Growth Performance of Chilli in Major Producing States, India: Need for Technological Interventions to Augment Productivity

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Abstract

India is the largest producer of chilli in the world, plays a very important role in the global chilli production landscape. This paper is an attempt to analyses the growth performance of chilli in major producing states in India. Chilli is one of the most important commercial crops grown predominantly in the states of Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, West Bengal and Odisha. These six states account for >80 % of chilli production in the country. The data regarding area, production, and productivity were collected, which is available for major producing states, from 2011 to 2025, i.e., 14 years of data. The Analytical tools, such as CAGR(Compound Annual Growth Rate) and descriptive statistics. From the state-level analysis, it was found that the growth rate of chilli productivity was 3.27 per cent per annum in Andhra Pradesh and 3.35 per cent per annum in Telangana. It is clearly observed that the average productivity in Andhra Pradesh (4329 kg/ha) and Telangana (4301 kg/ha) was significantly higher compared to the national average productivity (2394 kg/ha). The growth rate of chilli productivity is 4.15 per cent per annum in Madhya Pradesh. This implies that in the chilli productivity was increasing faster in Madhya Pradesh. Thus, the chilli landscape in the state of Madhya Pradesh was performing better and gaining momentum than other states during the study period. Conversely, it was clearly witnessed that the low productivity in Karnataka (1346 kg/ha), Orissa (1003 kg/ha) and West Bengal (1677kg/ha) was significantly higher compared to the national average productivity (2394 kg/ha).In the low productivity state, it was found that the growth rate of chilli productivity was 1.15 per cent per annum in Karnataka, 2.01 per cent per annum in Orissa and 3.06 per cent per annum. Thus, it is essential to sustain chilli productivity in high-productivity states and enhance productivity in low-productivity states through technological interventions for stabilising chilli production and maintaining long-term competitiveness in the global chilli landscape.

Keywords: Chilli, Andhra Pradesh, Productivity, Stable, Sustain, Growth rate,

Introduction

India is the world's largest producer, consumer, and exporter of chilli, accounting for around 40% of the world's chilli production. This crop is a major source of income for farmers. Chilly is a high-value commercial crop, especially for small and marginal farmers. It is grown in both irrigated and rain-fed areas, making it versatile and generating employment in farming, harvesting, processing, and trading sectors. In the spice sector, chilli is one of the most valuable spice crops grown in a vast land area in the country. In Indian cuisine, chilli serves as a key ingredient in various curries, pickles, and chutneys, and is also used in vegetables, spices, medicinal applications, condiments, and sauces. Chilli possesses high nutritional value and is rich in medicinal properties.

Chilli is one of the most important commercial crops grown predominantly in the states of Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, West Bengal and Odisha. These six states account for >80 % of chilli production in the country. However, its cultivation is confined to small pockets in other states such as Gujarat and Assam. Currently, India is the largest producer and exporter of chilli in the world. It mainly exports to China, the USA, the UK, Bangladesh, Sri Lanka, the UAE, Singapore, Malaysia, Indonesia, and others.

Data and Methodology

The vital secondary data on area, production, and productivity of chilli have been collected from the Spice Board (www.indiaspices.com), Ministry of Industry and Commerce, Government of India. The data regarding area, production, and productivity were collected, which is available for major producing states, from 2011 to 2025, i.e., 14 years of data. Annual data on production were analysed to understand the dynamics, stability and variability of chilli production in major producing states.

Tabular analysis

For a meaningful interpretation of data, appropriate percentages and averages were worked **out** and presented in the form of tables.

Descriptive Statistics:

The measures, such as mean and variability measures, such as standard deviation, show how spread out the data. Visual tools like histograms and box plots help identify patterns and outliers. This analysis provides a clear snapshot of data.

Growth Analysis

To analyse the growth of area, production, and productivity of chillies in India and major producing states, the compound annual growth rate (CAGR) was estimated using nonlinear models, specifically the exponential model. Traditionally, the CAGR has been estimated by converting the growth model into a semi-logarithmic form and applying the Ordinary Least Squares (OLS) technique, which assumes multiplicative error terms. Nevertheless, this method has several drawbacks, including difficulties in estimating the standard errors for original parameter estimates. To overcome these issues, we employed a nonlinear estimation technique that assumes additive error terms for estimating the compound growth rate.

Compound annual growth rate analysis: Compound annual growth rates were calculated to know the trends in area, production and productivity and exports of chilli.

$$\ln Y_t = a_O + b_O \cdot t + \mu_t$$

To estimate this functional form using OLS, we would first transform the data for Y into logarithmic form. We would then run a regression of the log of Y on 't'. On computing OLS, we get the estimated regression line as

$$\ln \hat{Y}_t = \hat{a} + \hat{b} \cdot t$$

$$\text{CAGR} = [(\text{Antilog of } \hat{b}) - 1] * 100$$

Results and Discussion

State-level Performance of Chilli

Growth in the area, production and productivity of chilli in Andhra Pradesh

The growth rate was estimated for the period from 2011-12 to 2024-25 for Andhra Pradesh and presented in Table 1. In Andhra Pradesh, the average area, production and productivity of chilli from 2011-12 to 2024-25 were 189 thousand hectares, 816 thousand tonnes and 4329 kg/ha, respectively. The compound annual growth rate (CAGR) of the chilli area was 2.5 per cent, production was 4.28 per cent, and productivity was 3.27 per cent per annum, respectively. In the state of Andhra Pradesh, it is clearly observed that the average productivity (4329 kg/ha) was significantly higher than the national average productivity (2394 kg/ha). The average share of chilli area and production was 25 per cent and 43 per cent of the national chilli area and production during the study period. This reflects the significance of Andhra Pradesh in the national chilli production landscape.

Table1. Growth in the area, production and productivity of chilli in Andhra Pradesh

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	189	816	4329
CAGR	2.5	4.0	1.5
Share (%)	25	43	

Table 2. Descriptive statistics of chilli production in Andhra Pradesh

Particulars	Area (000 ha)	Production (000 tonnes)	Area (000 ha)
Mean	189	816	4329
Median	180	768	4539
Maximum	270	1459	5852
Minimum	131	418	1856
Std. Dev	43	292	1144
Skewness	0.50	0.79	-0.69
Kurtosis	-0.54	0.24	0.01
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity for Andhra Pradesh, where the data were analysed by several statistical tools from the period of 2011-12 to 2024-25, are presented in Table 2. The mean value observed for chilli area, production and productivity was 189 thousand hectares, 816 thousand tonnes and 4329 kg per hectare, respectively. Median value for area was 180 thousand-hectares, production 768 thousand tonnes and productivity 4539 kg per hectare. The maximum area observed was 270 thousand

hectares, production 1459 thousand tonnes, and productivity 5852 kg per hectare. Minimum area observed was 131 thousand hectares, production 418 thousand tonnes and productivity 1856 kg per hectare. Standard deviation observed for area, production and productivity was 43, 292 and 1144, respectively. The value of Skewness and Kurtosis statistics shows that the data with respect to area, production and productivity of chilli was not normally distributed.

Growth in the area, production and productivity of chilli in Telangana

The growth rate was estimated for the period from 2011-12 to 2024-25 for Telangana and presented in Table 3. The growth in area, production and productivity of chilli in Telangana for the study period revealed that there was a positive growth rate in the area (6.36 per cent), and production (9.93 per cent), but productivity witnessed a low growth rate of 3.35 per cent during the corresponding period. This indicates that in the chilli area, production was increasing at a faster rate in Telangana. The average share of chilli area and production was 13 per cent and 23 per cent of the national chilli area and production during the study period. Further, in the state of Telangana, it is clearly noticed that the average productivity is very high (4301 kg/ha) compared to the national average productivity (2394 kg/ha).

Table3. Growth in the area, production and productivity of chilli in Telangana

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	100	437	4301
CAGR	6.36	9.93	3.35
Share (%)	13	23	

Table 4. Descriptive statistics of chilli production in Telangana

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	100	437	4301
Median	82	403	4309
Maximum	159	794	6018
Minimum	66	228	2790
Std. Dev	35	186	881
Skewness	0.91	0.58	0.30
Kurtosis	-0.86	-0.89	-0.33
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity in Telangana, in which the data were analysed by several statistical tools for the period from 2011-12 to 2024-25, are presented in Table 4. The mean value observed for chilli area, production, and productivity was 100 thousand hectares, 437 thousand tonnes and 4301 kg per hectare, respectively. Median value for area was 82 thousand-hectares, production 403 thousand tonnes and productivity 4309 kg per hectare. The maximum area observed was 159 thousand hectares, production of 794 thousand tonnes and productivity 6018 kg per hectare. Minimum area observed was 66 thousand hectares, production 228 thousand tonnes and productivity 2790 kg per hectare. Standard deviation observed for area, production and productivity was 35, 186 and 881, respectively. The value of Skewness and Kurtosis statistics shows that the data with respect to area, production and productivity of chilli was not normally distributed.

Growth in the area, production and productivity of chilli in Madhya Pradesh

The growth rate was estimated for the period from 2011-12 to 2024-25 for Madhya Pradesh and presented in Table 5. It was revealed that there was a high growth rate in the area (7.18 per cent) and production (11.63 per cent), but productivity witnessed a relatively low growth rate of 4.15 per cent during the corresponding period. This implies that in the chilli area, production was increasing faster in Madhya Pradesh. Thus, the chilli landscape in the state of Madhya Pradesh was performing better and gaining momentum than other states during the study period. The average share of the chilli area and production was 12 per cent and 11 per cent of the national chilli area and production. It is clearly observed that the average productivity (2201 kg/ha) is slightly less than the national average productivity (2394 kg/ha).

Table 5. Growth in the area, production and productivity of chilli in Madhya Pradesh

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	90	206	2201
CAGR	7.18	11.63	4.15
Share (%)	12	11	

Table 6. Descriptive statistics of chilli production in Madhya Pradesh

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	90	206	2201
Median	88	213	2369
Maximum	122	320	2690

Minimum	54	94	1590
Std. Dev	26	90	430
Skewness	-0.06	0.00	-0.24
Kurtosis	-1.45	-1.79	-1.97
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity in Madhya Pradesh, in which the data were analysed with several statistical tools for the period from 2011-12 to 2024-25, were presented in Table 6. The mean value observed for chilli area, production and productivity was 90 thousand hectares, 206 thousand tonnes and 2201 kg per hectare, respectively. Median value for area was 88 thousand-hectares, production 213 thousand tonnes and productivity 2369 kg per hectare. The maximum area observed was 122 thousand hectares, production 320 thousand tonnes and productivity 2690 kg per hectare. Minimum area observed was 54 thousand hectares, production 94 thousand tonnes, and productivity 1590 kg per hectare. The standard deviation observed for area, production and productivity was 26, 90 and 430, respectively. The value of Skewness and Kurtosis statistics shows that the data with respect to area, production and productivity of chilli was not normally distributed.

Growth in the area, production and productivity of chilli in Karnataka

The growth rate was estimated for the period from 2011-12 to 2024-25 for Karnataka and presented in Table 7. The growth in area, production and productivity of chilli in Karnataka for the study period revealed that there was a high growth rate in the area (3.46 per cent) and production (4.66 per cent), but productivity witnessed a low growth rate of 1.15 per cent during the corresponding period. This indicates that the area and production of chilli were increasing moderately in the state of Karnataka. The average share of area and production was 16 per cent and 8 per cent of the national chilli area and production during the study period. It is clearly noticed that the average productivity is very low (1346 kg/ha) compared to the national average productivity (2394 kg/ha) in Karnataka.

Table 7. Growth in the area, production and productivity of chilli in Karnataka

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	120	159	1346
CAGR	3.46	4.66	1.15
Share (%)	16	8	

Table 8. Descriptive statistics of chilli production in Karnataka

Particulars	Area (000 ha)	Production (000 tonnes)	Area (000 ha)
Mean	120	159	1346
Median	106	150	1264
Maximum	220	281	2040
Minimum	74	103	953
Std. Dev	40	55	309
Skewness	1.30	1.21	0.97
Kurtosis	1.58	0.85	0.48
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity in Karnataka, in which the data were analysed with several statistical tools for the period from 2011-12 to 2024-25, were presented in Table 8. The mean value observed for chilli area, production and productivity was 120 thousand hectares, 159 thousand tonnes, and 1346 kg per hectare, respectively. Median value for area was 106 thousand-hectares, production 150 thousand tonnes and productivity 1264 kg per hectare. The maximum area observed was 220 thousand hectares, production 281 thousand tonnes and productivity 2040 kg per hectare. Minimum area observed was 74 thousand hectares, production 103 thousand tonnes and productivity 953 kg per hectare. The standard deviation observed for area, production and productivity was 40, 55 and 309, respectively. The value of Skewness and Kurtosis statistics show that the data with respect to area, production and productivity of chilli was not normally distributed.

Growth in the area, production and productivity of chilli in Odisha

The growth rate was estimated for the period from 2011-12 to 2024-25 for Odisha and presented in Table 9. The growth in area, production and productivity of chilli in Odisha for the study period revealed that there was a negative growth rate in the area (-0.22 per cent) and a positive growth rate in production (1.77 per cent) and productivity (2.01 per cent during the corresponding period. In Odisha, it is clearly noticed that the average productivity is very low (1003 kg/ha) compared to the national average productivity (2394 kg/ha). This indicates that chilli production needs to be enhanced in this state through area expansion, varietal and technology development, and deployment. The average share of chilli area and production

was 10 per cent and 4 per cent of the national chilli area and production during the study period.

Table 9. Growth in the area, production and productivity of chilli in Odisha

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	73.5	73.8	1003
CAGR	-0.22	1.77	2.01
Share (%)	10	4	

Table 10. Descriptive statistics of chilli production in Odisha

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	74	74	1003
Median	74	70	963
Maximum	76	90	1208
Minimum	72	69	926
Std. Dev	2	8	110
Skewness	-0.15	1.56	1.48
Kurtosis	-2.05	0.50	0.38
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity in Odisha, in which the data were analysed by several statistical tools for the period from 2011-12 to 2024-25, were presented in Table 10. The mean value observed for the chilli area, production and productivity was 74 thousand hectares, 74 thousand tonnes and 1003 kg per hectare, respectively. Median value for area was 74 thousand-hectares, production of 70 thousand tonnes and productivity of 963 kg per hectare. The maximum area observed was 76 thousand hectares, production of 90 thousand tonnes and productivity of 1208 kg per hectare. Minimum area observed was 72 thousand hectares, production 69 thousand tonnes and productivity 926 kg per hectare. Standard deviation observed for area, production and productivity was 2, 8 and 110, respectively. The value of Skewness and Kurtosis statistics shows that the data with respect to area, production and productivity of chilli was not normally distributed.

Growth in the area, production and productivity of chilli in West Bengal

The growth rate was estimated for the period from 2011-12 to 2024-25 for West Bengal and presented in Table 11. The growth in area, production and productivity of chilli in West Bengal for the study period revealed that there was a marginal growth rate in the area (0.9 per cent), while the growth rate was positive in production (4.0 per cent) and productivity (3.06 per cent) during the corresponding period. In West Bengal, it is clearly noticed that the average productivity is very low (1677 kg/ha) compared to the national average productivity (2394 kg/ha). This indicates that the chilli production needs to be increased in this state through area expansion, varietal and technology development and deployment. The average share of chilli area and production was 10 per cent and 4 per cent of the national chilli area and production during the study period.

Table 11. Growth in the area, production and productivity of chilli in West Bengal

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	62	105	1677
CAGR	0.9	4.0	3.06
Share (%)	8	6	

Table 12. Descriptive statistics of chilli production in West Bengal

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	62	105	1677
Median	64	99	1573
Maximum	79	164	2299
Minimum	45	78	1339
Std. Dev	10	32	266
Skewness	0.07	1.22	1.37
Kurtosis	-0.66	0.03	1.16
Observations	14	14	14

The descriptive statistics on chilli area, production and productivity in West Bengal, where the data were analysed by several statistical tools for the period from 2011-12 to 2024-25, were presented in Table 12. The mean value observed for chilli area, production and productivity was 62 thousand hectares, 105 thousand tonnes and 1677 kg per hectare, respectively. Median value for area was 64 thousand-hectares, production 99 thousand tonnes and productivity 1573 kg per hectare. The maximum area observed was 79 thousand hectares,

production 164 thousand tonnes and productivity 2299 kg per hectare. Minimum area observed was 45 thousand hectares, production 78 thousand tonnes and productivity 1339 kg per hectare. The standard deviation observed for area, production and productivity was 0.07, 1.22, and 1.37, respectively. The value of Skewness and Kurtosis statistics shows that the data with respect to area, production and productivity of chilli was not normally distributed.

Karnataka

The instability analysis of chilli production in Karnataka was analysed for the period from 2011-12 to 2024-25 and presented in Table 13. The CDVI for area and production was found to be 28.42 per cent and 28.63 per cent, respectively, while the instability index for the productivity of chilli was 22.41 per cent. It indicates high instability in the area and production, but relatively low instability in productivity during the study period. The variability in area and production was mostly due to crop diversification in chilli-growing areas, price fluctuations, and unpredictable climatic conditions.

Table 13. Degree of instability in the area, production and productivity of chilli in Karnataka from 2011-12 to 2024-25

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Mean	120	159	1346
SD	40.0	55.1	309.2
CV	33.25	34.65	22.96
CDVI	28.42	28.63	22.41

Odisha

The instability analysis of chilli production in Odisha was analysed for the period from 2011-12 to 2024-25 and presented in Table 14. The CDVI for the area was found to be 2.09 per cent, indicating low variability in the area, while the instability index for the production and productivity of chilli was medium, i.e., 8.31 per cent and 6.59, respectively. It indicates low variability in the area, but moderate variability in production and productivity during the study period.

Table 14. Degree of instability in the area, production and productivity of chilli in Odisha from 2011-12 to 2024-25

Particulars	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)

Mean	73.5	73.8	1003
SD	1.7	8.5	110.0
CV	2.30	11.48	10.96
CDVI	2.09	8.31	6.59

West Bengal

The instability analysis of chilli production in West Bengal was analysed for the period from 2011-12 to 2024-25 and presented in Table 15. The CDVI for the area was found to be 15.50 per cent, indicating moderate variability in the area, while the instability index for the production was 23.26 per cent, and productivity was 8.63, respectively. It indicates high variability in production, while it is low in productivity during the study period.

Table 15. Degree of instability in the area, production and productivity of chilli in West Bengal from 2011-12 to 2024-25

Particulars	**Area (000 ha)**	**Production (000 tonnes)**	**Productivity (kg/ha)**
Mean	62	105	1677
SD	10.0	31.6	265.9
CV	16.16	30.16	15.86
CDVI	15.50	23.26	8.63

Conclusions and Policy Implications

India is the world's largest producer, consumer, and exporter of chilli, accounting for around 40% of the world's chilli production. This crop is a major source of income for farmers. Chilly is a high-value commercial crop, especially for small and marginal farmers. From the state-level analysis, it was found that the growth rate of chilli productivity was 3.27 per cent per annum in Andhra Pradesh and 3.35 per cent per annum in Telangana. It is clearly observed that the average productivity in Andhra Pradesh (4329 kg/ha) and Telangana (4301 kg/ha) was significantly higher compared to the national average productivity (2394 kg/ha). The growth rate of chilli productivity is 4.15 per cent per annum in Madhya Pradesh. This implies that in the chilli productivity was increasing faster in Madhya Pradesh. Thus, the chilli landscape in the state of Madhya Pradesh was performing better and gaining momentum than other states during the study period. Conversely, it was clearly witnessed that the low productivity in Karnataka (1346 kg/ha), Orissa (1003 kg/ha) and West Bengal

(1677kg/ha) was significantly higher compared to the national average productivity (2394 kg/ha).In the low productivity state, it was found that the growth rate of chilli productivity was 1.15 per cent per annum in Karnataka, 2.01 per cent per annum in Orissa and 3.06 per cent per annum. Thus, it is essential to sustain chilli productivity in high-productivity states and enhance productivity in low-productivity states through technological interventions for stabilising chilli production and maintaining long-term competitiveness in the global chilli landscape.

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