2007         158                3020.7
4    Arunachal Pradesh  2008         163                2244.4
..                 …   …          …                     …
149        Uttarakhand  2013         578                1735.4
150        Uttarakhand  2014         603                1287.4
151        Uttarakhand  2015         639                1247.6
152        Uttarakhand  2016         630                1308.6
153        Uttarakhand  2017         646                1476.0
```

```
     State/UTs_LabelEncoded
0                         0
1                         0
2                         0
3                         0
4                         0
..                      …
149                      10
150                      10
151                      10
152                      10
153                      10

[148 rows x 5 columns]
```

```
<ipython-input-649-67b90f7bfbe8>:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['State/UTs_LabelEncoded'] =
label_encoder.fit_transform(grouped_df['State/UTs'])
```

[ ]:
```python
# Drop rows with missing target values
grouped_df.dropna(subset=['PRODUCTION'], inplace=True)
```

```
<ipython-input-650-f0796ab26acd>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df.dropna(subset=['PRODUCTION'], inplace=True)
```

[ ]:
```python
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

# Define features and target variable
# Assume 'PRODUCTION' is the target variable and the rest are features
X = grouped_df.drop(['PRODUCTION','State/UTs'], axis=1)  # Features
y = grouped_df['PRODUCTION']  # Target variable

# Split data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Train a linear regression model
```

```
model = LinearRegression()
model.fit(X_train, y_train)

# Make predictions on the testing data
y_pred = model.predict(X_test)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
print("Mean Squared Error:", mse)
```

```
Mean Squared Error: 9963855.051168028
```

[ ]:
```
from sklearn.metrics import mean_squared_error, mean_absolute_error
import numpy as np

# Calculate Mean Squared Error (MSE)
mse = mean_squared_error(y_test, y_pred)
print("Mean Squared Error (MSE):", mse)

# Calculate Root Mean Squared Error (RMSE)
rmse = np.sqrt(mse)
print("Root Mean Squared Error (RMSE):", rmse)

# Calculate Mean Absolute Error (MAE)
mae = mean_absolute_error(y_test, y_pred)
print("Mean Absolute Error (MAE):", mae)
```

```
Mean Squared Error (MSE): 9963855.051168028
Root Mean Squared Error (RMSE): 3156.557468377224
Mean Absolute Error (MAE): 2820.3116334197994
```

[ ]:
```
from sklearn.metrics import r2_score

# Calculate R-squared (R^2) score
r2 = r2_score(y_test, y_pred)
print("R-squared (R^2) score:", r2)
```

```
R-squared (R^2) score: 0.03285496247691244
```

[ ]:
```
from sklearn.linear_model import LinearRegression

# Assuming 'PRODUCTION' is the name of the production column and 'ANNUAL␣
↪RAINFALL (mm)' is the name of the rainfall column
# Assume 'State/UTs' is the name of the state column

# Initialize lists to store predictions for each state
predictions = []
```

```
# Iterate over each state
for state, state_data in grouped_df.groupby('State/UTs'):
    # Sort the data by year
    state_data = state_data.sort_values(by='YEAR')

    # Prepare X (features) and y (target) data for the state
    X_state = state_data[['YEAR', 'ANNUAL RAINFALL (mm)']].iloc[:-1]  # Exclude␣
 ↪the last year for prediction
    y_state = state_data['PRODUCTION'].iloc[1:]  # Production for the next year

    # Train a linear regression model
    model = LinearRegression()
    model.fit(X_state, y_state)

    # Prepare data for prediction (data from the last year)
    X_pred = state_data[['YEAR', 'ANNUAL RAINFALL (mm)']].iloc[[-1]]

    # Make prediction for the next year's production
    next_year_production = model.predict(X_pred)

    # Append prediction to the list
    predictions.append({'State/UTs': state, 'Next Year Production Prediction':␣
 ↪next_year_production[0]})

# Convert predictions list to DataFrame
predictions_df = pd.DataFrame(predictions)

# Print the predictions
print(predictions_df)
```

```
            State/UTs  Next Year Production Prediction
0   Arunachal Pradesh                       275.636908
1               Bihar                      8188.509888
2        Chhattisgarh                      6955.974348
3    Himachal Pradesh                       134.656687
4     Jammu & Kashmir                       600.417218
5            Jharkhand                      3725.291345
6              Kerala                       480.009587
7              Punjab                     12408.857886
8           Tamil Nadu                      5082.735801
9           Telangana                      5036.813482
10        Uttarakhand                       632.404295
```

[ ]:
```
len(grouped_df['State/UTs'].unique())
```

[ ]: 11

[ ]:
```
from sklearn.linear_model import LinearRegression

# Initialize lists to store predictions for each state
predictions = []

# Iterate over each state
for state, state_data in grouped_df.groupby('State/UTs'):
    # Sort the data by year
    state_data = state_data.sort_values(by='YEAR')

    # Check if the state has enough historical data points
    if len(state_data) >= 6:  # Assuming you want to predict for the next five␣
 ↪years

        # Prepare X (features) and y (target) data for the state
        X_state = state_data[['YEAR', 'ANNUAL RAINFALL (mm)']].iloc[:-5]  #␣
 ↪Exclude the last five years for prediction
        y_state = state_data['PRODUCTION'].iloc[5:]  # Production for the next␣
 ↪five years

        # Train a linear regression model
        model = LinearRegression()
        model.fit(X_state, y_state)

        # Prepare data for prediction (data from the last year)
        X_pred = state_data[['YEAR', 'ANNUAL RAINFALL (mm)']].iloc[[-1]]

        # Make predictions for the next five years' production
        next_five_years_production = []
        for i in range(1, 6):
            year = X_pred.iloc[0]['YEAR'] + i
            X_pred['YEAR'] = year
            prediction = model.predict(X_pred)
            rounded_prediction = round(prediction[0], 2)  # Round to 2 decimal␣
 ↪places (adjust as needed)
            next_five_years_production.append(rounded_prediction)
        # Append predictions to the list
        predictions.append({'State/UTs': state, 'Next Five Years Production␣
 ↪Prediction': next_five_years_production})

# Convert predictions list to DataFrame
predictions_df = pd.DataFrame(predictions)

# Print the predictions
print(predictions_df)
```

```
          State/UTs              Next Five Years Production Prediction
```

```
0    Arunachal Pradesh           [241.17, 241.94, 243.09, 244.62, 246.54]
1                Bihar  [12272.23, 13447.49, 15210.39, 17560.91, 20499…
2         Chhattisgarh      [7571.35, 7856.88, 8285.16, 8856.21, 9570.02]
3     Himachal Pradesh             [145.23, 148.31, 152.93, 159.1, 166.8]
4      Jammu & Kashmir            [619.69, 626.9, 637.71, 652.13, 670.15]
5            Jharkhand      [6171.93, 6828.99, 7814.57, 9128.67, 10771.3]
6               Kerala            [427.87, 405.85, 372.83, 328.8, 273.77]
7               Punjab  [13819.45, 14277.45, 14964.45, 15880.46, 17025…
8           Tamil Nadu      [4090.33, 3766.75, 3281.39, 2634.24, 1825.31]
9            Telangana   [15094.1, 17952.51, 22240.13, 27956.96, 35103.0]
10         Uttarakhand            [685.49, 702.4, 727.76, 761.58, 803.85]
```

[ ]:
```
predictions_df.head(11)
```

[ ]:
```
             State/UTs              Next Five Years Production Prediction
0    Arunachal Pradesh           [241.17, 241.94, 243.09, 244.62, 246.54]
1                Bihar  [12272.23, 13447.49, 15210.39, 17560.91, 20499…
2         Chhattisgarh      [7571.35, 7856.88, 8285.16, 8856.21, 9570.02]
3     Himachal Pradesh             [145.23, 148.31, 152.93, 159.1, 166.8]
4      Jammu & Kashmir            [619.69, 626.9, 637.71, 652.13, 670.15]
5            Jharkhand      [6171.93, 6828.99, 7814.57, 9128.67, 10771.3]
6               Kerala            [427.87, 405.85, 372.83, 328.8, 273.77]
7               Punjab  [13819.45, 14277.45, 14964.45, 15880.46, 17025…
8           Tamil Nadu      [4090.33, 3766.75, 3281.39, 2634.24, 1825.31]
9            Telangana   [15094.1, 17952.51, 22240.13, 27956.96, 35103.0]
10         Uttarakhand            [685.49, 702.4, 727.76, 761.58, 803.85]
```

[ ]:
```
grouped_df.isnull().sum()
```

[ ]:
```
State/UTs                0
YEAR                     0
PRODUCTION               0
ANNUAL RAINFALL (mm)     0
State/UTs_LabelEncoded   0
dtype: int64
```

[ ]:
```
#
```