

## Research Article

# An Economic Analysis of Trends in Area, Production and Yield of Cotton Cultivation in India: A Trend Analysis

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## Abstract

The study examines the growth trends in cotton production and yield in India. Cotton is a vital crop for the sustainable development of the country's economy and for ensuring livelihood security, particularly in the Indian cotton farming community. The Indian cotton sector provides a livelihood to approximately 60 million people. India is the world's third-largest exporter of cotton and the second-largest exporter of textiles, thereby making a significant contribution to the national economy. Cotton is cultivated on 312 lakh hectares globally, with approximately 117 lakh hectares under cultivation in India. Thus, India accounts for 37.5% of the global cotton area and contributes 26% (i.e., 6.20 million tonnes) of the global cotton production, which stands at 23.92 million tonnes. Cotton continues to hold a pre-eminent position as the most favoured fiber among Indian textile mills, serving as the primary raw material for the textile industry (Economic Survey of India, 2024). This sector, which relies heavily on cotton, contributes about 4% to the Gross Domestic Product and remains a major source of foreign exchange earnings for the country. Cotton is a crop of immense significance to the Indian economy and the livelihoods of millions of Indian cotton farmers. Therefore, the growth and development of cotton and the cotton-based textile industry have a vital impact on the overall progress of the Indian economy. The present study primarily focuses on the current status of area, production, and yield of cotton, and aims to analyze the state-wise growth trends in these parameters across India.

**Keywords:** Cotton, Performance, Instability Index, Area, Production, and Yield.

## 1. Introduction

Agriculture continues to be the backbone of inclusive growth in India, serving as the minimum and necessary condition for ensuring food security, price stability, and sustainable livelihoods for the majority of the population (Keshava S. R., 2023). Within this broader agricultural framework, cotton cultivation holds a particularly vital place, not just as a crop, but as a source of livelihood, economic empowerment, and national economic strength.

Cotton contributes significantly to rural employment and income, particularly for millions of marginal and smallholder farmers. Presently, close to 60 million Indians are directly or indirectly dependent on the cotton value chain, spanning cultivation, marketing, processing, and export activities (reports from the Ministry of Textiles). This makes cotton a crucial pillar for both livelihood security and rural resilience.

India's cotton sector is uniquely positioned. It is the only country that grows all four cultivated species of cotton, including a wide range of intra- and interspecific hybrids on a commercial scale. This genetic diversity, combined with traditional knowledge and evolving agricultural practices, provides India with a distinct comparative advantage.

India stands as the largest producer of cotton in the world, contributing approximately 23% of global cotton production as of 2024. The country's performance in the cotton export sector has also been noteworthy. According to data from the Ministry of Commerce and Industry, the value of cotton exports reached US\$6.78 billion in FY 2023–24, and Rs. 73,233 crore (approximately US\$8.48 billion) during FY 2024–25 (up to December 2024). Over the years, India has made notable strides in cotton yarn and textile exports, steadily increasing its share in the global market.

To sustain and strengthen this momentum, the cotton sector must move toward being knowledge-based and market-responsive. It must continue evolving through scientific innovation and technological advancements to overcome challenges in productivity and quality, meet the rising domestic and international demand, and enhance India's global competitiveness.

A dynamic and forward-looking cotton economy has the potential to deliver wide-ranging benefits — from rural prosperity and employment generation to industrial growth and national economic stability.

## **2. Objectives of the Study**

1. To study the performance and growth trends of cotton cultivation in India.
2. To examine the state-wise growth of area, production, and yield of cotton cultivation in the country.

## **3. Hypothesis**

1. The area, production, and yield of cotton in India have significantly increased over the past few years.

## **4. Materials and Methods**

The present paper is based on secondary data. The data on the area under cotton, production, and yield were collected from various sources, including annual reports of the Ministry of Agriculture and Farmers Welfare (Government of India), Cotton Corporation of India Ltd., Ministry of Textiles, All India Coordinated Cotton Improvement Project, the Economic Survey of India (2024-25), as well as articles published in scholarly journals, specialized publications, and seminal books authored by experts in cotton production. Time series data for the period from 2010–11 to 2022–23 were used for the analysis. Statistical tools such as the mean, Compound Annual Growth Rate (CAGR), and the Cuddy-Della Valle Index were employed for the analysis using Excel, SPSS 21, and Gretl statistical software.

## **5. Compound Annual Growth Rate (CAGR)**

Compound Annual Growth Rate of area, production and productivity was computed by using semi-log growth model (Log-Lin model). The logarithmic form of the following equation was used to calculate CAGR:

$$Y_t = Y_0 (1+r)^t$$

$$\ln Y_t = \ln Y_0 + t \ln(1+r)$$

$$\ln Y_t = \beta_1 + \beta_2 t + u_t$$

Where,

$\ln Y_t$  is the natural logarithm of time series data for area, production, and yield of cotton for year  $t$

$\beta_1$  is the constant term

$t$  is the time in years

$u_t$  is the error term

$\beta_2$  is growth rate for the period under consideration (i.e., slope coefficient) CAGR was calculated using following equation:

$$\text{CAGR}(r) = (\text{Antilog of } (\beta_2) - 1) \times 100$$

In order to facilitate the use of ordinary least square and for estimation of parameter, the growth equation was converted into logarithmic form.

#### **6. Instability Index: Cuddy-Della Valle Instability Index (CDVI)**

The instability in area, production and yield of cotton cultivation was examined by using the CDVI. Co-efficient of variation measures instability, but it over-estimates the level of it in time series data. The Cuddy-Della Valle Index (1978) de-trends and shows the exact direction of the instability. It can be denoted by the CDVI formula:

$$\text{CDVI} = \text{CV} \cdot \sqrt{1 - \text{AdjR}^2}$$

Where, CDVI - Cuddy-Della Valle Instability Index (In Percent), CV- Co-efficient of Variation (In Percent), and Adjusted R<sup>2</sup> - Co-efficient of determination from a time trend regression adjusted for its degrees of freedom.

The ranges of CDVI are given as follows:

Between 0 and 15 = Low Instability

Greater than 15 and lower than 30 = Medium Instability

Greater than 30 = High Instability

#### **7. Performance and Cotton Production: National Scenario**

Cotton cultivation in India is a major agricultural activity, contributing significant role to the national economy and livelihood of millions. India is a leading producer of cotton, with a large area under cultivation and a diverse range of cotton species. The crop is grown in various regions, including Maharashtra, Gujarat, Telangana, and Andhra Pradesh, each with its own unique characteristics and cultivation practices (Economic Survey of India, 2024).

Cotton, one of the foremost amongst these crops, has a strategic role in India's international agriculture play. India is the world's third-largest exporter of cotton and the second-largest exporter of textiles, therefore, also contributing significantly to the country's economy. India is the country to grow all four species of cultivated cotton *G.arboreum* and *Herbaceum* (Asian cotton), *G.barbadense* (Egyptian cotton) and *G. hirsutum* (American Upland cotton). *G.hirsutum* represents 94% of the hybrid cotton production in India and all the current Bt cotton hybrids are *G. hirsutum*. India has first place in the world in cotton acreage with 120.69 lakh hectares. Around 67 percent of India's cotton is grown on rain-fed areas and 33 percent on irrigated area. In terms of productivity, India is on 40th rank with yield of 510 kg/ hectares area, production, and yield of cotton for the previous years. However, the growth of the area, yield, and consumption of the cotton sector in India during the period from 2016-17 to 2021-22. The above mentioned years, the area of cotton is 108.26 lakhs hectares in 2016-17, which increased to 130.07 lakhs/ ha in 2020-21, and then it has sharply declined to 120.69 lakh/ hectares in 2021-22.

The growth of yield in the cotton sector is a significant increase from this study period, which is 542 lint in kg/ hectares in 2016-17, which sharply decreased to 462 lint/ kg/ha in 2020-21, and then it has again significantly increased to 510 lint/kg per hectare in 2021-22. In the cotton sector, the growth of consumption is 310.41 lakh bales in 2016-17, which significantly increased to 319.06 in 2017-18, then it sharply decreased to 269.19 lakh bales in 2019-20, and then it again significantly increased to 338 lakh bales in 2021-22. The above table represents the average and CAGR for the cotton sector in India from 2016-17 to 2021-22. The values of the average in the area, yield, and consumption are 124.30, 487.17, and 313.79, respectively. The CAGR of the cotton sector in the area, yield, and consumption is 2.04 percent, -1.47 percent, and 1.22 percent respectively.

## 8. Results and Discussion

### Growth in Area, Production, and Yield of Cotton in India: Present Scenario

India ranks first in the world in cotton production, with an estimated output of 362.18 lakh bales (6.16 million metric tonnes) during the 2021–22 cotton seasons. This accounts for approximately 23% of the global cotton production, which stood at 1,555 lakh bales (26.44 million metric tonnes). India is also the second-largest consumer of cotton globally, with an estimated consumption of 338 lakh bales (5.75 million metric tonnes), representing about 22% of the world's total cotton consumption of 1,507 lakh bales (25.63 million metric tonnes).

**Table-1 Growth in Trends of Area, Production and Yield of Cotton in India from 2009-10 to 2021-22**

Year	Area (Hectare)	Production (Million Tonnes) (In Million Bales of 170 kg each)	Yield (Kg/Hectare)
2010-11	111.42	339	517
2011-12	121.78	367	512
2012-13	119.78	370	525
2013-14	119.6	398	566
2014-15	128.46	386	513
2015-16	122.92	332	459
2016-17	108.26	345	542
2017-18	125.86	370	500
2018-19	126.14	333	449
2019-20	134.77	365	460
2020-21	132.85	352.48	451
2021-22	119.1	312.03	445
2022-23	125.1	341.91	465
<b>CAGR (%)</b>	0.74	-0.77	-1.50
<b>Average</b>	114.06	329.33	457.32
<b>Std</b>	7.51	23.97	39.97

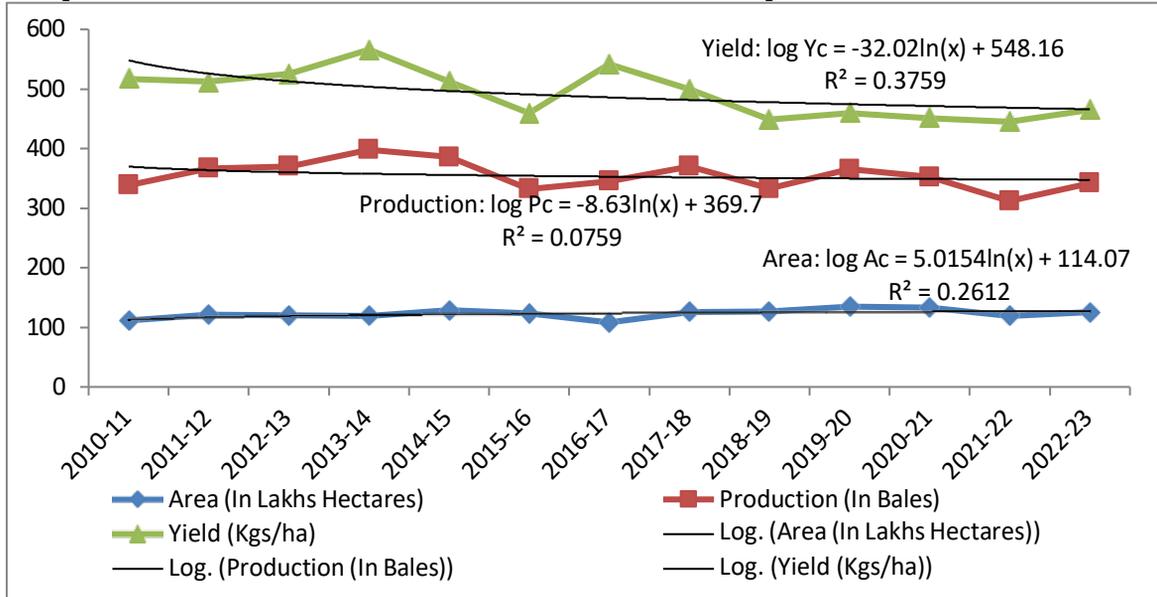
**Source:** Annual Report (2017), Various Reports of Cotton Corporation of India, Government of India.

The below table presents the trends in the growth of area, production, and yield of cotton cultivation in India during the period from 2010 to 2022. The area under cotton cultivation was 111.42 lakh hectares in 2010–11, which decreased to 108 lakh hectares in 2016–17. It then sharply increased to 132.85 lakh hectares in 2020–21, followed by a decline to 119.1 lakh hectares in 2021–22, and rose again to 125.1 lakh hectares in 2022–23. Cotton production in 2010–11 was 339 lakh bales, which increased significantly to 386 lakh bales in 2014–15. However, it dropped to 332 lakh bales in 2015–16, and then rose again to 352.48 lakh bales in 2020–21. This was followed by a decrease to 312.03 lakh bales in 2021–22, and a subsequent increase to 341.91 lakh bales in 2022–23. In terms of yield, cotton recorded 517 kg/ha in 2010–11. It increased to 566 kg/ha in 2013–14, then declined sharply to 459 kg/ha in 2015–16. The yield recovered to 542 kg/ha in 2016–17, but later fell again to 445 kg/ha in 2021–22, before slightly increased to 465 kg/ha in 2022–23.

Finally, the below table presents the average values and Compound Annual Growth Rate (CAGR) of cotton production in India from 2010 to 2022. During the study period, the overall

average area under cotton cultivation was 114.06 lakh hectares, the average production was 329.33 lakh bales, and the average yield was 457.32 kg/ha. The CAGR for area, production, and yield was 0.74%, -0.77%, and -1.50%, respectively. These figures suggest a marginal increase in the area under cultivation, but a declining trend in both production and yield over the study period

**Graph-1 Trends in Area, Production and Yield of Cotton Crop in India from 2010 to 2022**



**Table-2 Variability Index for Cotton Cultivation in India**

Variables	CV	AdR <sup>2</sup>	CDVI	INFERENCE
Area	6.59	.149	6.07	Low Instability
Production	7.28	.122	6.82	Low Instability
Yield	8.74	.477	6.32	Low Instability

The above table presents the variability index for cotton cultivation in India. The instability in the area, production, and yield of cotton cultivation was measured in relative terms using the Cuddy-Della Valle Index (CDVI) for the study period from 2010 to 2022. The results indicate that the CDVI provides reliable estimates of variability. Among the three parameters, instability was highest in production (6.82), followed by yield (6.32), and area (6.07). This suggests that the growth in area, production, and yield of cotton cultivation in India experienced relatively low levels of instability during the study period.

**9. Growth in Area, Production, and Yield of Cotton in India: State-wise Analysis**

Cotton cultivation plays a crucial role in both the agricultural and industrial economy of India. Cotton fiber is the primary raw material for the cotton textile industry. In India, around 40 to 50 million people are employed in cotton processing and trade. In 2021-22, India’s total cotton production was 34.1 million bales (each bale weighing 170 kg). The Central Zone, which includes states like Gujarat, Maharashtra, and Madhya Pradesh, is the largest cotton-producing region in the country, with Gujarat being the leading producer in both the Central Zone and India, contributing 8.516 million bales. The Southern Zone, comprising Telangana, Andhra Pradesh, Karnataka, and Tamil Nadu, is the second-largest producer, accounting for about 30%

of the nation's cotton production. Telangana is the leading producer in the Southern Zone and the third-largest in the country, contributing 6.587 million bales. The cotton textile industry is the second-largest employer in India after agriculture, supporting the livelihoods of an estimated 6.5 million cotton farmers and significantly contributing to the country's export economy.

**Table-3 Major States of Cotton Cultivation in India (2019 to 2022) Area in lakh ha, Production in lakh bales of 170 kgs, and Yield kgs per ha)**

State	2020-21			2021-22			2022-23		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
Punjab	2.52	10.23	690	2.51	6.47	438	2.41	9.22	650
Haryana	7.4	18.23	419	6.36	13.16	352	6.49	17.21	451
Rajasthan	8.07	32.07	676	7.56	24.81	558	6.83	27.12	675
<b>North total</b>	<b>17.99</b>	<b>60.53</b>	<b>572</b>	<b>16.43</b>	<b>44.44</b>	<b>460</b>	<b>15.73</b>	<b>53.55</b>	<b>579</b>
Gujarat	22.7	72.18	541	22.84	74.82	557	25.38	91.83	615
Maharashtra	45.44	101.05	378	39.54	71.18	306	41.98	80.25	325
Madhya Pradesh	5.88	13.38	387	5.6	14.2	431	5.99	15.19	431
<b>Central total</b>	<b>74.02</b>	<b>186.61</b>	<b>429</b>	<b>67.98</b>	<b>160.2</b>	<b>401</b>	<b>73.35</b>	<b>187.27</b>	<b>434</b>
Telangana	23.58	57.97	418	18.89	60.67	546	19.81	53.25	457
Andhra Pradesh	6.06	16	449	5.54	17.08	524	6.02	17.85	504
Karnataka	8.2	23.2	481	6.67	19.5	497	7.11	21.04	503
Tamil Nadu	1.12	2.43	369	1.48	3.6	414	0.79	1.87	402
<b>South Total</b>	<b>38.96</b>	<b>99.6</b>	<b>435</b>	<b>32.58</b>	<b>100.85</b>	<b>526</b>	<b>33.73</b>	<b>94.01</b>	<b>474</b>
Orissa	1.71	5.51	548	1.93	6.26	551	2.04	6.82	568
Others	0.17	0.23	230	0.18	0.28	264	0.17	0.26	260
<b>Grand Total</b>	<b>132.85</b>	<b>352.48</b>	<b>451</b>	<b>119.1</b>	<b>312.03</b>	<b>445</b>	<b>125.02</b>	<b>341.91</b>	<b>465</b>

**Source:** Annual Report (2017), Various Reports of Cotton Corporation of India, Government of India.

**Graph-2 Major States of Cotton Cultivation in India (2019 to 2022)**

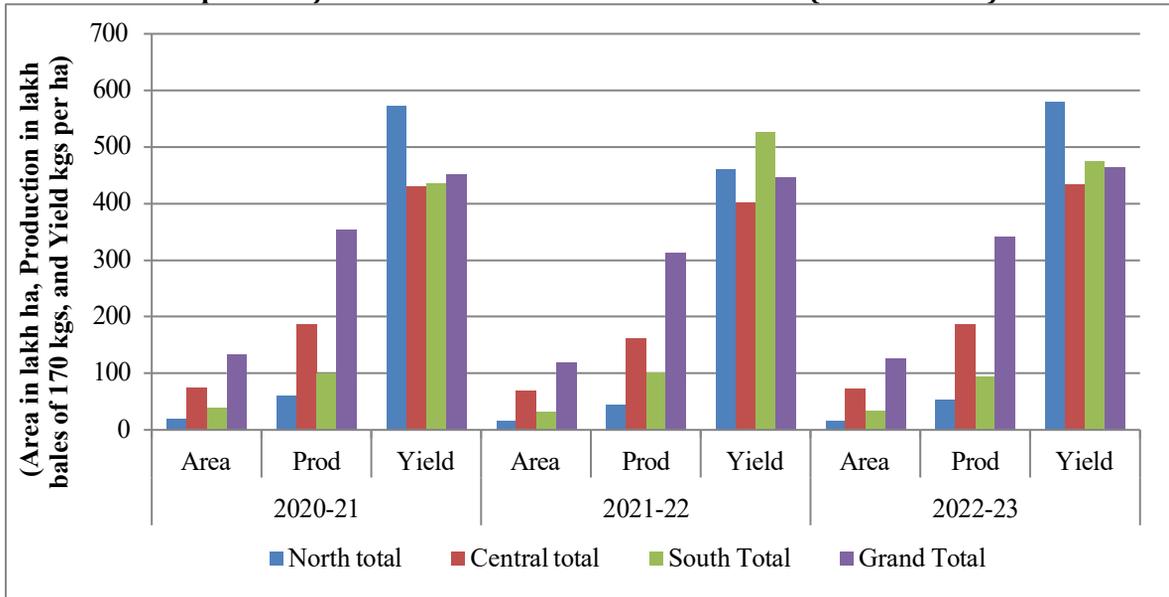


Table-3 and Graph-2 present the state-wise cotton production in India, as estimated by the Committee on Cotton Production and Consumption (COCPC) for the period between 2020 and 2022. Cotton production in India is primarily distributed across three major regions: the Northern, Central, and Southern regions. Each region plays a significant role in determining the area under cultivation, production volume, and yield. In 2020–21, the Central region contributed the most to cotton cultivation, with an area of 74.02 lakh hectares, production of 186.61 lakh bales, and a yield of 429 kg per hectare. By 2022–23, these figures had slightly changed to 73.35 lakh hectares, 187.27 lakh bales, and a yield of 434 kg per hectare. The Southern region was the second-largest contributor in 2020–21, with an area of 38.96 lakh hectares, production of 99.60 lakh bales, and a yield of 435 kg per hectare. In 2022–23, the area declined to 33.73 lakh hectares, while production decreased to 94.01 lakh bales; however, yield improved to 474 kg per hectare. The Northern region ranked third in terms of cotton production. In 2020–21, it had an area of 17.99 lakh hectares, production of 60.53 lakh bales, and a yield of 572 kg per hectare. By 2022–23, the area reduced to 15.73 lakh hectares and production to 53.55 lakh bales, while yield slightly increased to 579 kg per hectare.

**10. Testing Hypothesis**

1. The area, production, and yield of cotton in India have significantly increased over the past few years.

**Table -4 Growth in the Area, Production, and Yield of Cotton Cultivation in India**

Model Summary and Parameter Estimates							
Dependent Variable: Area, Production and Yield							
Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Area	.215	3.009	1	11	.111	116.386	.007
Production	.196	2.688	1	11	.129	373.571	-.008
Yield	.534	12.582	1	11	.005	545.890	-.015

The table presents the results of the Exponential Growth Model used to analyse the growth in area, production, and yield of cotton cultivation in India during the study period from 2010 to 2022. The results indicate that the area, production, and yield of cotton grew, on average, by 21.5%, 19.6%, and 53.4%, respectively. However, the growth in area and production was not statistically significant at the 10% level, while the growth in yield was significant at the 1% level. The goodness-of-fit ( $R^2$ ) values for area, production, and yield were 3.009, 2.688, and 12.582, respectively. These findings suggest that there has been a significant improvement in the yield of cotton cultivation in India, even though growth in area and production was not statistically significant.

## **11. Conclusion**

The findings of the present study highlight the dynamic and evolving nature of cotton cultivation in India between 2010 and 2022. Using Compound Annual Growth Rate (CAGR) and the Cuddy-Della Valle Index (CDVI) as analytical tools, the study observed notable fluctuations in the area under cotton, its production, and yield across the years. While these ups and downs reflect the sector's sensitivity to various agro-economic and policy factors, the broader trend points to an encouraging improvement in performance over time.

For instance, during the 2021–22 cotton season (October–September), there was a reported decline in production by 10.51%, falling to 315.43 lakh bales, compared to 352.48 lakh bales in the previous year. However, alternate estimates by the Ministry of Agriculture and Farmers Welfare suggest that production during the same year actually rose slightly to 362.19 lakh bales, marking a 2.30% increase over the revised figure of 353.84 lakh bales for 2020–21. This variation underscores the complexities in data reporting and estimation in the agricultural sector.

Over the entire study period, average growth in the area, production, and yield of cotton stood at 21.5%, 19.6%, and 53.4% respectively. Interestingly, while growth in area and production did not reach statistical significance at the 10% confidence level, the rise in yield was found to be statistically significant at the 1% level, suggesting that productivity gains were both substantial and robust.

Overall, the study reflects a sector that, despite its volatility, has made meaningful strides, particularly in improving cotton yield, a key indicator of agricultural efficiency and resilience.

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