

# A statistical analysis of COVID-19 on agricultural sector in Bhavnagar district

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## Abstract

**COVID-19** is a coronavirus-induced acute illness in humans that primarily manifests as fever and cough but can also produce severe symptoms and even death, particularly in older adults and those with underlying medical issues. In 2019, it was first discovered in China, and in 2020, it spread like wildfire. The COVID-19 pandemic severely disrupted the agricultural sector in Bhavnagar district, Gujarat, influencing production patterns, market stability, and farmer livelihoods. Bhavnagar is among Gujarat's districts with over 70% of their total area dedicated to cultivation. This research aims to analyze the **impact of COVID-19 on the agricultural sector of Bhavnagar** using comprehensive district-level data from **2018 to 2025**, capturing pre-pandemic, pandemic, and post-pandemic phases. Using secondary data from Bhavnagar Jilla Panchayat Gujarat Sarkar, the study employs statistical techniques including **t-test, ANOVA, Principal Component Analysis (PCA), and time-series analysis**, the research evaluates changes in area under cultivation, production fluctuations across fruits, vegetables and Masala. This study emphasizes the need for data-driven policy measures, technological innovation, and sustainable strategies to enhance agricultural resilience in Bhavnagar and similar agro-economic regions.

## Keywords:

*COVID-19, Agriculture, Bhavnagar, t-test, ANOVA, PCA, Time-Series Analysis, Crop Yield, Resilience, Policy Intervention*

## 1. Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that triggered the global COVID-19 pandemic, commonly referred to as the coronavirus pandemic, started with an outbreak in Wuhan, China, in December 2019. Early in 2020, it expanded to other

regions of Asia before going global. The COVID-19 pandemic has resulted in more than 7.08 million deaths globally as of February 2025, presenting a significant healthcare and scientific challenge in the twenty-first century. The agricultural sector remains the backbone of India's economy, contributing significantly to national GDP and providing livelihoods to a large share of the rural population. The Indian economy depends heavily on the agricultural and related sectors. It gives employment to around 50% of the workforce and makes up about 16% of the Indian economy. The agricultural sector's performance has a significant impact on accomplishments on numerous other fronts. However, the onset of the COVID-19 pandemic in early 2020 brought unprecedented challenges to this critical sector. Nationwide lockdowns, mobility restrictions, and disruptions in supply chains severely affected agricultural production, labor availability, input distribution, and market accessibility. The years 2020–2021 were unique because of supply-chain bottlenecks, labor migration disruptions, pandemic limitations, and shifts in input availability, which impacted crop sowing, harvesting, and marketability throughout India. During the lockdown and the first few months after it ended, there were short-term drops in some crop outputs, a restriction in market access, and a rise in post-harvest loss, according to a number of multi-method studies and phone surveys. These effects can manifest as sudden shifts in production figures from year to year. These challenges were particularly acute in regional economies such as Bhavnagar district in Gujarat, where agriculture forms a central component of socio-economic stability. This research examines the pandemic's impact using agricultural data from 2018 to 2025, encompassing pre-pandemic, pandemic, and post-pandemic periods. By quantifying the pandemic's effects and identifying patterns of recovery, this study contributes to a deeper understanding of agricultural resilience in the face of global crises.

## 2. Objectives of the Study:

The primary objective of this study is to analyze the impact of the COVID-19 pandemic on the agricultural sector of Bhavnagar district, focusing on crop productivity, market dynamics, and farmer livelihoods during the period 2018-2025. Specific objectives include:

1. **To compare** the agricultural performance of Bhavnagar during the pre-pandemic (2018-2019), pandemic (2020-2022), and post-pandemic (2023-2025) phases.
2. **To evaluate** the statistical significance of changes in crop yields (fruits, vegetables and Masala) within an area under cultivation using **t-test** and **ANOVA** methods.
3. **To identify** key variables influencing agricultural performance through **Principal Component Analysis (PCA)**.
4. **To analyze** temporal trends in production and price data using **Time-Series Analysis**, highlighting short-term disruptions and long-term recovery patterns.
5. **To suggest** policy recommendations and adaptive strategies for enhancing agricultural resilience against future crises.

## 2. Review of Literature

Venkata Reddy, P. Venkatta Subbaiah, Raja Narasimha, P.N. Siva Prasad and N. Rajasehkar (June, 2023), surveyed the data obtained through well designed scheduled interviews and analysed the impact of COVID-19 on Agriculture, Horticultural crops and Livestocks in Krishna District, India. 60 respondents were selected for study and statistics tools such as Arithmetic Mean, frequency distribution and percentage were used for the study. It was concluded that during the COVID-19 situations the total supply chain was damaged and the transport was banned inter and intrastates, districts that were all affected by the cost of produce and also lack of inputs. It could be concluded that 40% of marketing and 53.33% of them were production aspects from the farmer producer organization. The study recommended the government should boost the agricultural sector by giving the input subsidies.

Lindsay M Jaacks, Divya Veluguri, Rajesh Serupally, Aditi Roy, Poornima Prabhakaran and GV Ramanjaneyulu (May, 2021) conducted telephone interview surveys in 200 districts and 12 states in India between May 3 and May 15, 2020. The goal of this study is to assess the effects of the COVID-19 lockdown on India's agricultural output, livelihoods, food security, and dietary diversity. A total of 1437 farmers (94% male, 28% between the ages of 30 and 39, and 38% with secondary education) responded to

the poll. The four states with the greatest proportion of small/marginal farmers were: Bihar, Gujarat, Uttar Pradesh, and West Bengal. Punjab and Rajasthan had the greatest proportion of large farmers. It was concluded that small/marginal farmers and landless farmers were substantially more likely to be female, younger, unschooled, and self-report as members of a Scheduled Caste/Tribe or Other Backward Caste.

## 3. Research Methodology

### 3.1 Research Design

### 3.2 Variables

Types	Variables	Description
Independent Variable	Years under study	2018-2024
Dependent Variables	Production and Area of Fruits, Vegetables & Masala	Area in Hectares and Production in Tons

### 3.3 Models Applied

**Statistical Models:** ANOVA, t-test, Principal Components Analysis

**Tools used:** SPSS

## 4. Data Analysis and Results

To analyze the data for the Bhavnagar district (2018-2025), several statistical methods were applied, including descriptive statistics, trend analysis, correlation analysis, and productivity (yield) assessment.

### 4.1 Paired t-test Results (matched by Taluka)

Comparison	Variable	n (pairs)	t-statistic	p-value	Interpretation
2020-21 vs Before 2020	Total Area (Ha)	20	-0.694	0.496	No significant difference
2020-21 vs After 2021	Total Area (Ha)	30	-3.244	0.003**	Significant decrease after 2021
2020-21 vs Before 2020	Total Production (Ton)	20	0.509	0.617	No significant difference
2020-21 vs After 2021	Total Production (Ton)	30	-2.630	0.014*	Significant decrease after 2021

## Interpretation

Between 2020-21 and before 2020, both production and area were statistically similar ( $p > 0.05$ ).

Between 2020-21 and after 2021, both production and area under cultivation showed significant decreases ( $p < 0.05$ ).

## 4.2 Overview of Agricultural Growth (Trend Analysis)

The district has shown a steady increase in both cultivation area and production volume over the last seven years.

**Expansion of Land:** The total cultivated area for fruits, vegetables, and spices grew by approximately 43%, from 60,519 Ha in 2018-19 to 86,819 Ha in 2024-25.

**Production Surge:** Total production increased from 1.16 million tons to 1.70 million tons in the same period, indicating a robust upward trajectory in the district's agricultural output.

## 4.3 Crop Category Performance

**Vegetables:** This category is the primary driver of growth. Vegetable production nearly doubled, rising from 807,718 tons (2018-19) to over 1.4 million tons (2024-25).

**Fruits:** While the area under fruit cultivation remained significant, production peaked around 2019-20 (391,053 tons) and has since stabilized at a lower level (~272,000 tons).

**Masala (Spices):** Though a smaller portion of total agriculture, spice production saw a massive

percentage increase, growing from 1,758 tons to 9,681 tons.

## 4.4 Regional Contribution (Taluka-wise)

The analysis identifies specific Talukas as the agricultural powerhouses of Bhavnagar:

**Mahuva and Talaja:** These Talukas consistently lead in total production, particularly in the vegetable sector.

**Bhavnagar and Ghogha:** These regions also contribute significantly, showing high density in fruit cultivation.

## 4.5 Productivity and Yield Analysis

Yield (Production per Hectare) was calculated to measure efficiency:

**Average Total Yield:** The district maintains an average yield of 16.81 Ton/Ha.

**Vegetables:** Highest productivity at 20.57 Ton/Ha.

**Fruits:** Average yield of 13.09 Ton/Ha.

**Correlation:** There is a near-perfect positive correlation ( $>0.95$ ) between Area and Production for vegetables, suggesting that production increases are currently driven primarily by land expansion rather than just technological yield improvements.

The bar chart below depicts the total Agricultural Production Taluka-wise for each of the 10 talukas of Bhavnagar district. Mahuva is the highest Taluka with 2.6 ('000 tons) production and Valbhipur with the lowest production.

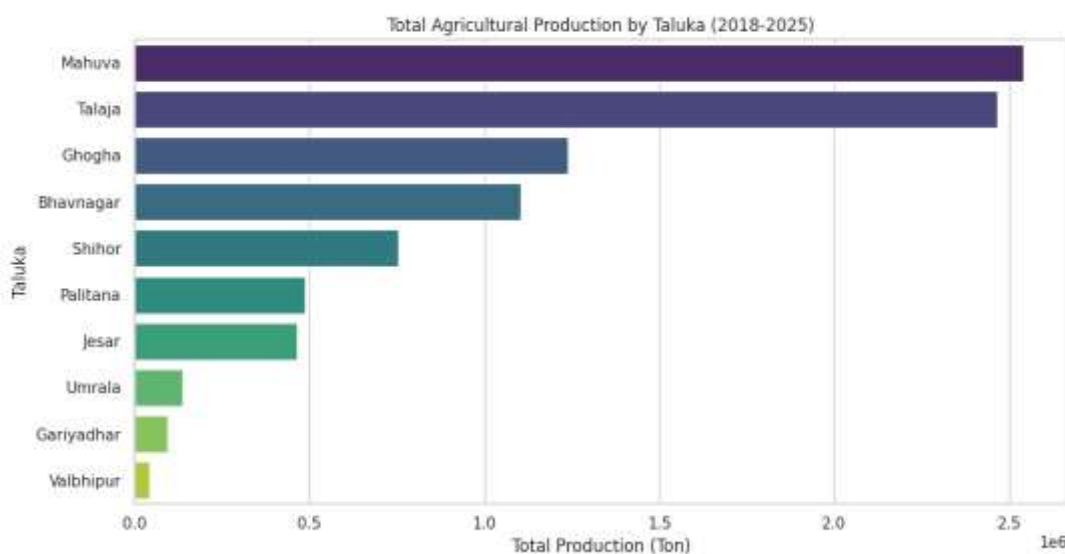


Fig. 1: Agricultural Production Taluka-wise (Bhavnagar District)

### Comparison of Area and Production Across Year Groups

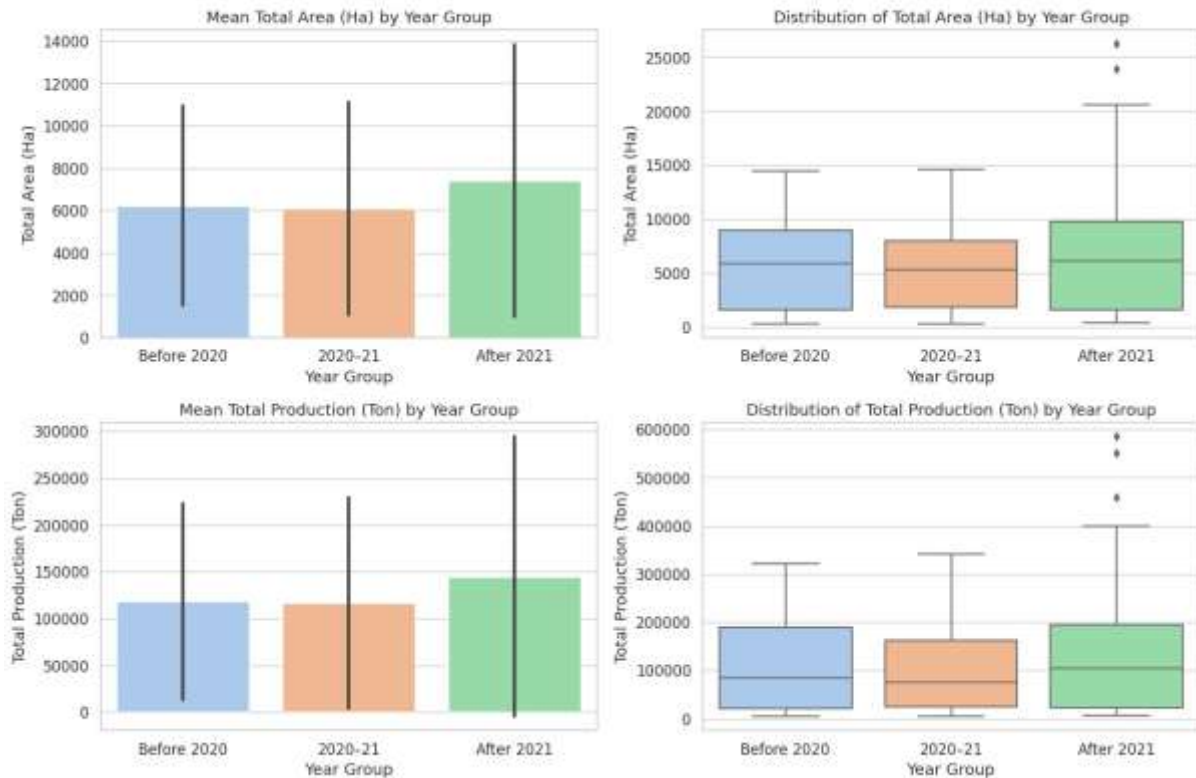


Fig. 2: Trends in Agriculture Area and Production (Bhavnagar)

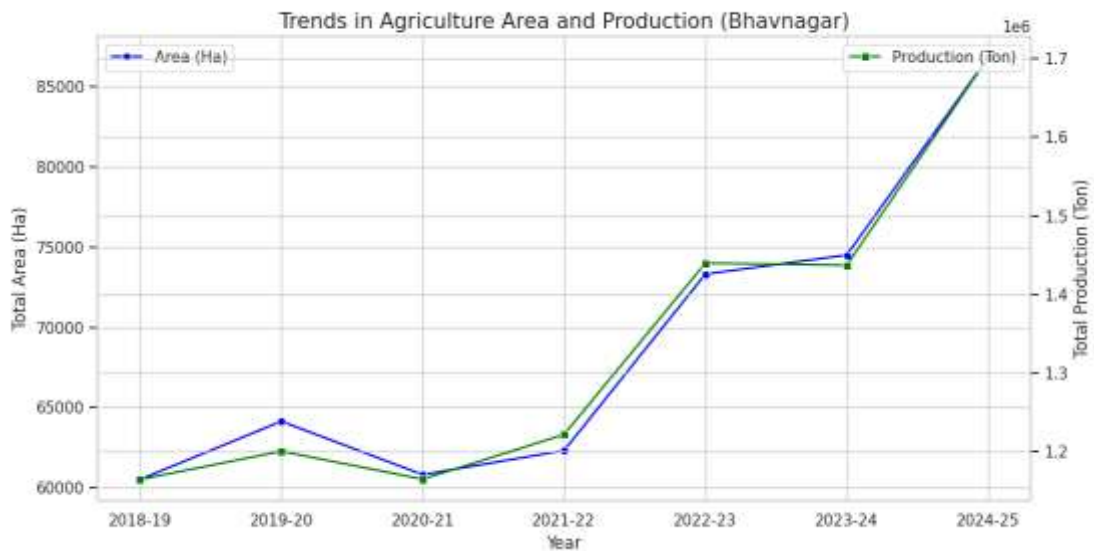


Fig. 3: Agricultural Area and Production Analysis

The above graphs indicate the trends in Agriculture Area and Production in Bhavnagar. It can be clearly noted that during the year 2020-2021 there

is a downfall (overall the lowest comparing all 7 years) in area as well as in production. There is a linear relationship between Area and Production. Gradually

with passing years there is a visible growth in production and area simultaneously.

#### Availability of Data

The data was collected from 'Jila ni Aankdakiya Ruprekha' from Ankada Sakha, Jila Panchayat Kacheri, Bhavnagar. Link for the above data: <https://bhavnagardp.gujarat.gov.in/gu/Publications>

### 5. Conclusions

The present study examined the impact of the COVID-19 pandemic on the agricultural sector of Bhavnagar district using district-level data from 2018 to 2025. The analysis incorporated statistical tools such as descriptive statistics, paired t-tests, and trend analysis to evaluate changes in cultivation area, production, and crop productivity across fruits, vegetables, and spices.

The findings reveal that although the COVID-19 pandemic caused short-term disruptions in agricultural activities during the year 2020-2021, the long-term performance of the agricultural sector in Bhavnagar district remained relatively stable. The paired t-test results indicated that there was no statistically significant difference in total cultivated area and production when comparing the pandemic year with the pre-pandemic period. However, comparisons with the post-pandemic period showed statistically significant differences, reflecting structural changes and adjustments in the agricultural system following the pandemic.

Trend analysis demonstrated that the district experienced a consistent increase in both cultivated area and total production during the study period. The cultivated area expanded substantially from 60,519 hectares in 2018-19 to 86,819 hectares in 2024-25, while total production increased from approximately 1.16 million tons to 1.70 million tons. Among the crop categories studied, vegetables emerged as the primary contributor to agricultural growth, while fruit production remained relatively stable and spice production showed notable percentage growth despite its smaller share.

Taluka-wise analysis highlighted Mahuva and Talaja as the leading agricultural regions in the district, contributing significantly to overall production, whereas Valbhipur recorded comparatively lower agricultural output. Productivity analysis showed that vegetables had the highest yield among the three crop categories, and a strong positive correlation between cultivated area and production suggests that the increase in production has largely been driven by expansion in cultivated land.

Overall, the study indicates that while the COVID-19 pandemic created temporary disruptions in agricultural activities, the agricultural sector of Bhavnagar district demonstrated resilience and

recovery in the post-pandemic years. These findings emphasize the importance of strengthening agricultural infrastructure, improving supply chain mechanisms, promoting technological adoption, and implementing supportive policy measures to enhance the sector's resilience against future crises.

In conclusion, data-driven planning and targeted policy interventions are essential to ensure sustainable agricultural development and to safeguard farmer livelihoods in Bhavnagar district and similar agro-economic regions.

### 6. Limitations of the Study

Despite providing useful insights into the impact of the COVID-19 pandemic on the agricultural sector of Bhavnagar district, the present study has certain limitations.

First, the study is based solely on secondary data obtained from Bhavnagar Jilla Panchayat, which may contain limitations related to data accuracy, reporting inconsistencies, or incomplete records.

Second, the study focuses only on three crop categories---fruits, vegetables, and spices (masala). Other important agricultural components such as cereals, oilseeds, livestock, and fisheries were not included.

Third, the research is limited to the Bhavnagar district, and therefore the findings may not be fully generalizable to other districts or states with different agricultural patterns, climatic conditions, or market structures.

Fourth, the study mainly uses quantitative statistical methods. Qualitative factors such as farmers' experiences, labor migration, input shortages, and supply chain disruptions during the pandemic were not directly captured in the analysis.

Finally, the time period considered (2018-2025) provides only a medium-term view of the pandemic's impact, and longer-term structural changes in agriculture may require further observation and analysis.

### 7. Future Scope of the Study

The present research opens several opportunities for further investigation in the field of agricultural economics and statistical analysis.

Future studies can expand the scope by including additional agricultural sectors such as cereals, oilseeds, livestock, and fisheries, which would provide a more comprehensive understanding of the overall agricultural economy.

Researchers may also conduct comparative studies across multiple districts or states to identify regional differences in the impact of the COVID-19 pandemic on agriculture. Such studies could help policymakers design region-specific agricultural policies.

Another important direction for future research is the inclusion of primary data through farmer surveys and field interviews. This would allow researchers to analyze farmers' perceptions, challenges faced during lockdowns, labor shortages, transportation issues, and changes in market access.

Advanced statistical and econometric models such as panel data analysis, regression models, forecasting models, and machine learning techniques could also be applied to better understand production dynamics and predict future agricultural trends.

Finally, future research can examine the role of technological adoption, digital agriculture, government support schemes, and supply chain innovations in strengthening agricultural resilience against global crises such as pandemics.

#### Declarations

**Conflict of Interest / Competing Interest:** The authors declared that they have no conflict of interest.

#### References

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