Growth Performance and Decomposition Analysis of Major Cotton Growing States of India

Abstract

Cotton is often referred as 'King' of fiber crop and also called as 'White Gold'. It is one of important commercial crop. Cotton servers as a raw material to textile industries and over the years India had gained competitive increase in its production. Therefore, to know the ground situation of cotton in major cotton growing states, the present study was conducted with major objectives as growth and decomposition analysis. The secondary data were collected from various authentic websites and publications pertaining to 30 years starting from 1989-90 to 2018-19. The collected data was then further analysed using exponential function, Cuddy Della Valle's Instability Index and Minhas Decomposition Model. The results revealed that, the growth rate of major cotton growing states like Maharashtra, Gujarat, Andhra Pradesh, Madhya Pradesh and Haryana had positive and significant growth for area, production and yield during overall study period. The growth of area, production and yield of major cotton growing states were moderately unstable except Andhra Pradesh where, high instability was observed for area (44.33 per cent), production (48.99 per cent) and moderate instability was observed for yield (18.02 per cent). Among the major cotton growing states, except Gujarat, in all other states area played a driving role in changing cotton production. In Gujarat area played a dominant role for change in the cotton production.

Introduction

Agriculture is the main source of national income in developing countries, more than 70 per cent of people directly depends on agriculture. It has been associated with production of food crops, providing raw material to the industries apart from this, it provides employment opportunities to a large population. Cotton is one of the important fiber cash crops, which plays an important role in Indian economy as it provides raw material to the multiple industries in the country. Textile industry is one such industry which draws its raw material from agriculture. It contributes 5 per cent to the country's GDP, 7 per cent of industrial output in terms of value and 12 per cent of country's export earnings. India is one of the largest producers and exporters of cotton in the world. Cotton is cultivated in 134.77

lakh hectare in India, with a production of 353.84 lakh bales of 170 kg and 462 kg per hectare yield in India. Cotton is mainly grown in three zones in the country that is northern zone, central zone and southern zone. North zone consists of states like Punjab, Haryana and Rajasthan, which holds 12 per cent of total area under cotton in the country. Central zone includes the states like Madhya Pradesh, Maharashtra and Gujarat and holds 60 per cent to area under cotton. In southern zone cotton is cultivated in states like Andhra Pradesh, Telangana, Karnataka and Tamil Nadu, which holds around 26 per cent of area under cotton out of total country's cotton area.

Maharashtra stands first in terms of area under cotton with 44.91 lakh hectare, followed by Gujarat (26.55 lakh hectare), Telangana (21.57 lakh hectare) and Karnataka (8.17 lakh hectare). In terms of production, Gujarat holds top position in the country with 89.00 lakh bales, followed by Maharashtra (87.00 lakh bales), Telangana (54.00 lakh hectare) and Rajasthan (29.00 lakh hectares). Punjab is in leading position in productivity of cotton with 651 kgs/ha, followed by Haryana (623 kg/ha), Gujarat (570 kg/ha) and Maharashtra (523 kg/ha) (CAB, 2021). Despite of having such large area under cotton cultivation, India's raw cotton production is below expectations and it ranks poorly in terms of productivity as compared to USA and China.

The present study examines the state-wise growth and instability in area, production and productivity of cotton in major cotton growing states. The study furthermore, decomposes the change in production of cotton in area, yield and interaction effects.

Methodology

The study was based on secondary data. Top 5 cotton growing states were selected for the study based on area under cotton cultivation that is Maharashtra, Gujarat, Andhra Pradesh, Madhya Pradesh and Haryana and other states. Time series data related to state-wise area, production and productivity of cotton were collected from various sources like INDIASTAT website, FAO, CCI, and other publications. The data so collected pertained to a 30-year period spanning from 1989-90 to 2018-19. The entire period was divided into three sub-periods, period I (1989-90 to 1998-99), period II (1999-2000 to 2008-09) and period III (2009-10 to 2018-19) for the propose of analysis.

Compound Annual Growth Rate

Growth rate of cotton was calculated using compound annual growth rate (CAGR) which indicates the tendency of variable to increase, decrease or remain constant over a period of time. The compound annual growth rate (CAGR) was estimated using the following model.

$Y=AB^t$

$\text{Log } Y = \log A + t \log B$

$\text{Log } Y = y$, $\log A = a$ and $\text{Log} B = b$

$y = a + bt$

$r = (\text{antilog } 'b' - 1) \times 100$

Where, Y = area/ production/ productivity

a= Intercept

b = Regression coefficient

t = Time periods (t= 1, 2, 3,…… 10)

r = Compound Annual Growth Rate (CAGR).

Measurement of instability

Instability is the deviation from the trend. It was measured by using co-efficient of variation. The standard deviation as percentage of means called as co-efficient of variation.

$CV = \sigma / \mu \times 100$

Where, CV = Co-efficient of variation

σ = Standard deviation of the variable

μ = Mean of the variable.

Cuddy-Della Valle Index (%) = $CV\sqrt{1 - R^2}$

Where, C.V = coefficient of variation

R^2 = co-efficient of determination from a time trend regression adjusted to its degrees of freedom.

Decomposition analysis

To measure the relative contribution of area, yield to the total output of the cotton crop, Minhas (1964), decomposition analysis model was used which is given below.

$P_o = A_o \times Y_o$

$P_n = An \times Yn$ ---------- (1)

A_0, P_0, and Y_0 area area. Production and productivity of base year and A_n, P_n and Y_n are value of the respective variable in nth year item respectively.

Where,
A_o and A_n = Area
Y_o and Y_n = yield in the base year and nth year respectively.
$P_n - P_o = \Delta P$
$A_n - A_o = \Delta A$
$Y_n - Y_o = \Delta Y$---------- (2)

For equation (1) and (2) we can write

$P_o + \Delta P = (A_o + \Delta A)(Y_o + \Delta Y)$

Hence,

$$P = \frac{A0\,\Delta Y}{\Delta P} \text{ X } 100 + \frac{YO\,\Delta A}{\Delta P} \text{ X } 100 + \frac{\Delta Y \Delta A}{\Delta P} \text{ X } 100$$

Production = yield effect + area effect + interaction effect. Thus, the total change ion production can be decomposed into yield effect area effect and the interaction effect due to change in yield and area.

Results and discussion

State wise growth rate of area, production and yield of cotton were analyzed for the period of 30 years beginning from 1989-90to 2018-19 using compound annual growth rate. Table 1 depicted the analyzed results of CAGR of area, production and yield of cotton in selected major cotton growing states in period I, period II, period III and overall period under consideration. It is clear from the table that, area, production and yield of cotton in Maharashtra had a statistically significant rate of growth at 1 per cent level of probability during overall study period that is 1.69 per cent per annum growth in area, 6.92 per cent per annum growth in production and 5.23 per cent per annum in the yield of cotton. Period-wise analysis indicated that area under cotton increased at the rate of 2.42 per cent per annum which was statistically significant at 1 per cent level of probability in period I, while period II and period III had a non-significant growth at the rate of 0.15 and 1.09 per cent per annum respectively. Production of cotton in Maharashtra was found to be increasing at a significant rate of 7.86 per cent per annum at 5 per cent level of probability in period I, which further increased to a statistically significant rate of 10.34 per cent per annum at 1 per cent level of probability during period II. Period III showed a non-significant growth at the rate of 1.27 per cent per annum in production of cotton. Growth in yield of cotton was found to be statistically significant in period II at the rate of 10.22 per cent per annum at 1 per cent level of probability. Period I and period III witnessed a non-significant growth of 6.07 per cent and 0.17 per cent per annum respectively.

Growth in area, production and yield of cotton in Gujarat has been shown in the Table 1. It was clear from the table that period I, period II and overall period had a statistically significant growth rate at 1 per cent level of probability in area, production and yield of cotton in the state. Production of cotton had a higher rate of growth of 7.66 per cent per annum, while area under cotton and yield of cotton had a similar growth rate of 3.79 per cent per annum during the overall study period. Inter-period comparison of growth in area, production and yield of cotton indicated that area under cotton had almost similar rate of growth of 5.69 per cent and 5.61 per cent per annum in period I and period II respectively, while period III showed the non-significant negative growth rate of 0.37 per cent per annum. A high growth in production of cotton was observed in period I at the rate of 13.94 per cent per annum which further increased to 20.48 per cent per annum in period II but negative and non-significant growth of 1.48 per cent per annum was found in period III. Similar trend was found in yield of cotton which showed a high growth rate of 8.29 per cent per annum in period I and it further increased to 14.08 per cent per annum in period II. Non-significant negative growth was observed in period III, with a growth rate of 1.13 per cent per annum in yield of cotton. Similar results were found in a study conducted by Makhare and Tarpara (2016).

Andhra Pradesh showed a statistically significant growth rate of 1.88 per cent per annum in production of cotton at 5 per cent level of probability and 1.38 per cent per annum significant growth rate in yield of cotton at 1 per cent level of probability during the overall study period. Area under cotton was found to be increasing at a non-significant rate of 1.14 per cent per annum during the overall study period. Period-wise analysis registered a statistically significant growth rate of 7.08 per cent per annum at 1 per cent level of probability in area under cotton during period I. While negatively significant growth was found in period III at the rate of 15.27 per cent per annum and non-significant growth rate of 2.67 per cent per annum was registered in period II. In case of production of cotton in Andhra Pradesh had showed a statistically significant growth rate of 9.57 per cent per annum but period III also found to be significant but at the negative growth rate of 15.90 per cent per annum at 1 per cent level of probability. Period I had a non-significant growth rate of 3.23 per cent per annum. It was observed that yield of cotton had a statistically significant growth rate of 2.20 per cent per annum in period II. Non-significant positive growth was found in period I at the rate of 1.59 per cent per annum but non-significant negative growth was found in period III at the rate of 0.98 per cent per annum.

Table 1: Growth in area, production and productivity of cotton in major states.

Period		Period I		Period II		Period III		Overall	
States		CAGR	t value	CAGR	t value	CAGR	t value	CAGR	t value
Maharashtra	A	2.42**	4.51	0.15	0.22	1.09	1.63	1.69**	9.32
	P	7.86*	2.9	10.34**	3.29	1.27	1.16	6.92**	13.86
	Y	6.07	2.23	10.22**	3.58	0.17	0.16	5.23**	10.64
Gujarat	A	5.69**	4.13	5.61**	7.15	-0.37	-0.55	3.79**	15.01
	P	13.94**	8.68	20.48**	7.79	-1.48	-1.19	7.66**	11.4
	Y	8.29**	7.91	14.08**	5.61	-1.13	-0.93	3.79**	7.28
Andhra Pradesh	A	7.08**	4.88	2.67	1.63	-15.27**	-3.66	1.14	1.33
	P	3.23	1.87	9.57**	5.79	-15.90**	-4.21	1.88*	2.09
	Y	1.59	0.52	6.68**	6.89	-0.98	-0.59	1.38**	3.25
Madhya Pradesh	A	-1.49	-1.85	2.20**	3.61	-0.91	-0.94	0.39*	2.16
	P	7.74*	2.66	0.79	0.78	3.96**	5.77	1.87**	4.59
	Y	9.29*	3.15	-1.46	-1.55	4.85**	5.59	1.49*	3.22
Haryana	A	2.96**	3.60	-1.67	-1.75	2.45	1.87	0.36	1.48
	P	-4.81*	-2.55	7.23*	2.51	1.61	0.66	2.86**	4.57
	Y	-4.71	-1.78	9.24*	3.00	-0.82	-0.39	2.87**	4.46
Other States	A	0.77	1.09	-2.01	-1.52	11.71**	4.97	0.97	1.59
	P	0.76	0.45	4.54*	2.94	11.26**	5.83	3.66**	7.47
	Y	-0.006	-0.003	6.68**	6.42	-0.4	-0.35	2.66	0.67

Note: - *- 5% level of significance. ** - 1% level of significance

Statistically significant growth was found in area, production and yield of cotton in Madhya Pradesh during the whole period under consideration that is 0.39 and 1.49 per cent per annum rate of growth was observed in area and yield respectively which had a significance growth at 5 per cent level of probability. While production of cotton had a 1.87

per cent per annum growth rate at 1 per cent level of probability. Detailed period-wise analysis showed the increased significant growth in area at the rate of 2.20 per cent per annum during period II, while period I and period II showed the negative non-significant growth of 1.49 and 0.98 per cent per annum respectively. Production of cotton in Madhya Pradesh showed statistically significant growth at the rate of 7.74 per cent per annum at 5 per cent level of probability. Period III showed the increased significant growth rate of 3.96 per cent per annum at 1 per cent level of probability. While period II showed a non-significant growth rate of 0.79 per cent per annum in production. Similar trend was found in yield of cotton in the state that is increased significant growth rate of 9.29 per cent per annum at 5 per cent level of probability in period I and significant growth rate of 4.85 per cent per annum at 1 per cent level of probability in period III. Negatively non-significant growth rate of 1.46 per cent per annum in period II was observed.

It is evident from the table that Haryana state had a increased growth at the rate of 2.86 per cent per annum in production and 2.87 per cent per annum in yield of cotton which was statistically significant at 1 per cent level of probability but area under cotton was found to be non-significant growth at the rate of 0.36 per cent per annum during the overall period under consideration. Inter-period comparison of growth in area, production and yield of cotton in the state showed statistically significant growth rate of 2.96 per cent per annum in area under cotton at 1 per cent level of probability while negatively non-significant growth rate of 1.67 per cent per annum was observed in period II and positively non-significant growth rate of 2.45 per cent per annum was observed in period III. In case of production of cotton in Haryana showed a negatively significant growth rate of 4.81 per cent per annum at 5 per cent level of probability in period I, positive growth rate of 7.23 per cent per annum was registered in period II which was statistically significant at 5 per cent level of probability and non-significant growth was observed in period III at the rate of 1.87 per cent per annum. Yield of cotton showed a significant growth rate of 9.24 per cent per annum at 5 per cent level of probability in period II while period I and period III had a negatively non-significant growth rate of 4.71 and 0.82 per cent per annum respectively.

Analysis of growth rates in other states showed the increased significant growth in production of cotton at the rate of 3.66 per cent per annum at 1 per cent level of probability. Area and yield of cotton showed the non-significant growth rate of 0.97 and 2.66 per cent per annum during overall period under study. Period-wise analysis found that statistically significant growth rate of 11.71 per cent per annum at 1 per cent level of probability in area

under cotton during period III, while positive and non-significant growth was observed in period I at the rate of 0.77 per cent per annum and negatively non-significant growth at the rate of 2.01 per cent per annum in period II was found. Production of cotton in other states showed the statistically growth rate of 4.54 per cent per annum at 5 per cent probability level in period II and statistically significant growth rate of 11.26 per cent per annum at 1 per cent level of probability in period III. While non-significant growth was found in period I at the rate of 0.76 per cent per annum. Yield of cotton had a significant growth rate of 6.68 per cent per annum at 1 per cent level of significance in period II, while negligible negative non-significant growth rate of 0.006 per cent per annum was found in period I and negative non-significant growth at the rate of 0.40 per cent per annum was found in period III.

Instability analysis of area, production and productivity of cotton in major states.

Instability in area, production and productivity of major cotton growing states were analyzed using co-efficient of variation and Cuddy Della Vally index during the period under consideration and the results were presented in Table 2. It is clear from the Table that Andhra Pradesh has highest instability in area and production with co-efficient of variation of 46.72 and 53.45 and Cuddy Della Valle's Index of 44.33 and 48.99 during the overall period. Haryana showed the highly instable in yield with the indices of CV 35.73 and CDVI 25.52 during overall study period.

Maharashtra state had a stability in area with 17.48 and 8.74 of CV and CDVI, relatively instable in production and yield of cotton with indices of 56.08 and 20.22 and 43.78 and 18.57 respectively. Period-wise instability analysis in area, production and yield of cotton in Maharashtra found to be stable in all the period in area under cotton and indices were 8.57 and 4.45; 5.79 and 5.78; 6.42 and 5.56 of CV and CDVI in period I, period II and period III respectively. Period I and period II showed the relatively instable in terms of production of cotton with indices 31.42 and 22.44; 36.61 and 22.27 of CV and CDVI respectively. Period III was found to be stable in production with CV of 9.62 and CDVI of 8.97 yield of cotton in Maharashtra was stable during the period III with indices 9.21 (CV) and 9.20 (CDVI). Whereas it was relatively instable during period I and period II with 28.06 and 22.62; 33.99 and 19.53 of CV and CDVI values.

Stable growth was found in area of cotton in Gujarat during the overall study period with indices of 32.13 and 10.66 of CV and CDVI. While production and yield of cotton in the state was found to be relatively instable during the period under consideration and the

instability indices were 58.96 and 27.02; 36.33 and 22.09 of CV and CDVI respectively. Sub-period analysis of instability in area of cotton in Gujarat, period III had low instability compared to period I and period II with CV of 5.94 and CDVI of 5.82. CV and CDVI of cotton in area during period I were 19.52 and 10.15 respectively and 18.35 and 7.34 during period II. Period II showed the relatively instable in production of cotton in the state with the CV 53.67 and CDVI 19.35. During period I instability indices were 42.13 and 13.97 and in period III it was 11.84 and 10.98. Period-wise instability in Yield of cotton in Gujarat was found to be stable in period I and period III and relatively instable during period II and the indices were 25.59 and 8.49 in period I; 40.37 and 18.93 in period II and 11.30 and 10.84 in period III.

Table 2: Instability index in area, production and productivity of cotton in major states.

States / Periods		**Period I**		**Period II**		**Period III**		**Overall**	
		CV	**CDVI**	**CV**	**CDVI**	**CV**	**CDVI**	**CV**	**CDVI**
Maharashtra	**A**	8.57	4.45	5.79	5.78	6.42	5.56	17.48	8.74
	P	31.42	22.44	36.61	22.27	9.62	8.97	56.08	20.22
	Y	28.06	22.62	33.99	19.53	9.21	9.2	43.78	18.57
Gujarat	**A**	19.52	10.15	18.35	7.34	5.94	5.82	32.13	10.66
	P	42.13	13.97	53.67	19.35	11.84	10.98	58.96	27.02
	Y	25.59	8.49	40.37	18.93	11.3	10.84	36.33	22.09
Andhra Pradesh	**A**	25.76	13.87	16.33	13.85	58.22	40.34	46.72	44.33
	P	16.72	13.89	32.47	14.88	58.78	40.29	53.45	48.99
	Y	24.14	23.9	21.18	8.47	13.85	13.71	21.09	18.02
Madhya Pradesh	**A**	8.27	6.87	8.15	5.03	8.74	8.24	8.96	8.31
	P	32.29	22.6	8.61	8.34	13.14	5.73	21.4	16.02
	Y	35.57	22.21	9.67	8.49	15.5	6..93	22.18	19.34
Haryana	**A**	11.38	7.11	9.62	8.32	13.12	10.82	11.72	11.24
	P	2.22	15.27	27.19	18.84	20.01	19.71	37.4	26.71
	Y	26.11	22.15	30.79	17.42	17.58	17.41	35.73	25.52
Other States	**A**	6.57	6.13	12.63	10.86	37.83	20.02	33.58	30.96
	P	14.26	14.19	19.9	11.87	3s4.01	16.31	45.98	28.71
	Y	15.41	15.39	20.71	8.02	10.27	10.21	26.44	15.19

Andhra Pradesh was highly instable in area and production and relatively instabile in yield of cotton in the overall study period. The CV and CDVI were 46.72 and 44.33 in area; 53.45 and 48.99 in production; 21.09 and 18.02 in yield. Period-wise analysis of variability in area under cotton in Andhra Pradesh was observed to be stable in period I and period II and highly instable in period III and the indices were 25.76 and 13.87; 16.33 and 13.85 and 58.22 and 40.34 in the respective periods. Similar pattern was observed in production of cotton in the state and the indices were 16.72 and 13.89; 32.47 and 14.88; 58.78 and 40.29 in period I, period II and period III respectively. Instability in yield of cotton in Andhra Pradesh registered 24.14 and 23.90 during period I, 21.18 and 8.47 in period II and 13.85 and 13.71 in period III.

Madhya Pradesh registered a stable growth in area under cotton with CV of 8.96 and CDVI of 8.31, relatively instable growth was observed in production of cotton and the indices were 21.40 and 16.02 and yield of cotton in Madhya Pradesh was also found to be relatively instable with 22.18 per cent of co-efficient of variation and 19.34 of Cuddy Della Vally index during period under consideration. It was evident from the Table that area under cotton was found to be stable in all the periods and the indices were 8.27 and 6.87; 8.15 and 5.03; and 8.74 and 8.24 in period I, period II and period III respectively. Production of cotton was relatively instable in period I and had a stability in period II and period III and the CV and CDVI were 32.29 and 22.60; 8.61 and 8.34 and 13.14 and 5.73 respectively. Similar pattern was observed in yield of cotton and the indices were 35.57 and 22.21; 9.67 and 8.49 and 15.50 and 6.93 in period I, period II and period III.

The results of instability analysis of area, production and yield of cotton in Haryana state were showed in the Table. It was found that Haryana had a relatively instable in production and yield of cotton but area under cotton in the state showed the stability during the overall period under consideration. The instability indices CV and CDVI were 11.72 and 11.24 in area under cotton, 37.40 and 26.71 in production of cotton and 35.73 and 25.52 in the yield of cotton during the period under consideration. Period-wise analysis showed that, instability indices for area of cotton were 11.38 and 7.11; 9.62 and 8.32 and 13.12 and 10.82 in period I, period II and period III respectively. CV and CDVI for production were 2.22 and 15.57; 27.19 and 18.84 and 20.01 and 19.71 in period I, period II and period III respectively. Yield of cotton was relatively instable in all the periods and the indices were 26.11 and 22.15; 30.79 and 17.42 and 17.58and 17.41 in period I, period II and period III respectively. The results were supported by Shimar (2014).

Analyzed results of instability for area, production and yield of cotton in other states) shown in the Table 2. It was found that high instability in area of cotton with CV and CDVI were 33.58 and 30.96, relatively instable in production and yield of cotton with 45.98 and 28.71 26.44 and 15.19 instability indices respectively during the overall study period. Period-wise analysis recorded instability indices as 6.57 and 6.13; 12.63 and 10.86 and 37.83 and 20.02 in period I, period II and period III respectively in area under cotton. Indices for production of cotton were 14.26 and 14.19; 19.90 and 11.87 and 34.01 and 16.31 in period I, period II and period III respectively. Stable growth was found in yield of cotton in other states and CV and CDVI were 15.41 and 15.39; 20.71 and 8.02 and 10.27 and 10.21 period I, period II and period III respectively.

Decomposition analysis

An effort has been made to analyse the contribution of area and productivity for change in production of cotton in major cotton growing states of India. The study period was divided into three sub-periods period I, period II and period III and overall period taking into consideration the importance of each sub-period as discussed in methodology. Period-wise analysis of percentage contribution of area, yield and their interaction for change into production of cotton in different states was carried out and the results have been shown in Table 3.

The table depicted that yield effect was the major factor responsible for change in production of cotton in Maharashtra during the overall period under consideration. Period-wise analysis showed that yield effect had a major role in production of cotton during period I and period II with 63.38 per cent and 109.29 per cent contribution to the change in production of cotton respectively. In period II however, negative but small effect of area and interaction of area and yield on change in production of cotton was observed. In sum, yield effect had a more important role in change in production of cotton in period I, period II and overall period while area effect had a major role in change in production of cotton in period III in Maharashtra. It indicated that technology played a more role in increasing the production of cotton in Maharashtra over time.

In case of Gujarat, it was found that interaction effect of both area effect and yield effect of cotton was made larger contribution to production of cotton. Interaction effect was 39.65 per cent, area effect was 32.37 per cent and the yield effect was 27.98 per cent during overall period. Detailed analysis of change in production of cotton in the state showed that

yield effect had a major contribution in all the three periods that is 52.13 per cent in period I, 50.13 per cent in period II and 110.07 in period III. Period I and period II showed almost a similar area effect in production of cotton with 23.84 per cent and 23.32 per cent shares respectively. Negative area effect was found in period III i.e., 11.49 in production of cotton. Period-wise interaction effect was found to be 24.03 per cent, 26.55 per cent and 1.43 per cent in period I, period II and period III respectively.

Table 3: Percentage contribution of area, yield and their interaction to change in production of cotton in major states of India

Period/ States		Period I	Period II	Period III	Overall
Maharashtra	**Area effect**	23.38	-5.5	96.93	13.51
	Yield effect	63.38	109.26	2.53	53.79
	Interaction effect	13.25	-3.76	0.54	32.69
Gujarat	**Area effect**	23.84	23.32	-11.49	32.37
	Yield effect	52.13	50.13	110.07	27.98
	Interaction effect	24.03	26.55	1.43	39.65
Andhra Pradesh	**Area effect**	57.39	25.55	81.55	-7.34
	Yield effect	21.68	55.29	43.81	112.35
	Interaction effect	20.94	19.16	-25.37	-5.01
Madhya Pradesh	**Area effect**	-16.92	117.56	0.84	8.67
	Yield effect	130.92	-14.75	98.67	83.45
	Interaction effect	-14	-2.81	0.48	7.88
Haryana	**Area effect**	-173.97	-52.64	71.05	18.48
	Yield effect	241.96	182.77	20.73	59.19
	Interaction effect	32.01	-30.13	8.23	22.34
INDIA	**Area effect**	46.39	9.03	155.49	32.66
	Yield effect	44.41	84.43	-45.38	41.09
	Interaction effect	9.2	6.54	-10.11	26.24

Production of cotton in Andhra Pradesh was mostly effected by yield of cotton during the overall period under study with 112.35 per cent contribution to increase in production of cotton. Whereas area effect of cotton and interaction effect of area and yield were found to be negative that is 7.34 per cent and 5.01 per cent respectively. Period-wise analysis showed that

area effect was largely responsible for increased production of cotton over time with a percentage shares of 57.39 and 81.55 during period I and period III respectively. 25.55 per cent of area effect was observed in cotton production during period II. Yield effect was found to be more in period II with 55.29 per cent, followed by 43.81 per cent in period III and 21.68 per cent in period I. Negative interaction effect was observed in period III with 25.37 per cent, positive and almost the same percentage share of interaction effect was observed during period I and period II with 20.94 and 19.16 in production of cotton.

Yield effect had a major contribution in cotton production in Madhya Pradesh during the overall study period with 83.45 per cent share. Area effect contributed 8.67 per cent and 7.88 per cent was contributed by interaction effect in cotton production in overall period under consideration. Period-wise analysis found a negative contribution of area effect and interaction effect in period I with 16.92 per cent and 14.00 per cent respectively. Production of cotton was majorly influenced by yield effect (130.92 per cent) during period I. Area effect was found to be a major contributor to cotton production in period II with 117.56 per cent share. While yield effect and interaction effect showed a negative effect (14.75 and 2.81 per cent respectively) on cotton production. In period III, yield effect had a major contribution in production of cotton which showed the per cent share of 98.67. The table revealed that yield effect was the main contributor to increase in cotton production in overall period and period I while area effect had a dominant role in influencing cotton production in period II.

In case of Haryana, cotton production was mostly influenced by yield effect with 59.19 per cent, followed by 22.34 per cent of interaction effect and 18.48 per cent of area effect during the overall study period. Yield effect was found to be major contributor in cotton production in Haryana during period I and period II with a percentage share of 241.96 and 182.77 respectively. Negative area effect was found in period I and period II with 173.97 per cent and 52.64 per cent respectively. Interaction effect was also found negative during period II with 30.13 per cent while positive effect was found in period I with 32.01 per cent and 8.23 per cent in period III. Area effect was observed to be more during period III with 71.05 per cent followed by yield effect pf 20.73 per cent in production of cotton. In short it may be inferred that yield effect played a major role in production of cotton in overall period, period I and period II.

So far production of cotton in India was concerned, it was mostly influenced by yield effect with 41.09 per cent, followed by area effect (32.66 per cent) and interaction effect

(26.24 per cent) in overall time period. There are evidences to show that yield effect was stronger than area effect in cotton production (Singh et.al. 2019). Period-wise analysis showed that area effect was a major contributor to cotton production during period III with 155.49 per cent, followed by 46.39 per cent in period I and 9.03 per cent in period II. Yield effect played a major role in cotton production during period II with 84.43 per cent contribution, followed by 44.41 per cent contribution in period I and negative yield effect was observed in period III with 45.38 per cent share in cotton production. Period-wise interaction effect was found to be 9.20 per cent in period I, 6.54 per cent in period II and negative effect was found in period III with 10.11 per cent. The overall picture that emerged, revealed that yield effect had larger influence on cotton production in overall period and period II. On the other hand, area effect had a dominant role in period I and period III.

Conclusion

It can be concluded that growth performance of cotton in major cotton growing states witnessed that Maharashtra and Gujarat state had a positive and significant growth rate in area under cotton, production of cotton and yield of cotton during the overall study period. Andhra Pradesh showed the negative growth rate in area and production of cotton in period III which may be due to partition of state into Andhra Pradesh and Telangana in 2014. But yield of cotton showed a significant growth rate during overall study period. Production of cotton was also found to be significant in Madhya Pradesh, Haryana and other states.

It was evident from the study that the variability in area, production and yield of cotton in major cotton growing states had a stable growth in area under cotton in states like Maharashtra, Gujarat, Madhya Pradesh, and Haryana. While, Andhra Pradesh and other states showed the highly instable in area under cotton during the overall study period. in case of production of cotton all selected states showed relatively instable except Andhra Pradesh which showed highly instable in production during overall period under consideration. All the selected states showed the relatively instability in yield of cotton during the overall period under study.

Contribution of yield effect was more in production of cotton in India during the overall study period. It played a dominant role in increasing cotton production in almost all cotton growing states other than Gujrat wherein area effect was found to have a more important role in production of cotton during the period under study. In nutshell, technology

was found to be the largely responsible for increased production of cotton in India in the period under study.

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