

Report On

Crop Production Analysis in India: Trends Across States and Seasons

Submitted in partial fulfillment of the requirements of the Course Project for
Deep Learning in Semester VII of Fourth Year Artificial Intelligence &
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by
Omkar Bhikle (Roll No. 3)
Aditya Biradar (Roll No.4)

Under the guidance
Prof. Bhavika Gharat



University of Mumbai

Vidyavardhini's College of Engineering & Technology

Department of Artificial Intelligence and Data Science



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Vidyavardhini's College of Engineering and Technology
Department of Artificial Intelligence & Data Science

CERTIFICATE

This is to certify that the project entitled “Crop Production Analysis in India: Trends Across States and Seasons” is a bonafide work of Omkar Bhikle (Roll No.3), Aditya Biradar (Roll No.4) submitted to the University of Mumbai in partial fulfillment of the requirement for the Course project in semester VII of Fourth Year Artificial Intelligence and Data Science engineering.

Prof. Bhavika Gharat

Abstract

Agriculture plays a pivotal role in India's economy, supporting the livelihoods of millions of people and contributing significantly to the nation's GDP. This project focuses on a detailed analysis of crop production data from various states and districts in India, aiming to derive insights about the country's agricultural output over time. The dataset analyzed includes information about the state, district, crop year, season, crop type, area under cultivation, and production quantity.

By leveraging data analysis tools such as Pandas, Matplotlib, and Seaborn, this report explores state-wise, crop-wise, and seasonal trends in crop production. The findings offer valuable insights into key agricultural regions, trends over time, and the impact of different seasons on production. This project is not only useful for policymakers and agricultural bodies but also for farmers and researchers interested in optimizing crop yield and land utilization.

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1. Introduction

India's agriculture sector is known for its diversity in terms of crops, seasons, and cultivation techniques. With over half of the country's population depending on agriculture for their livelihood, understanding the factors that influence crop production is essential. India is divided into various agro-climatic zones, and each zone supports different types of crops, which are influenced by factors such as climate, soil type, and available resources.

In this report, we delve into a dataset containing comprehensive information on crop production across India. The dataset consists of key variables like:

- **State_Name:** The state in which the crop production data was recorded.
- **District_Name:** The specific district within the state where the data was collected.
- **Crop_Year:** The year in which the crop was harvested.
- **Season:** The agricultural season during which the crop was grown (Kharif, Rabi, etc.).
- **Crop:** The type of crop that was cultivated.
- **Area:** The total land area used for cultivating the crop.
- **Production:** The total quantity of the crop produced from the specified area.

By analyzing this dataset, we aim to answer important questions about agricultural production, such as:

1. Which states and districts are the leading producers of certain crops?
2. How does crop production vary across different seasons?
3. What trends can be observed in crop production over the years?
4. Which crops are the most commonly produced, and how does their production compare across regions?

This report explores these questions, providing a clear picture of the status of agriculture in India.

2. Problem Statement

India's agriculture sector, despite being vast, faces numerous challenges such as uneven rainfall distribution, lack of modern farming techniques in many regions, and inefficient resource allocation. Additionally, agricultural practices are highly dependent on seasons, leading to substantial variations in crop production. The lack of data-driven decision-making often results in inefficiencies that hinder the country's overall agricultural output.

The following problems are addressed in this report:

1. **Regional Disparities:** Identifying which states and districts are the most productive and which regions need more attention for growth.
2. **Seasonal Variations:** Understanding how different agricultural seasons impact the production of various crops.
3. **Time-based Analysis:** Identifying long-term trends in crop production and determining whether production is increasing or decreasing over time.
4. **Crop Dominance:** Investigating which crops are most commonly produced and how production varies across regions.

By analyzing crop production data, this report seeks to provide insights that could help in improving crop yield, optimizing land use, and ensuring better resource allocation in Indian agriculture.

3. Proposed System

The system for this project is designed to analyze large-scale crop production data and derive insights through a step-by-step approach. The workflow involves cleaning and preparing the data, followed by analysis using data grouping, summarization, and visualization techniques. The system also includes a module for handling missing data and generating informative plots to identify trends and outliers in the dataset.

3.1 Data Analysis Workflow Description

The following steps outline the data analysis workflow:

1. **Data Loading and Cleaning:** The dataset, provided in CSV format, is imported using the pandas library. Data cleaning steps include filling missing values in critical columns such as 'Production' and converting data types for numerical analysis.
2. **Exploratory Data Analysis (EDA):** EDA is performed to understand the structure of the data, using descriptive statistics and checking for missing or anomalous values. We explore the distribution of data across states, districts, crop types, and seasons.
3. **Grouping and Summarization:** Grouping the data by relevant categories (state, crop, year, season) helps in identifying production trends and key contributors to crop yield. We calculate the total and median production for each category to draw meaningful insights.
4. **Visualization:** Using the matplotlib and seaborn libraries, visualizations are created to identify top-performing states, crops, and districts. Bar plots and line plots are employed to analyze both temporal and regional trends in production.

3.2 Module Description

1. **State-wise Production Analysis:** The dataset is grouped by the State_Name column to calculate the total crop production for each state. This helps in identifying the states

that contribute the most to India's overall agricultural output. Visualizing this data using bar plots provides a clear comparison of crop production across different states.

2. **Crop-wise Production Analysis:** By grouping the data based on the Crop column, we can determine the most produced crops and their total production. This analysis helps in identifying staple crops like rice, wheat, and sugarcane, which dominate India's agricultural landscape.
3. **Year-wise Production Trends:** The Crop_Year column is used to analyze production over time, allowing us to detect any upward or downward trends in agricultural output. This analysis can be crucial for understanding the long-term effects of climate change, government policies, and farming practices on crop production.
4. **Seasonal Variation Analysis:** Grouping the data by the Season column reveals how different seasons affect crop production. The Kharif season, which relies heavily on monsoon rains, and the Rabi season, which depends on winter irrigation, are compared to see how they contribute to total production.

4. Implementation Plan Details

The implementation of this project followed a phased approach:

1. **Data Preprocessing:** The dataset was first cleaned to handle missing values and ensure all data types were correctly formatted for analysis. This involved filling null values in the 'Production' column and converting it to numeric form.
2. **Exploratory Data Analysis (EDA):** Initial exploration helped in understanding the distribution of data and identifying patterns. Summary statistics were generated to get an overview of crop production across various states and crops.
3. **Visualization and Analysis:** Key trends were identified through bar plots, line plots, and other visualizations that compared crop production across states, districts, and seasons.

5. Implementation Results and Analysis

The results of the analysis provide several key insights into India's crop production patterns. These insights are represented through data visualizations that highlight trends across regions, crops, and time periods.

5.1 Data Visualizations and Insights

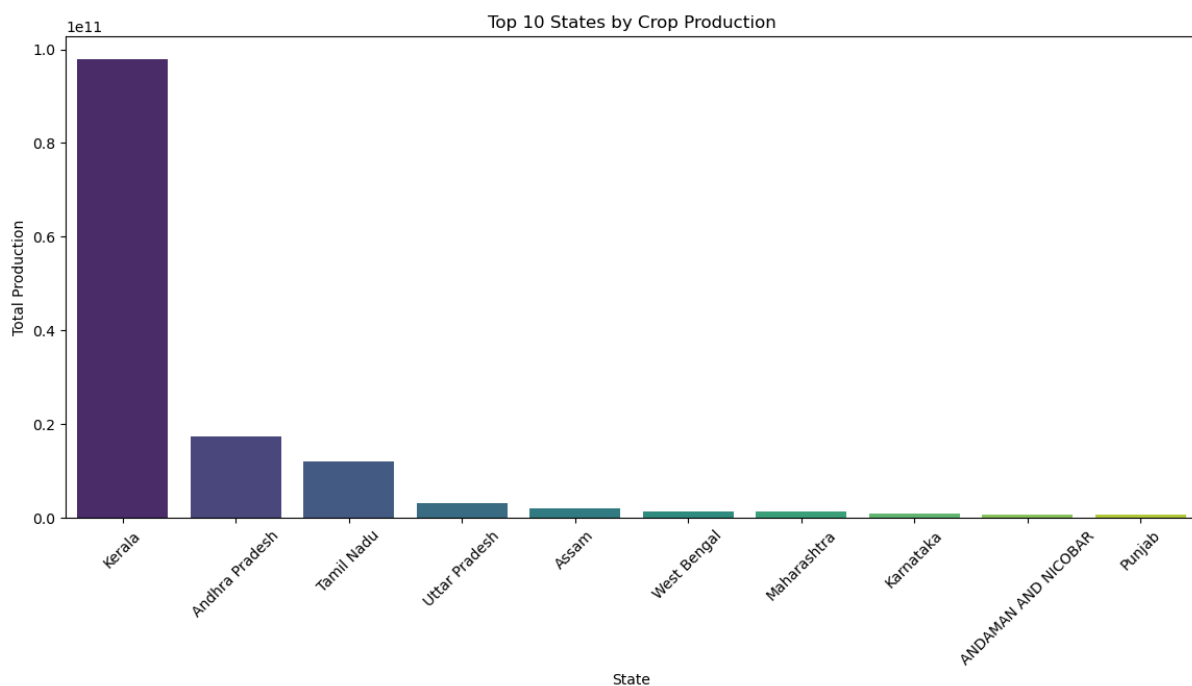


Fig 1: Top 10 states by crop production

This plot shows the top 10 states in terms of total crop production. States like Uttar Pradesh, Punjab, and Maharashtra rank high in overall output due to their favorable agricultural conditions and large areas of arable land.

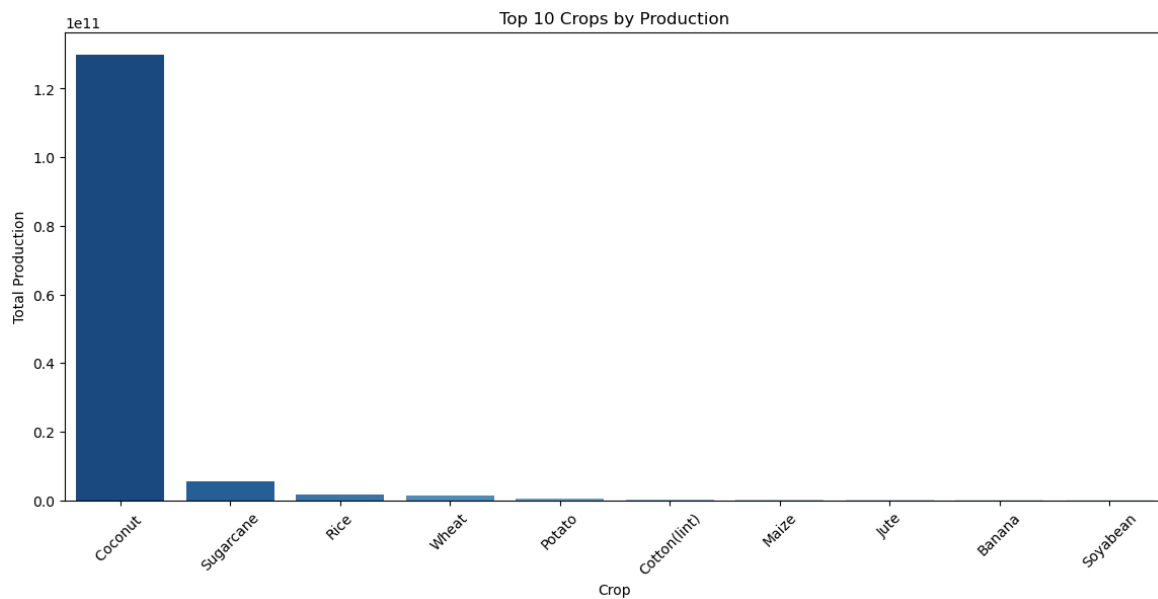


Fig 2: Top 10 crops by production

Staple crops such as rice, wheat, and sugarcane emerge as the dominant crops across India. These crops are essential for the country's food security and also have a strong export value.

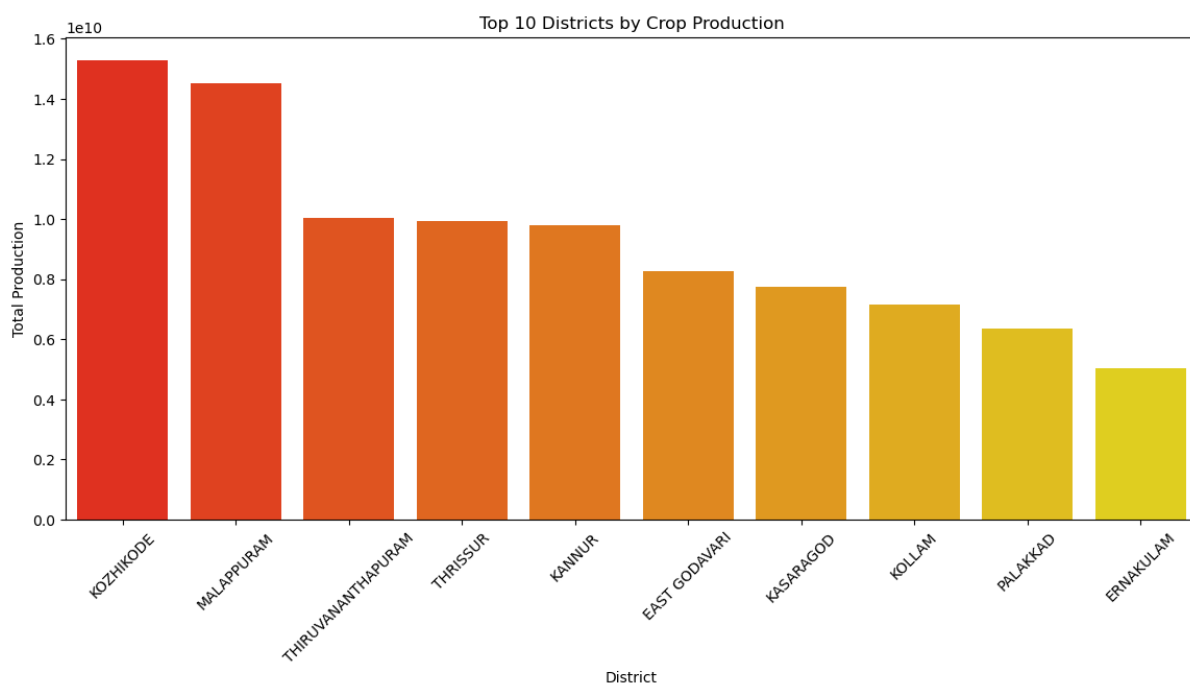


Fig 3: Top 10 districts by crop production

This analysis identifies districts that are key contributors to India's agricultural production. Districts in states like Punjab, Haryana, and Andhra Pradesh dominate the rankings.

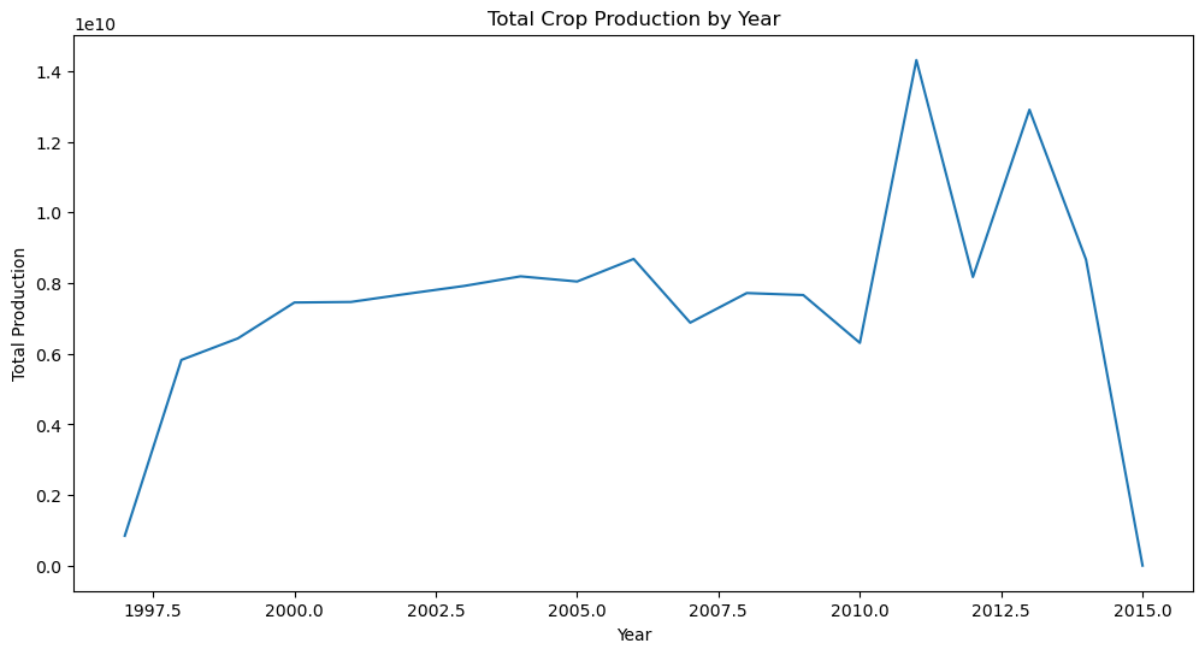


Fig 4: Total crop production by year.

The year-wise trend analysis reveals how crop production has fluctuated over time, reflecting the impact of factors such as rainfall patterns, government policies, and technological advancements in farming.

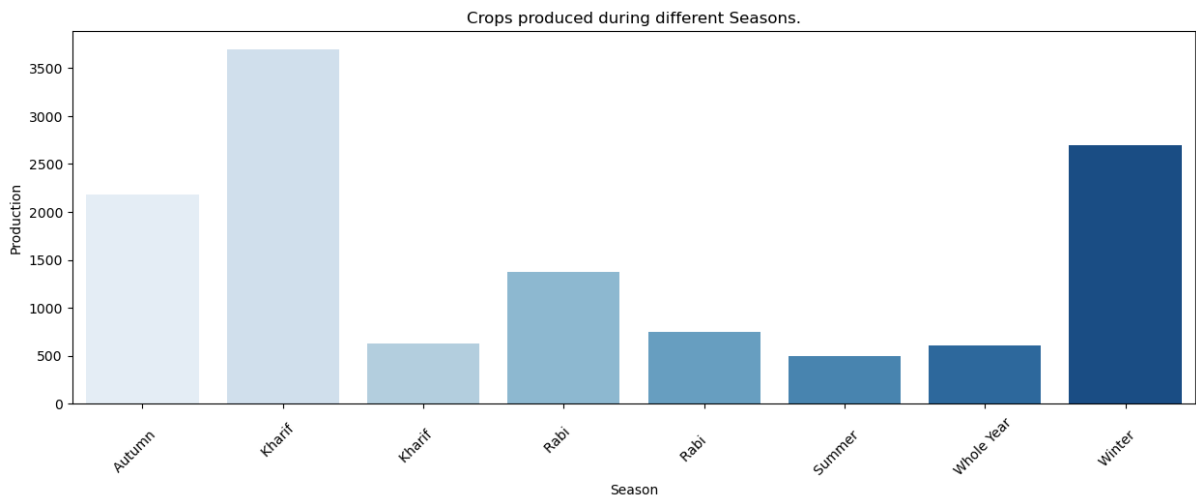


Fig 5: Crops produced during seasons.

Seasonal variations play a crucial role in determining crop output. This plot compares production across different agricultural seasons, revealing the dominance of Kharif crops during the monsoon season.

6. Conclusion

The analysis of crop production data in India underscores the significant disparities in agricultural output across various states and districts. States like Uttar Pradesh and Punjab stand out as leaders in crop production, thanks to their fertile lands and effective irrigation systems. However, regions in the northeastern part of the country show lower production levels, suggesting a need for targeted interventions to enhance agricultural practices and infrastructure in those areas.

Our examination of crop types reveals that staple crops such as rice and wheat are central to India's agricultural economy. These crops thrive in their respective growing seasons, indicating the critical role of weather patterns in determining production outcomes. Notably, years marked by irregular rainfall highlight the vulnerability of agriculture to climate change, emphasizing the necessity for sustainable farming practices and improved water management to safeguard future yields.

Overall, this report provides valuable insights that can inform policymakers and agricultural stakeholders about the current state of crop production in India. By understanding regional strengths and weaknesses, the aim should be to foster a more equitable agricultural landscape that optimizes production and addresses food security challenges.

7. Code

```
#!/usr/bin/env python
# coding: utf-8

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

# Load the dataset
df = pd.read_csv('./Crop Production data.csv')

# Display the dataframe structure and check for missing values
print(df.columns)
print(df.isnull().sum())

# Fill missing production values with zero and convert to numeric
df['Production'] = df['Production'].fillna(0)
df['Production'] = pd.to_numeric(df['Production'], errors='coerce')

# Drop rows with null production values
df.dropna(subset=['Production'], inplace=True)

# Summary statistics
print(df.info())
print(df.describe())

# State-wise production analysis
state_production =
df.groupby('State_Name')['Production'].sum().sort_values(ascending=False).reset_index()

plt.figure(figsize=(14, 6))
```

```

sns.barplot(data=state_production.head(10),      x='State_Name',      y='Production',
palette='viridis')
plt.title('Top 10 States by Crop Production')
plt.xlabel('State')
plt.ylabel('Total Production')
plt.xticks(rotation=45)
plt.show()

```

Crop-wise production analysis

```

crop_production                                     =
df.groupby('Crop')['Production'].sum().sort_values(ascending=False).reset_index()
plt.figure(figsize=(14, 6))
sns.barplot(data=crop_production.head(10),      x='Crop',      y='Production',
palette='Blues_r')
plt.title('Top 10 Crops by Production')
plt.xlabel('Crop')
plt.ylabel('Total Production')
plt.xticks(rotation=45)
plt.show()

```

District-wise production analysis

```

district_production                                     =
df.groupby('District_Name')['Production'].sum().sort_values(ascending=False).reset_index()
plt.figure(figsize=(14, 6))
sns.barplot(data=district_production.head(10),  x='District_Name',  y='Production',
palette='autumn')
plt.title('Top 10 Districts by Crop Production')
plt.xlabel('District')
plt.ylabel('Total Production')
plt.xticks(rotation=45)
plt.show()

```

Overall distribution of the top 10 crops

```

crop_counts = df['Crop'].value_counts().head(10)
plt.figure(figsize=(10, 6))
plt.bar(crop_counts.index, crop_counts.values, color='gold', edgecolor='black')
plt.title('Overall Distribution of the Top 10 Crops Produced in India', fontsize=12)
plt.xticks(rotation=90)
plt.xlabel('Name of the Crop')
plt.ylabel('Total Count')
plt.show()

```

```

# Total crop production by year
plt.figure(figsize=(12, 6))
production_by_year = df.groupby('Crop_Year')['Production'].sum().reset_index()
sns.lineplot(data=production_by_year, x='Crop_Year', y='Production')
plt.title('Total Crop Production by Year')
plt.xlabel('Year')
plt.ylabel('Total Production')
plt.show()

```

```

# Crop production by season
groupby_crop = df.groupby("Season")["Production"].median().reset_index()
plt.figure(figsize=(15, 5))
sns.barplot(x=groupby_crop["Season"], y=groupby_crop["Production"],
palette='Blues')
plt.title("Crops Produced During Different Seasons")
plt.xlabel("Season")
plt.ylabel("Production")
plt.xticks(rotation=45)
plt.show()

```

```

# Production comparison across states (median)
state_median_production =
df.groupby("State_Name")["Production"].median().reset_index().head(25)
plt.figure(figsize=(20, 5))

```



```
sns.barplot(x=state_median_production["State_Name"],  
y=state_median_production["Production"], palette='plasma')  
plt.title("Median Production Comparison Across Different States", fontsize=20)  
plt.xlabel("State", fontsize=12)  
plt.ylabel("Production", fontsize=12)  
plt.xticks(rotation=45)  
plt.show()
```

References

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