Crop Production Analysis in INDIA

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Problem Statement

The Agriculture business domain, as a vital part of the overall supply chain, is expected to highly evolve in the upcoming years via the developments, which are taking place on the side of the Future Internet. This paper presents a novel Business-to-Business collaboration platform from the agri-food sector perspective, which aims to facilitate the collaboration of numerous stakeholders belonging to associated business domains, in an effective and flexible manner.

This dataset provides a huge amount of information on crop production in India ranging from several years. Based on the Information the ultimate goal would be to predict crop production and find important insights highlighting key indicators and metrics that influence crop production.

Make views and dashboards first and also make a story out of it.

Introduction to Agriculture

1. **Economic Contribution**:

   - Agriculture contributes around **17-18%** to India's Gross Domestic Product (GDP).
   - It provides employment to over **50%** of India's population, making it a primary source of livelihood.

2. **Diverse Crop Production**:

   India is one of the top global producers of:

   - **Rice**: India ranks 2nd, producing around **122 million tonnes** annually.
   - **Wheat**: India ranks 2nd, producing about **110 million tonnes** annually.
   - **Pulses**: India is the largest producer, contributing **23-25%** of global production.
   - **Sugarcane**: India ranks 2nd, producing **405 million tonnes** annually.
   - **Cotton**: India is the largest producer, producing over **6 million tonnes** annually.
   - **Spices**: India produces **75%** of the world's spices.

3. **Agro-Climatic Diversity**:

   - India has **15 major agro-climatic zones**, supporting a variety of crops such as cereals, fruits, vegetables, oilseeds, and pulses.
   - The country's climate ranges from tropical in the south to temperate in the north, allowing for year-round cultivation.

4. **Green Revolution Impact**:

   - The Green Revolution (1960s-70s) increased food grain production significantly:
     - Wheat production increased from **10 million tonnes** (1960) to over **110 million tonnes** (current levels).
     - The adoption of high-yield variety (HYV) seeds and modern irrigation methods played a major role.

5. **Horticulture and Dairy**:

   - India is the world's largest producer of **milk**, with an annual production of **210 million tonnes**.
   - India is also a leading producer of **fruits and vegetables**, with annual production exceeding **320 million tonnes**.

6. **Exports**:

   - Agriculture exports contribute significantly to India’s foreign exchange:
     - Total agricultural exports were valued at around **$50 billion** in **2022-2023**.
     - Major export items include rice, spices, sugar, and tea.

7. **Government Initiatives**:

   - **Pradhan Mantri Fasal Bima Yojana (PMFBY)**: Provides crop insurance to farmers to mitigate risks due to crop failure, covering over **30 million farmers**.
   - **PM-KISAN**: A direct income support scheme providing **₹6,000 per year** to small and marginal farmers, benefiting around **115 million farmers**.
   - **National Agriculture Market (e-NAM)**: A digital platform connecting **1,000+ agricultural markets**, facilitating better market access.

8. **Challenges**:

   - **Fragmented Land Holdings**: Over **85%** of India's farmers are small and marginal, with average landholding size being **1.08 hectares**.
   - **Water Scarcity**: Agriculture consumes **80%** of India's freshwater resources, with looming challenges of depleting water tables.
   - **Soil Degradation**: About **30%** of India's soil is facing degradation, affecting productivity.

9. **Sustainability and Modernization**:

   - Efforts are underway to promote **sustainable farming practices**, organic agriculture, and the use of technology such as **precision farming**, **AI**, and **drones**.
   - The government is also encouraging the use of **solar energy** in agriculture with schemes like **PM-KUSUM** for solar pumps.

10. **Future Outlook**:

    - The Indian agricultural market is projected to grow at a CAGR of **4.9%** between **2022-2027**.
    - The government aims to double farmers' incomes by **2024** through a combination of improved infrastructure, market access, and diversification into allied sectors such as fisheries and animal husbandry.

About Data & Data Collection

1. Data Collected from unified mentor portal as Excel Workbook.

2. 246092 rows of data with 7 columns.

3. 7 columns are:

   - **State_Name** : List of all the States and UT in INDIA.
   - **District_Name** : List of all the District's present in States and UT's.
   - **Crop_Year** : From 1997 – 2015.
   - **Season** : Winter, Summer, Kharif, Rabi, Autumn, Whole Year.
   - **Crop** : List's all the crops grown in INDIA.
   - **Area** : Numeric data about the area where crops are sown.
   - **Production** : Numeric data on how much crop production is done.

4. Based on the Information the goal is to find important insights highlighting key indicators and metrics that influence crop production in India.

Data Cleaning & Data Analysis (Pre visualization)

1. Data collected as Excel workbook was converted to csv format.

2. Data loaded into pycharm for data cleaning and data analysis.

3. **Tools used:** Pandas, Seaborn, Matplotlib, python.

4. Steps in data cleaning:

   - Filled empty spaces of numeric data with mean values of that particular column.
   - Dropped Duplicates.
   - Adjusted the title name and converted the data types.

5. EDA was done to remove outliers using IQR (Data analysis).

6. Saved the file in csv format

7. Code is displayed below.

8.

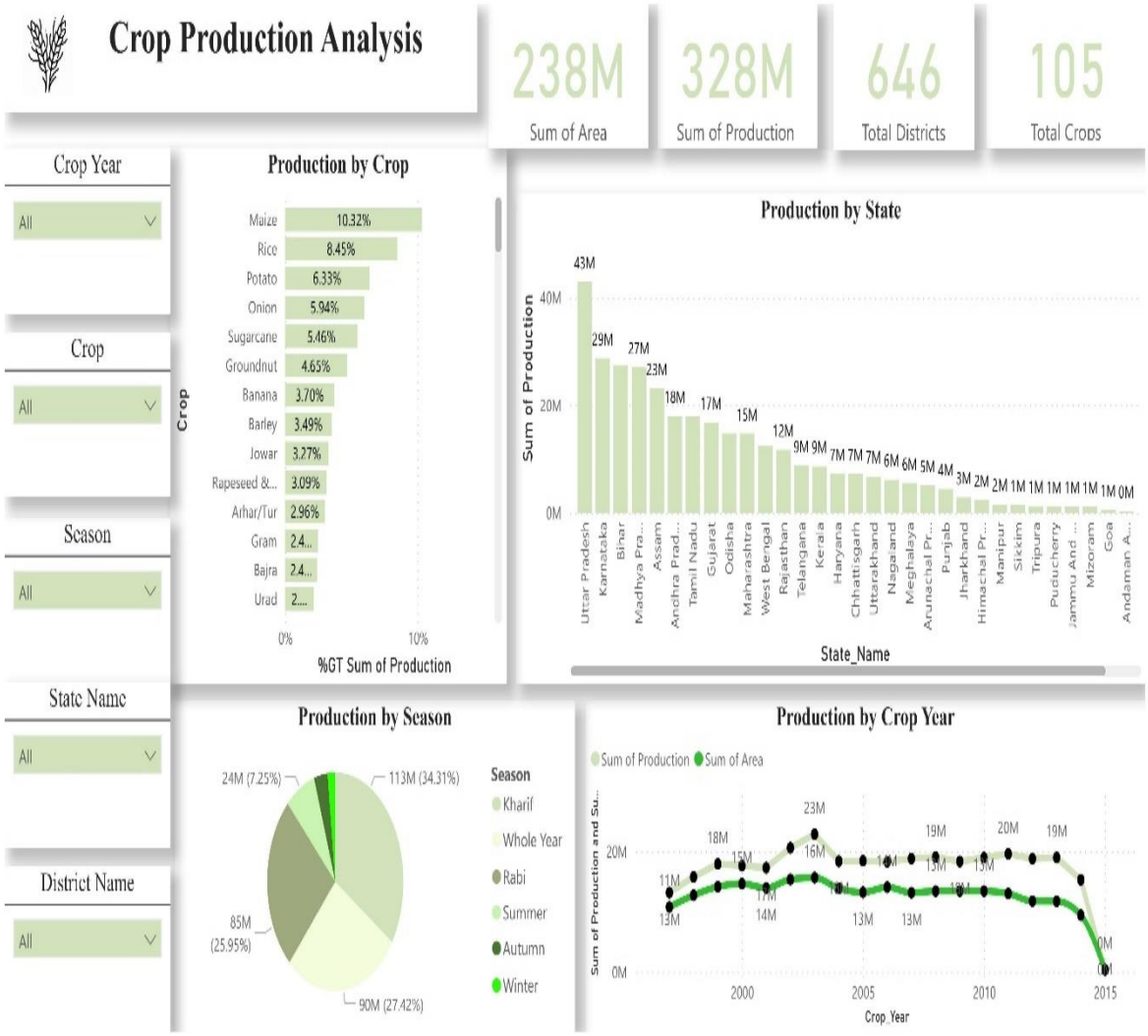
```python
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

df = pd.read_csv("Crop Production data.csv")
print(df.shape)

print(df.isnull().sum())
df2 = df.copy()

df2['Production'] = df2['Production'].fillna(df2['Production'].mean())

print(df2.isnull().sum())

print(df2.duplicated().sum())
df2 = df2.drop_duplicates()

df2['State_Name'] = df2['State_Name'].str.strip().str.title()
df2['District_Name'] = df2['District_Name'].str.strip().str.title()
df2['Season'] = df2['Season'].str.strip().str.title()
df2['Crop'] = df2['Crop'].str.strip().str.title()

df2['Area'] = df2['Area'].astype(int)
df2['Crop_Year'] = df2['Crop_Year'].astype(int)
df2['Production'] = df2['Production'].astype(int)
df2['Season'] = df2['Season'].astype('category')

x = (df2 == 0).any()
print(x)
```

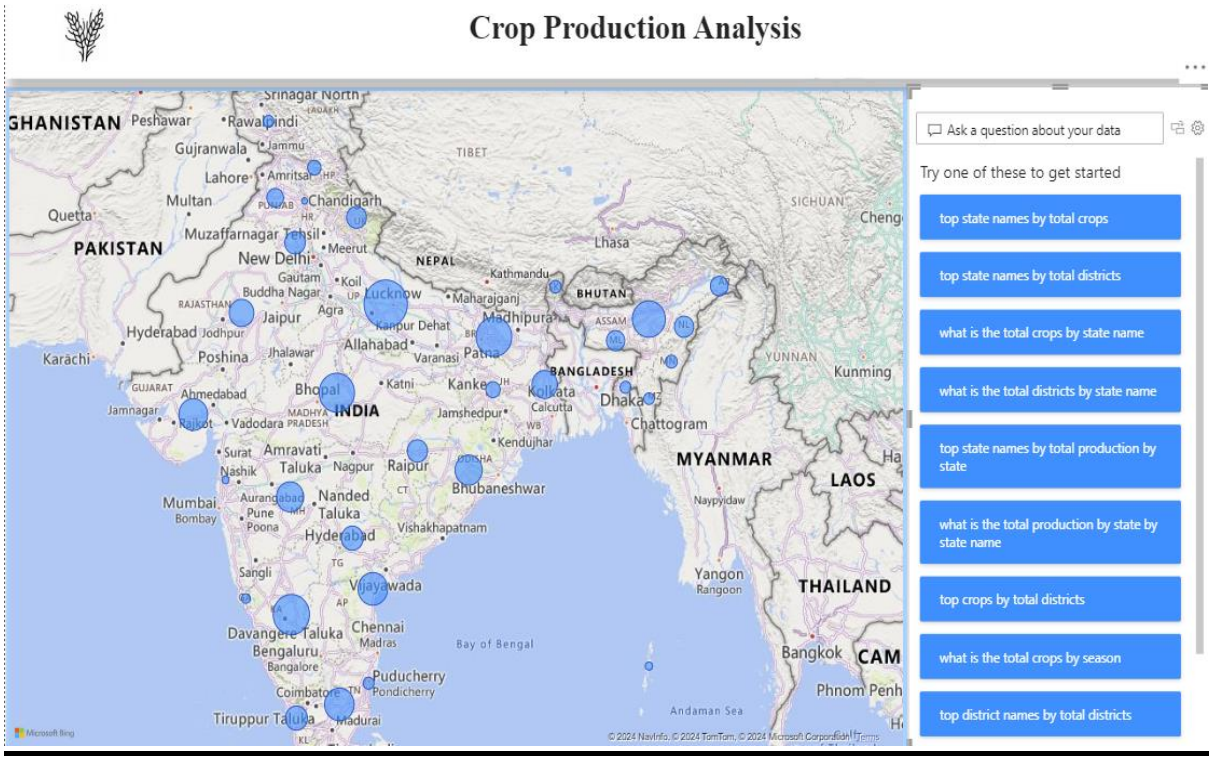
9.

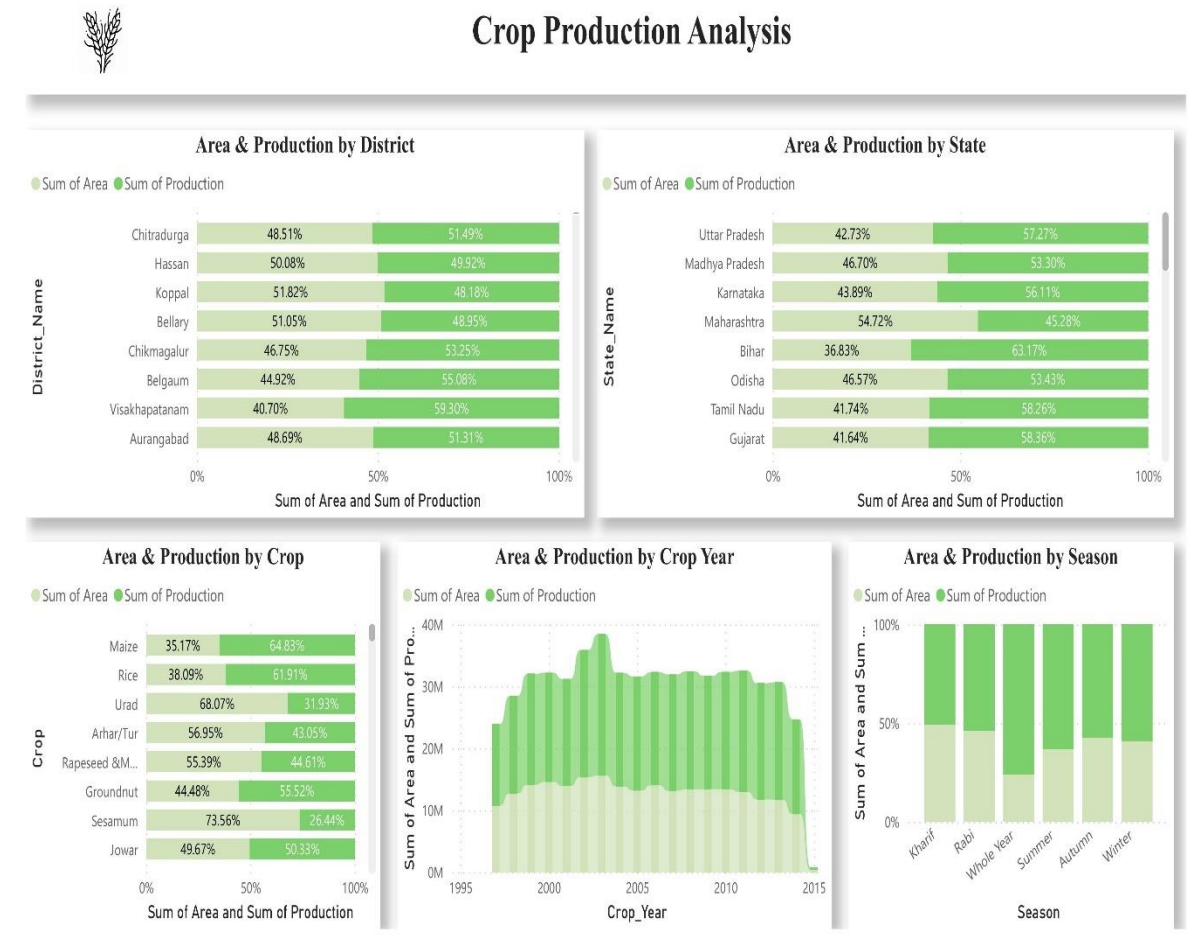
```
df2 = df2[(df2['Area'] > 0) & (df2['Production'] > 0)]

Q1_area = df2['Area'].quantile(0.25)
Q3_area = df2['Area'].quantile(0.75)
IQR_area = Q3_area - Q1_area

# Calculate the IQR for Area and Production
Q1_area = df2['Area'].quantile(0.25)
Q3_area = df2['Area'].quantile(0.75)
IQR_area = Q3_area - Q1_area

Q1_production = df2['Production'].quantile(0.25)
Q3_production = df2['Production'].quantile(0.75)
IQR_production = Q3_production - Q1_production

# Define outlier boundaries for 'Area' and 'Production'
lower_bound_area = Q1_area - 1.5 * IQR_area
upper_bound_area = Q3_area + 1.5 * IQR_area

lower_bound_production = Q1_production - 1.5 * IQR_production
upper_bound_production = Q3_production + 1.5 * IQR_production

# Remove outliers
df2 = df2[(df2['Area'] >= lower_bound_area) & (df2['Area'] <= upper_bound_area) &
     (df2['Production'] >= lower_bound_production) &
     (df2['Production'] <= upper_bound_production)]


df2.to_csv("Crop_Production_Data_Cleaned.csv", index = False)
```

Data Visualization

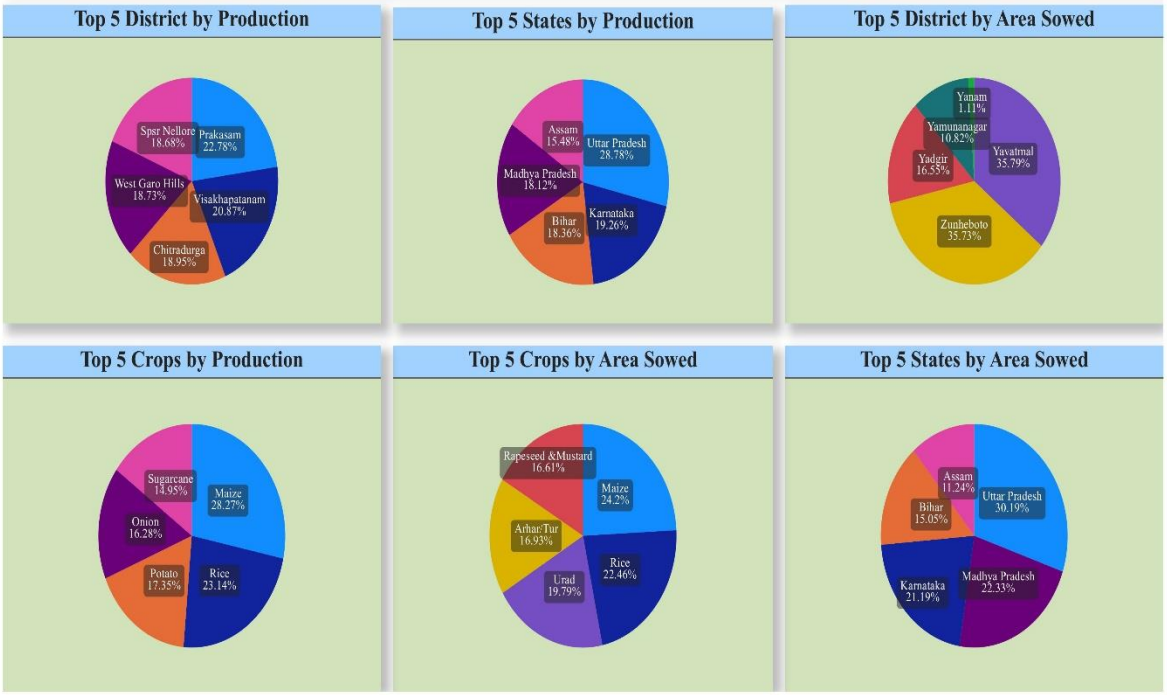
1. **Tool used:** Power BI.
2. Data obtained from data cleaning was loaded into Power BI.
3. Many cards, slicers, bar chart, pie chart, stacked bar chart, tables, column chart, map was used.
4. Slicer was synced to all pages so when slicer is used in 1st page data automatically changes in all pages.
5. Images of visualization are displayed below:




Crop Production Analysis
Ask a question about your data
Try one of these to get started
top state names by total crops
top state names by total districts
what is the total crops by state name
what is the total districts by state name
top state names by total production by state
what is the total production by state by state name
top crops by total districts
what is the total crops by season
top district names by total districts
PAKISTAN
INDIA
NEPAL
BHUTAN
BANGLADESH
MYANMAR
LAOS
THAILAND
TIBET
Bay of Bengal
Andaman Sea


Crop Production Analysis
Area & Production by District
Sum of Area
Sum of Production
District_Name
Chitradurga 48.51% 51.49%
Hassan 50.08% 49.92%
Koppal 51.82% 48.18%
Bellary 51.05% 48.95%
Chikmagalur 46.75% 53.25%
Belgaum 44.92% 55.08%
Visakhapatanam 40.70% 59.30%
Aurangabad 48.69% 51.31%
0%
50%
100%
Sum of Area and Sum of Production
Area & Production by State
State_Name
Uttar Pradesh 42.73% 57.27%
Madhya Pradesh 46.70% 53.30%
Karnataka 43.89% 56.11%
Maharashtra 54.72% 45.28%
Bihar 36.83% 63.17%
Odisha 46.57% 53.43%
Tamil Nadu 41.74% 58.26%
Gujarat 41.64% 58.36%
Area & Production by Crop
Crop
Maize 35.17% 64.83%
Rice 38.09% 61.91%
Urad 68.07% 31.93%
Arhar/Tur 56.95% 43.05%
Rapeseed &M... 55.39% 44.61%
Groundnut 44.48% 55.52%
Sesamum 73.56% 26.44%
Jowar 49.67% 50.33%
Area & Production by Crop Year
Sum of Area and Sum of Pro...
40M
30M
20M
10M
0M
1995
2000
2005
2010
2015
Crop_Year
Area & Production by Season
Sum of Area and Sum ...
100%
50%
0%
Kharif
Rabi
Whole Year
Summer
Autumn
Winter
Season

Crop Production Analysis



Crop Production Analysis

State Wise Crop Wise Production

State_Name	Arcanut (Processed)	Arecanut	Arhar/Tur	Atcanut (Raw)	Bajra	B
Andaman And Nicobar Islands		18.69%	0.04%			3
Andhra Pradesh		0.02%	1.14%		3.57%	
Arunachal Pradesh						
Assam		4.25%	0.38%			1
Bihar			2.99%		0.19%	
Chandigarh			0.14%			
Chhattisgarh			4.28%		0.01%	
Dadra And Nagar Haveli			9.06%			
Goa		1.11%				1
Gujarat			2.72%		9.02%	
Haryana			4.65%		11.01%	
Himachal Pradesh			0.03%		0.06%	
Jammu And Kashmir			0.00%		2.35%	
Jharkhand			6.32%			
Karnataka	0.07%	2.75%	2.42%	0.19%	0.77%	
Kerala		9.06%	0.06%			2
Madhya Pradesh			5.59%		1.63%	
Maharashtra			3.63%		1.93%	
Manipur			0.00%			2
Meghalaya		5.04%	0.25%			1
Mizoram			0.12%			
Nagaland			1.03%		0.39%	
Total	**0.01%**	**0.96%**	**2.96%**	**0.02%**	**2.40%**	

District Wise Crop Wise Production

District_Name	Arcanut (Processed)	Arecanut	Arhar/Tur	Atcanut (Raw)	Bajra	Banana	B
24 Paraganas North		4.45%	0.04%				
24 Paraganas South		1.63%	0.36%				
Adilabad			0.81%		0.79%	1.48%	
Agar Malwa			2.43%		0.01%		
Agra			9.49%				2
Ahmadabad			4.47%		13.95%	7.98%	
Ahmednagar			2.73%		0.22%	1.44%	
Aizawl			0.19%				
Ajmer			0.01%				3
Akola			0.16%		3.91%		
Alappuzha		2.95%				13.49%	
Aligarh			12.19%			0.12%	1
Alirajpur			2.96%				
Allahabad			2.79%			0.37%	2
Almora			0.04%				1
Alwar			8.13%				
Ambala			0.38%		0.30%		
Ambedkar Nagar			14.29%		0.56%	0.30%	1
Amethi			7.11%		2.20%	0.02%	1
Amravati			0.20%		1.23%		
Amreli			1.83%		8.40%	1.14%	
Amritsar			4.97%		0.93%		
Total	**0.01%**	**0.96%**	**2.96%**	**0.02%**	**2.40%**	**3.70%**	

Crop Production Analysis

State Wise Crop Wise Area Sowed

State_Name	Arcanut (Processed)	Arecanut	Arhar/Tur	Atcanut (Raw)	Bajra	B
Andaman And Nicobar Islands		39.13%	0.37%			1
Andhra Pradesh		0.04%	4.71%		4.99%	
Arunachal Pradesh						
Assam		9.48%	0.99%			
Bihar			3.72%		0.31%	
Chandigarh			0.70%			
Chhattisgarh			6.99%		0.02%	
Dadra And Nagar Haveli			12.17%			
Goa		1.78%				
Gujarat			4.53%		8.00%	
Haryana			8.73%		12.63%	
Himachal Pradesh			0.20%		0.19%	
Jammu And Kashmir			0.00%		3.75%	
Jharkhand			7.00%			
Karnataka	0.06%	0.95%	6.02%	0.04%	1.35%	
Kerala		16.32%	0.07%			
Madhya Pradesh			9.58%		2.09%	
Maharashtra			5.34%		3.01%	
Manipur			0.01%			
Meghalaya		9.14%	0.67%			
Mizoram			0.19%			
Nagaland			2.18%		0.66%	
Total	**0.01%**	**1.08%**	**5.40%**	**0.00%**	**2.87%**	

District Wise Crop Wise Area Sowed

District_Name	Arcanut (Processed)	Arecanut	Arhar/Tur	Atcanut (Raw)	Bajra	Banana	Ba
24 Paraganas North		3.16%	0.07%				
24 Paraganas South		1.70%	0.46%				0
Adilabad			1.93%		1.53%	0.09%	
Agar Malwa			7.41%		0.02%		1
Agra			13.50%				17
Ahmadabad			6.84%		7.34%	0.17%	
Ahmednagar			5.27%		0.23%	0.01%	
Aizawl			0.19%				
Ajmer			0.02%				12
Akola			0.16%		8.52%		
Alappuzha		12.45%				3.26%	
Aligarh			13.93%			0.00%	7
Alirajpur			5.09%				0
Allahabad			1.72%			0.01%	18
Almora			0.09%				21
Alwar			11.66%				
Ambala			0.70%		0.72%		
Ambedkar Nagar			14.26%		0.42%	0.01%	4
Amethi			9.81%		1.85%	0.00%	4
Amravati			0.15%		1.86%		
Amreli			3.18%		8.63%	0.02%	
Amritsar			6.72%		1.13%		
Total	**0.01%**	**1.08%**	**5.40%**	**0.00%**	**2.87%**	**0.38%**	**2**

Crop Production Analysis

Percent of Area Sowed by State

State_Name	%GT Sum of Area
Uttar Pradesh	13.44%
Madhya Pradesh	9.94%
Karnataka	9.43%
Maharashtra	7.46%
Bihar	6.70%
Odisha	5.40%
Tamil Nadu	5.37%
Gujarat	5.02%
Assam	5.00%
Rajasthan	4.53%
Andhra Pradesh	4.31%
Chhattisgarh	3.72%
West Bengal	3.36%
Telangana	2.78%
Kerala	2.17%
Uttarakhand	1.75%
Haryana	1.57%
Arunachal Pradesh	1.31%
Total	100.00%

Percent of Production by State

State_Name	%GT Sum of Production
Uttar Pradesh	13.06%
Karnataka	8.75%
Bihar	8.33%
Madhya Pradesh	8.23%
Assam	7.03%
Andhra Pradesh	5.46%
Tamil Nadu	5.43%
Gujarat	5.10%
Odisha	4.49%
Maharashtra	4.47%
West Bengal	3.79%
Rajasthan	3.55%
Telangana	2.64%
Kerala	2.62%
Haryana	2.21%
Chhattisgarh	2.19%
Uttarakhand	2.06%
Nagaland	1.88%
Total	100.00%

Deatiled Report

State_Name	District_Name	Sum of Area	Sum of Production
Andaman And Nicobar Islands	Nicobars	17020	25443
Andaman And Nicobar Islands	North And Middle Andaman	32754	106929
Andaman And Nicobar Islands	South Andamans	35416	124582
Andhra Pradesh	Anantapur	717168	1356986
Andhra Pradesh	Chittoor	727771	1212210
Andhra Pradesh	East Godavari	480743	1076457
Andhra Pradesh	Guntur	718472	1498617
Andhra Pradesh	Kadapa	793957	1315086
Andhra Pradesh	Krishna	722743	1435352
Andhra Pradesh	Kurnool	817988	1167251
Andhra Pradesh	Prakasam	1081990	1891972
Andhra Pradesh	Spsr Nellore	851239	1551112
Andhra Pradesh	Srikakulam	727988	1428085
Andhra Pradesh	Visakhapatanam	1189497	1732904
Andhra Pradesh	Vizianagaram	873741	1252153
Andhra Pradesh	West Godavari	551954	1000397
Total		237904671	328116252

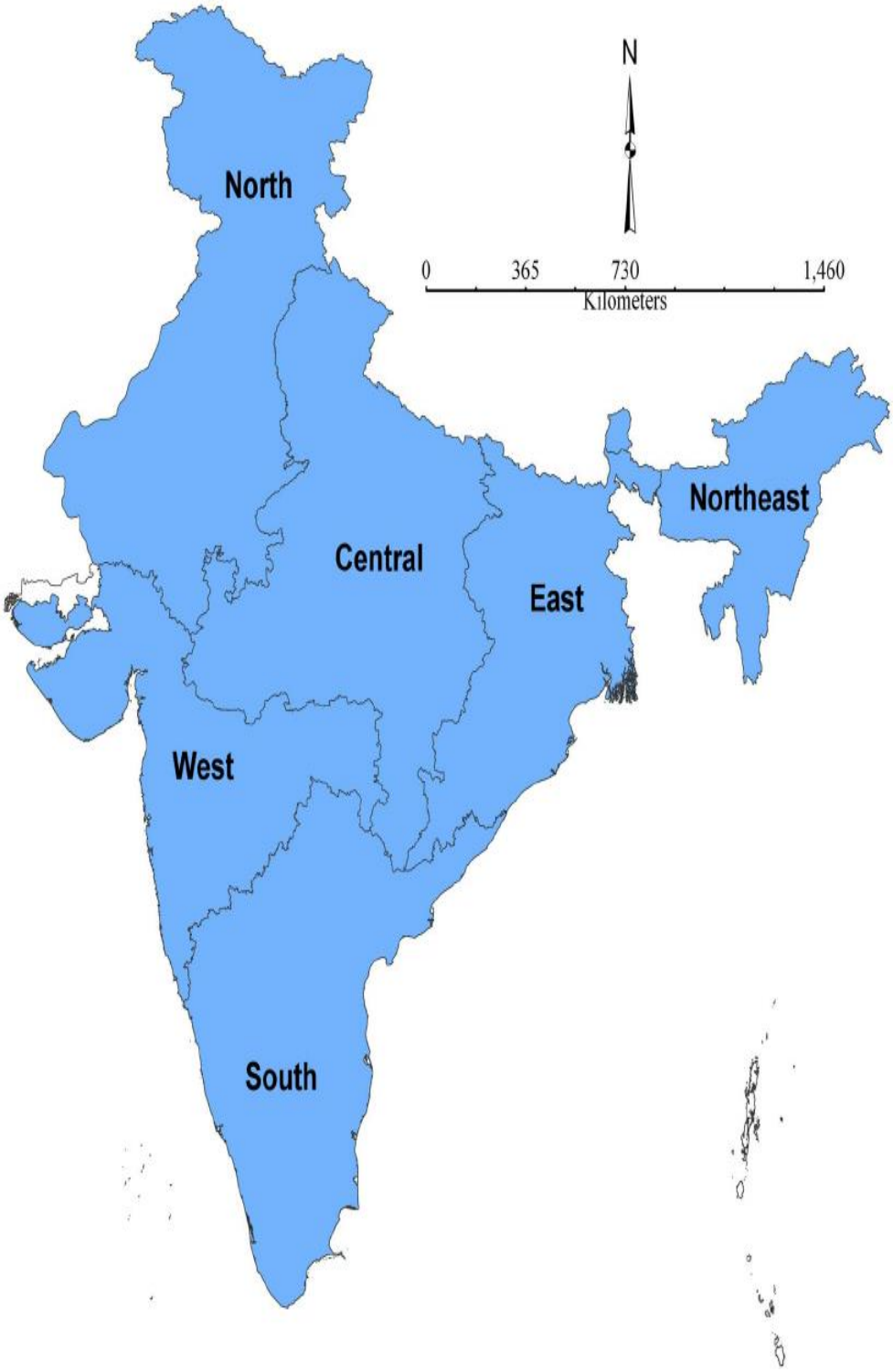
Insights Generated

1. Total crop production across all regions: 238M units.
2. Total area sown across all regions: 328M units.
3. Total district across all over India: 646 districts.
4. Total crops grown in India: 105 crops.
5. Year with highest crop production: 2003.
6. Year with lowest crop production: 2015
7. Year with highest area sown: 2003.
8. Year with lowest area sown: 2015
9. Highest produced crop in India: Maize.
10. Lowest produced crop in India: Bitter Gourd
11. Highest produced Region in India: Uttar Pradesh.
12. Lowest produced Region in India: Chandigarh.
13. In which season was highest crop was produced: Kharif.
14. In which season lowest crop was produced: Winter.
15. Top 5 state with highest production: UP, Karnataka, Bihar, MP, Assam.
16. Top 5 district with highest production: Prakasam, Visakhapatanam, Chitradurga, West Garo Hills, Spsr Nellore.
17. Top 5 crops with highest production: Maize, Rice, Potato, Onion, Sugarcane.
18. Top 5 state with highest area sowed: UP, MP, Karnataka, Bihar, Assam.
19. Top 5 district with highest area sowed: Yavatmal, Zunheboto, Yadgir, Yamunanagar, Yanam.
20. Top 5 crops with highest area sowed: Maize, Rice, Urad, Arhar/Tur, Rapseed & Mustard.
21. Seasonal Analysis:

	Kharif	Rabi	Autumn	Winter	Whole year	Summer
Highest produced crop	Maize	Barley	Rice	Rice	Sugarcane	Rice
Highest produced state	UP	UP	Assam	Odisha	MP	Bihar
Year with highest production	2003	2002	2014	2007	2003	2011
Year with highest area sown	2003	2011	2007	2005	2009	2011
Total crops grown	82	68	25	28	83	31
Total area sown	110M	73M	8M	4M	29M	14M
Total crop production	113M	85M	11M	6M	90M	24M
Regions of crop production	India	India	North East	Odisha &NE& Kerala	India	Region beyond vindya range

22. Regional analysis:

Geographically India is divided into 6 regions they are as follows:



	South	North	West	East	Central	NE
States & UT's	Andhra Pradesh, Telangana, Tamil Nadu, Kerala, Karnataka, Puducherry, Lakshadweep	Jammu and Kashmir, Ladakh, Himachal Pradesh, Punjab, Uttarakhand, Haryana, Delhi, Chandigarh	Maharashtra, Gujarat, Rajasthan, Goa, Dadra and Nagar Haveli and Daman and Diu	Odisha, West Bengal, Jharkhand, Bihar, Andaman and Nicobar Islands	Madhya Pradesh, Chattisgarh	AP. Mizoram, Tripur, Meghalaya, Manipur, Nagaland, Sikkim, Assam
Top 5 crops	Rice, Maize, Groundnut, Onion, Banana	Potatao, Barley, Rice, Maize, Rapseed & Mustard	Groundnut, Maize, Rice, Jowar, Sugarcane	Maize,Rice,Sugarcane, Potato, Onion	Potato, Onion, Maize, Sugarcane, Jowar	Rice, Potato, Sugarcane, maize, banana.
Total Crops	83	53	56	52	47	85
Total District	102	91	97	113	78	96
Total Area sown	58M	13M	41M	39M	32M	23M
Total crop production	83M	22M	44M	58M	34M	45M
Year with highest production	2003	2003	2003	1999	2012	2014
Year with highest area sown	2002	2002	2003	1999	2013	2014
Highest producing region	Karnataka	Haryana	Gujarat	Bihar	Madhya Pradesh	Assam
Lowest Producing region	Puducherry	Chandigarh	Dadra & Nagar Haveli	Andaman and Nicobar islands.	Chhattisgarh	Mizoram

23. Crop wise analysis:

	Maize	Rice	Potato	Onion	Sugarcane
Year with highest production	2013	2005	2008	2003	2009
Year with highest area sowed	2002	2005	2008	2002	2007
Highest producing state	Bihar	Assam	MP	UP	MP
Area sowed	18M	17M	2M	2M	623K
Highest producing District	Banka	Kottayam	Golaghat	Chamrajanagar	Lakhimpur
Production volume	34M	28M	21M	20M	18M
Total districts where crop is grown	542	446	450	486	368

Decision Making

- India witness most crop production in kharif & rabi season.
- Crops are grown all over India during kharif and rabi season.
- Crop Production and area sown are decreasing continuously since it peaked in 2003.
- Winter witness the lowest crop production in India and odisha, kerala and NE are the regions where crops are grown during this period.
- Major crops grown in India are maize, rice, potato, onion, sugarcane.
- Maize is grown extensively all over India with Bihar being the highest produced state and Banka being most maize producing region and almost 542 district grow maize all over India.
- Southern India stands number 1 in highest crop production where rice and maize are extensively grown & Karnataka ranks top in crop production.
- Rice and potato is grown extensively in NE region with assam state being the most produced state in north east.
- Karnataka, Haryana, Gujarat, Bihar, MP, Assam are the highest producing state in south, north, west, east, central, NE Regions of India.

Conclusion

- Implement advance AI & IOT in agriculture field to enhance production.
- Conduct workshops to help farmers for utilizing scientific instruments on fields.
- Promote and practice organic and sustainable farming.
- Regularly conduct market research to find and solve arising problems.
- Help farmers with knowledge on soil, water and weather impact on crops and how crop rotation is useful in production.
- Diversify crop production.
- Help farmers with government policies and let no farmer be untouched with government policies.
- Improve supply chain management so that no crop goes to waste.
- Make use of GPS to monitor fields and data analytics to optimize field level management.