

**CONTEMPORARY DYNAMICS IN GROWTH AND INSTABILITY IN AREA,
PRODUCTION AND PRODUCTIVITY IN MAJOR COTTON PRODUCING STATES
OF INDIA**

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ABSTRACT

Cotton is the most promising crop in Indian agriculture in terms of its contribution to the country's agricultural gross domestic product as well as in creating gross employment and export earnings. But despite technological and policy interventions having ensured phenomenal growth in cotton sector over the decades, the country's yield is still 30 per cent less than the world average. At the same time, with the introduction of Bt technology there has been significant increases in growth dimensions of cotton. Such dynamic changes call for the study of growth and instability in cotton production. Accordingly, in the present study, the growth dynamics in cotton has been analyzed from 1971-72 to 2015-16. The findings showed that the growth rates after Bt introduction (2001-2015) in terms of area (3.70 %), production (9.89 %) and productivity (5.98 %) were more than that of the overall study period. At the same time, instability was less in earlier pre-Bt periods. Besides, the observations from Gujarat state revealed that the local cotton cultivators of the state were equally effective as that of Bt cotton in productivity. As suggestions, the study puts forward that cotton productivity can further be accelerated by strengthening the research system with singular focus on developing multiple resistances to pests and diseases.

KEY WORDS: Cotton, Growth, Instability, Bt technology, India

INTRODUCTION

Cotton is the world's most popular textile raw material and is often referred to as the '**King of Fibres**' or '**White Gold**'. Worldwide, cotton is grown in over 120 countries among which India continues to hold the largest area under cotton (34 % of world area) and has attained the status of world's largest cotton producer (30.01 million bales, which happens to be 25 % of the world's total production) surpassing the China (28.20 million bales) in 2015-16. In

India, cotton is grown in the nine major states and in three different zones viz., Punjab, Haryana and Rajasthan (north zone), Maharashtra, Gujarat and Madhya Pradesh (central zone) and Andhra Pradesh, Karnataka and Tamil Nadu (south zone). About 60 million people including 15 million cultivators get employment either directly or indirectly in the agricultural and industrial sectors related to cotton production, processing, textiles. By way of cotton exports, the foreign exchange

earnings in 2015-16 alone amount to Rs. 12,821 crores (Anonymous, 2016).

Till 1970s, the country used to import massive quantities of cotton in the range of 8 to 9 lakh bales per annum. It was only after the launch of special schemes like intensive cotton production programmes around mid 1970's, the cotton production in the country received the necessary impetus through increase in area and sowing of hybrid varieties. Over the years, country has achieved significant quantitative increases in cotton production. The growth in the cotton sector is led by several technological innovations and policy decisions such as development of hybrids in 1970's, new policy on seed development (NPSD) in 1988, economic reforms in 1992 and introduction of *Bt* cotton in 2002. Among all these interventions, the *Bt* technology single-handedly changed the landscape of cotton crop and has become the fastest adopted technology in the history of Indian agriculture.

Within a decade after its commercialization in 2002, totally 1128 *Bt* hybrids have been developed and *Bt* cotton hybrid seed portfolio has evolved remarkably from single-trait monopoly situation to multi-traits monopolistic situation, giving farmers a wider choice for seeds and boosting the agri-biotech industry in the country. Consequently, *Bt* hybrids have replaced almost the entire area of local and improved cotton cultivars in the country. However, in spite of universal adoption of *Bt*, there exists wide variation in cotton yield across cotton-growing states due to differences in climatic conditions, infrastructural developments and input utilization pattern. It is worth mentioning that cotton yield, though improved, is still 31 per cent lower than the average world cotton yield and the recent years have witnessed stagnation in the yield due to a

complex set of inter-related factors of cotton production (Srivastava and Kolady, 2016).

Growth rates are the measures of past performance of economic variables. Policy decisions are often made based on such growth rates which in turn get impacted by instability. It has been often reiterated that such instability in farm production cause serious shocks to supply and farm income (Chand and Raju, 2008). It is beyond any doubt that the Indian cotton production has undergone a metaphoric rise from 2002-03, after introduction of *Bt* cotton which occupies 95 per cent of the total cotton area in the country (Narala and Reddy, 2011). These dynamic changes underline the importance of studying the growth performance and instability of cotton before and after *Bt* cotton introduction. Therefore, the present study was undertaken to analyse the growth and instability in cotton area, production and productivity during 1971-72 to 2015-16.

MATERIALS AND METHODS

The present study is based on the secondary data collected from Directorate of Economics and Statistics, Government of India (Anonymous, 2016). The time series data on area, production, and productivity of cotton for major nine cotton growing states were collected for a period from 1971-72 to 2015-16. The study period was divided into four different periods. The first period (period – I) includes data from the year 1971-72 to 1985-86. It shows the growth and instability of area, production and yield of cotton in India after introduction of hybrids. Cultivation of hybrids in cotton crop throughout the India resulted in considerable growth of area, production and yield during the initial period of fifteen years. Then afterwards, extensive and mono cultivation resulted in severe pest and disease problems in major cotton cultivating states of India. These lead to stagnation in yield as well as instability in production

which have been captured in second period starting from the year 1986-87 to 2000-01.

Mahyco (Maharashtra Hybrid Seeds Company) in collaboration with a US based company (Monsanto Corporation) introduced *Bt* cotton technology in India in 2002. The *Bt* gene expression confers high level of tolerance to the bollworm complex, the most problematic pest hindrance in cotton cultivation. Since then, the *Bt* hybrids have covered almost the entire area and its positive impact is attributed in improving cotton yield at the macro level across major and minor cotton producing states (Srivastava and Kolady, 2016). The impacts are reflected through the reversal in India's position from a net importer to a net exporter of cotton, impressive growth in agro-biotech industry and narrowing down of difference between average yields of India and the world. Accordingly, the impact of *Bt* technologies as well as recent trend in cotton cultivation is analysed in third period (from 2001-02 to 2015-16). Overall trend in area, production and yield of cotton during last forty five years in India is given in period-IV (1971-72 to 2015-16).

Tools of analysis

(i) Growth rate

The compound growth rates (CGRs) of area, production and productivity of cotton in India as well as across the major cotton producing states were calculated using the exponential function of the following specification,

$$Y_t = ab^t \quad \text{..... (1)}$$

In the log form, the above function (1) was formulated as:

$$\text{Log } Y_t = \text{Log } a + t \text{ log } b \quad \text{..... (2)}$$

Where,

Y_t = Area/production/productivity of cotton in the year 't',

t = Time variable in years taking the value of 1, 2, 3,...,n,

a = Intercept,

b = Regression coefficient $(1+r)$, and

r = Compound growth rate

The value of log b in equation (2) was computed using the formula:

$$\text{Log } b = \frac{\sum t \cdot \text{Log } Y - (\sum t \cdot \sum \text{Log } Y / N)}{\sum t^2 - [(\sum t)^2 / N]} \quad \text{.....(3)}$$

Where, N = Number of years.

Subsequently, the compound growth rate (%) was computed using the formulation:

$$\text{Compound growth rate (r)} = [(\text{Antilog of log } b) - 1] \times 100 \quad \text{..... (4)}$$

The standard error (SE) of Log b arrived by using

$$\text{SE (Log } B) = \sqrt{\frac{\sum (Y - \bar{Y})^2 - \text{Log } b \cdot (\sum (Y \cdot t) - \sum (Y) \cdot \bar{t})}{(N-2) \sum (t - \bar{t})^2}} \quad \text{.....(5)}$$

Student 't' test was used to determine the significance of the growth rates of *Bt* aimed for which the following formulation was employed,

$$t = \frac{\text{Log } b}{\text{SE(Log } b)} \quad \text{..... (6)}$$

The calculated 't' values, from equation (6), were compared with the table 't' values and the significance were tested for 1 per cent, 5 per cent and 10 per cent probability levels.

(ii) Instability

The instability in cotton production in terms of area, production and productivity in India and across the major producing states was measured using coefficient of variation (CV) whose formulation is specified as,

$$\text{CV} = \frac{\left[\frac{1}{N-1} S(X_t - \bar{X})^2 \right]^{1/2}}{\bar{X}} \times 100 \quad \text{..... (7)}$$

Where,

N = Number of years,

X_t = Area / Production / Productivity of cotton in year 't', and

$\bar{X}$ = Mean of Area / Production / Productivity of cotton

RESULTS AND DISCUSSION

Trends in area, production and productivity of cotton in India

The results of mean, compound growth rates and coefficient of variation as a measure of instability of area, production and yield of cotton in India and major cotton producing states for four different periods has been presented and discussed. It was observed that the area under cotton cultivation in India increased at the rate of 1.82, 2.16 and 3.70 per cent during period-I, II and III, respectively (Table 1). The highest increase in area under cotton cultivation in India was observed during 2001-02 to 2015-16 (period-III) followed by period-II and period-I.

Shiv Sankar and Naidu (2015) also reported that India registered a positive growth of area of cotton at 0.3631 per cent during 1970-71 to 2013-14, which might be due to introduction of *Bt* hybrids in cotton cultivation. The findings of Srivastava and Kolady (2016) confirmed a structural change in yield levels since the introduction of *Bt* technology and its positive impact in improving cotton yield at the macro level. Kalamkar *et al.* (2002) reported that the production of cotton experienced a growth rate of 2.50 per cent and this increased production has been mainly as a result of growth in productivity, which was 2.22 per cent, where area contribution has been only 0.28 per cent per annum during 1949-50 to 1997-98 in India. So far as the stability of area under cotton cultivation is concerned, it was found to be the highest during period-II. The area under cotton cultivation in India increased at the rate of 1.25 per cent during overall period from 1971-72 to 2015-16 with an average of 8.48 million ha. Almost similar trend was observed in case of cotton production in India with the highest increase at the rate of 9.89 per cent during period-III. The cotton production was found more

stable during period-I as compared to other periods of study.

It is due to the fact that the hybrids are more sensitive to change in biotic and abiotic conditions as compared to local and improved varieties. During overall period of study, the cotton production in India was increased at the rate of 3.79 per cent. The yield of cotton in India also registered positive and significant growth during overall period as well as during all three sub periods with highest rate of increase during period-III. Narala and Reddy (2011) also observed that the growth in area, production and yield during post-*Bt* introduction (2002-03 to 2010-11) were 4.45, 9.72 and 5.02 per cent, respectively, as against the pre-*Bt* introduction (1993-94 to 2001-02) with 1.53, 4.37 and 2.83 per cent in that order. The rate of increase in productivity was more during 1971-72 to 1985-86 (period-I) as compared to period-II, because of better performance of hybrids during the initial period, while susceptibility to insects and pests lowers its productivity during late 80s and 90s. These results are in conformity with the findings of Narmadha and Alagumani (2015), who reported that the growth in area, production and productivity during post-WTO (1994-95 to 2013-14) were 1.69, 5.88 and 4.09 per cent, respectively, whereas during pre-WTO period (1970-71 to 1993-94), the area has decreased (-0.18 %) and production and productivity registered positive growth rates of 3.41 and 2.83 per cent, respectively.

Growth performance of cotton in central zone states

The results of three major cotton producing states of Maharashtra, Gujarat and Madhya Pradesh lies in central cotton zone has been presented in Table 2. The results revealed that the highest increase in area, production and yield of cotton in Maharashtra was noticed in period-III to the tune of 3.56, 9.63 and 5.85 per cent per

annum, respectively, followed by period-II and I. A significant increase in area, production yield of cotton was found in Maharashtra during overall period. Higher magnitude of CGRs during period-II as compared to period-I was due to late adoption of hybrid in the state. The area, production and yield of cotton found more stable during period-I in Maharashtra. Similar trend was found in Gujarat except in case of area under cotton during period-I, which registered a negative and significant rate of decrease at 2.21 per cent. The highest increase in area (3.97 %), production (10.91 %) and yield (6.69 %) of cotton was observed during *Bt* cotton era (2001-02 to 2015-16).

The state of Gujarat registered an increase in area, production and yield of cotton at the rate of 1.19, 4.49 and 3.26 per cent, respectively during the overall period. These results are in conformity with the findings of Ardesbina and Shiyani (2010), who also observed that the area, production and yield of cotton increased at the rate of 0.19, 2.12 and 2.17 per cent during 1960-61 to 2007-08 in Gujarat state. Mehta (2012) also reported that the single most important factor of the widespread adoption of *Bt* cotton resulted in growth of area and productivity have combined to cause production growth rate of 15.4 per cent during the period 2000-01 to 2010-11 in Gujarat. The area, production and yield of cotton found more stable during period-I in Gujarat. The rate of increase in area under cotton was negative and non-significant in Madhya Pradesh during period-I and II as well as during overall period. So far as the production of cotton in Madhya Pradesh is concerned, it increased significantly at rate of 1.99, 13.03 and 4.30 per cent during period-II, III and IV, respectively. The increase in production of cotton in Madhya Pradesh was only due to increase in productivity during period-II, III and IV

which increase at the rate of 2.82, 12.93 and 4.47 percent, respectively. Narmadha and Alagumani (2015) also reported that the growth in area under cotton in Madhya Pradesh was -1.33 per cent during pre-WTO period (1970-71 to 1993-94). The area of cotton found more stable during period-II, while production and yield was more stable during period-I in Madhya Pradesh.

Growth performance of irrigated and un-irrigated cotton in Gujarat

The area, production and yield of irrigated and un-irrigated cotton in Gujarat has been also separately analysed and given in Table 3. The data revealed that the area under irrigated cotton was continuously increased throughout the study period, while area under un-irrigated cotton decreased at the rate of 1.03 per cent during 1986-87 to 2015-16. The production of irrigated cotton increased at the rate of 8.27, 11.69 and 10.62 per cent, which was quite higher than the rate of increase in production of un-irrigated to the tune of 6.16, 3.90 and 3.81 percent, respectively, during period-II, III and IV. It was due to the area as well as yield effect in irrigated cotton, while in un-irrigated cotton, the yield effect was more but area effect was stagnant during 1986-87 to 2015-16. The area and production were found to be remained more stable in un-irrigated cotton, while yield was found to be remained more stable in irrigated cotton. This revealed that introduction of *Bt* cotton did not contributed more in increase the yield of irrigated cotton. This means that our local hybrid varieties are equally capable as of *Bt* varieties, barring some pests' incidence. The release of the world's first intra-specific *hirsutum* hybrid cotton hybrid-4, from Surat in 1971 was a landmark in the history of cotton in Gujarat, which remarkably increased cotton productivity. The instability in yield of un-irrigated cotton was due to variation in rainfall, while instability of area

was due to price fluctuation and profitability.

Growth of area, production and yield of cotton in north zone

The results of north zone cotton producing states of Haryana, Punjab and Rajasthan has been presented in Table 4. The state of Haryana registered a positive and significant growth of area, production and yield of cotton in all the three sub periods and during overall period, except in period-II in case of production. The highest rate of increase in area (3.15 %) was in during period-I, while that of in Production (4.33 %) and yield 3.80 %) was observed during period-III. The area, production and yield of cotton found more stable during period-I, II and III, respectively in Haryana state.

In Punjab, the area under cotton increased at the rate of 1.36 per cent during period-I, while it decreased at the rate of 1.45, 1.84 and 0.52 per cent during period-II, III and IV, respectively. The production also showed decreasing trend during period-II in which, it was decreased at the rate of 5.97 per cent, while it was non-significant during period-III. During overall period of study, the cotton production in Punjab was increased at the rate of 1.09 per cent. The rate of increase in productivity was found negative during period-I (-0.93 %) and II (-4.59 %), while it was positive during period-III (1.49 %) and period-IV (1.62 %). The area, production and yield of cotton found more stable during period-I in Punjab. The highest rate of increase in area (4.58 %) and production (4.88 %) was observed in Rajasthan during period-II, while that of in yield was observed during period-III (1.02 %). It implies that the growth in production during period-II was merely due to area increase but in period-III, it was due to increase in productivity as a result of cultivation of *Bt* hybrids rather than area. The stability of area, production and yield of

cotton was more during period-I as compared to period-II and III in Rajasthan.

Growth of area, production and yield of cotton in south Zone

The area under cotton cultivation showed highest increase (8.90 %) during period-III followed by period-II and I among three sub periods in south zone cotton cultivating state of Andhra Pradesh (Table 5). The highest increase in production (13.5 %) and yield (8.82 %) was observed during period-I followed by period-III. During overall period the area, production and yield of cotton increased at the rate of 4.60, 7.71 and 3.21 per cent per annum, respectively in Andhra Pradesh. So far as the stability is concerned, area (23.47 %) was found more stable during period-I, while production (33.83 %) and yield (19.88 %) was more stable during period-II. The area, production and yield of cotton were increased at the rate of 4.60, 7.71 and 3.21 per cent, respectively, in Andhra Pradesh during 1971-72 to 2015-16. The state of Karnataka registered negative significant growth of area under cotton during period-I and period-IV. The highest increase in area, production and yield of cotton in Karnataka was observed during 2001-02 to 2015-16 (period-III) which was increased at the rate of 3.75, 13.69 and 9.58 per cent. So far as the stability is concerned, area (13.17 %) was found more stable during period-I while production (18.88 %) and yield (10.23 %) during period-II. The area under cotton decreased at the rate of 2.14, 1.28 and 2.18 per cent per annum, respectively, during period-I, II and IV, while it increased at the rate of 2.18 per cent per annum during period-III in Tamil Nadu. The growth of production of cotton observed to be increased at the rate of 10.86 per cent per annum, but it decreased during period-II (1.42 %) and remained non-significant during period-I as well as during overall period in Tamil Nadu. The highest

productivity growth of cotton was observed only during period-I followed by that of during period-III and IV in the state among the study periods. Thus, in Andhra Pradesh and Tamil Nadu, Bt cotton technology could not found impressive in increasing cotton yield.

CONCLUSION

The area, production and yield of cotton cultivation in India increased at the rate of 1.25, 3.79 and 3 per cent, respectively during 1971-72 to 2015-16. Except Andhra Pradesh and Tamil Nadu, all major cotton growing states in India experienced higher growth of area, production and productivity during 2001-02 to 2015-16 as compared to earlier era could be attributed to introduction of Bt cotton. In Gujarat, the area under irrigated cotton continuously increased throughout the study period, while area under un-irrigated cotton decreased at the rate of 1.03 per cent per annum during 1986-87 to 2015-16. The introduction of Bt cotton only marginally contributed for increasing irrigated cotton yield in Gujarat revealed that local hybrids evolved in state from 1971 and onwards were equally capable as that of Bt cotton, barring some incidence of pests. Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu registered around 3 per cent per annum cotton yield growth during 1971-72 to 1985-86 with less area under irrigation about 25 per cent, whereas Maharashtra, Gujarat, Madhya Pradesh, Rajasthan and Karnataka registered around 10 per cent cotton yield growth during 2001-02 to 2015-16 with introduction of Bt cotton and increased area under irrigation about 35 per cent. Improved technologies coupled with favourable weather and low insect pest pressure in major cotton growing tracts has enabled this transformation in production and productivity. This needs to further accelerating the productivity by strengthening cotton research system having

multi resistance to pests including diseases, weeds and nematodes.

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Table 1: Trends in area, production and productivity of cotton in India

Periods	Item	A	P	Y
Period – I (1971-72 to 1985-86)	Mean	7276.13	7513.37	156.87
	CGR (%)	1.82	0.42	2.00
	CV (%)	11.04	9.65	12.66
Period – II (1986-87 to 2000-01)	Mean	7992.60	10554.27	223.20
	CGR (%)	2.16	3.27	1.10
	CV (%)	10.98	20.01	14.03
Period – III (2001-02 to 2015-16)	Mean	10161.53	24348.27	394.73
	CGR (%)	3.70	9.89	5.98
	CV (%)	17.34	38.61	26.44
Period - IV (1971-72 to 2015-16)	Mean	8476.75	14138.63	258.27
	CGR (%)	1.25	3.79	3.00
	CV (%)	20.35	65.05	46.10

Note: Area (A) in '000' ha, Production (P) in '000' bales each of 170 kg and Yield (Y) in kg/ha

All CGRs are significant at 1 per cent probability level

Table 2: Growth of area, production and productivity of cotton in central zone

Periods	Item	Maharashtra			Gujarat			Madhya Pradesh		
		A	P	Y	A	P	Y	A	P	Y
Period-I (1971-72 to 1985-86)	Mean	2509.65	1283.81	86.40	1637.71	1813.35	190.73	614.15	293.14	81.33
	CGR(%)	1.27	3.18	1.86	-2.21	0.77	3.05	-1.58	-1.20	0.40
	CV (%)	7.74	29.07	24.69	11.45	15.15	19.73	9.04	20.91	19.05
Period-II (1986-87 to 2000-01)	Mean	2831.13	2074.67	123.80	1317.00	1976.47	247.93	520.07	366.80	120.53
	CGR(%)	1.75	5.64	3.81	3.69	7.33	3.48	-0.80	1.99	2.82
	CV (%)	9.71	33.87	30.62	18.84	45.21	34.54	7.66	22.11	23.34
Period-III (2001-02 to 2015-16)	Mean	3475.13	5559.87	263.27	2312.80	7110.80	503.93	596.93	1177.27	335.27
	CGR(%)	3.56	9.63	5.85	3.97	10.91	6.69	0.10 [#]	13.03	12.93
	CV (%)	16.92	40.74	28.98	18.46	39.39	30.11	8.46	54.85	54.84
Period-IV (1971-72 to 2015-16)	Mean	2938.64	2972.78	157.82	1755.84	3633.54	314.20	577.05	612.40	179.04
	CGR(%)	1.18	4.98	3.75	1.19	4.49	3.26	-0.17 [#]	4.30	4.47
	CV (%)	18.97	77.90	58.00	29.32	82.39	54.27	10.97	89.45	86.21

Note: Area (A) in '000' ha, Production (P) in '000' bales each of 170 kg and Yield(Y) in kg/ha

denotes non significant growth rates while remaining all CGRs are significant at 1 per cent probability level

Table 3: Growth performance of irrigated and un-irrigated cotton in Gujarat

Periods	Item	Irrigated			Un-irrigated		
		A	P	Y	A	P	Y
Period-II (1986-87 to 2000-01)	Mean	432.13	1133.43	432.18	883.27	841.30	158.81
	CGR (%)	5.11	8.27	3.00	3.01	6.16	3.05
	CV (%)	28.28	47.43	31.08	15.43	44.72	37.86
Period-III (2001-02 to 2015-16)	Mean	1376.93	5458.40	651.59	935.33	1323.87	243.52
	CGR (%)	8.38	11.69	3.01	-1.03	3.90	4.90
	CV (%)	35.93	45.22	28.04	13.86	34.61	32.53
Period-IV (1986-87 to 2015-16)	Mean	833.74	2966.47	522.25	923.71	1055.64	193.93
	CGR (%)	7.54	10.62	2.85	0.54	3.81	3.27
	CV (%)	69.47	91.93	35.70	14.47	42.76	40.06

Note: Area (A) in '000' ha, Production (P) in '000' bales each of 170 kg and Yield (Y) in kg/ha

All CGRs are significant at 1 per cent probability level

Table 4: Growth of area, production and yield of cotton in north zone

Periods	Item	Haryana			Punjab			Rajasthan		
		A	P	Y	A	P	Y	A	P	Y
Period-I (1971-72 to 1985-86)	Mean	300.06	566.39	320.40	586.26	1170.83	344.40	348.36	430.37	209.13
	CGR (%)	3.15	4.09	0.92	1.36	0.42	-0.93	1.49	3.37	1.84
	CV (%)	17.47	21.90	11.24	12.87	13.95	17.54	12.81	21.03	12.87
Period-II (1986-87 to 2000-01)	Mean	530.93	1167.07	375.07	642.67	1703.53	446.60	499.67	881.80	299.60
	CGR (%)	3.03	2.70	-0.31	-1.45	-5.97	-4.59	4.58	4.88	0.28 [#]
	CV (%)	15.61	20.73	16.70	14.98	32.87	26.87	22.38	30.95	24.07
Period-III (2001-02 to 2015-16)	Mean	559.93	1781.13	545.80	506.53	1892.80	628.73	413.27	919.27	380.20
	CGR (%)	0.50	4.33	3.80	-1.84	-0.38 [#]	1.49	0.48	10.56	10.02
	CV (%)	11.51	31.67	30.72	15.14	28.50	21.61	15.27	41.00	36.42
Period-IV (1971-72 to 2015-16)	Mean	463.64	1171.53	413.76	578.49	1589.05	473.24	420.43	743.81	296.31
	CGR (%)	2.14	3.76	1.59	-0.52	1.09	1.62	0.74	2.70	1.95
	CV (%)	29.11	52.36	34.20	17.13	34.26	33.92	23.56	46.95	38.45

Note: Area (A) in '000' ha, Production (P) in '000' bales each 170 kg and Yield (Y) in kg/ha

[#]denotes non significant growth rates while remaining all CGRs are significant at 1 per cent probability level

Table 5: Growth of area, production and yield of cotton in south zone

Periods	Item	Andhra Pradesh (Including Telangana)			Karnataka			Tamil Nadu		
		A	P	Y	A	P	Y	A	P	Y
Period-I (1971-72 to 1985-86)	Mean	411.97	494.34	192.73	953.78	636.53	114.00	260.12	372.17	242.07
	CGR (%)	4.32	13.51	8.82	-1.44	0.60	2.02	-2.14	0.77 [#]	2.97
	CV (%)	23.47	58.67	44.27	13.17	20.61	19.65	19.23	31.94	23.57
Period-II (1986-87 to 2000-01)	Mean	821.67	1236.93	254.20	589.07	783.60	225.07	233.55	397.21	290.23
	CGR (%)	6.26	8.23	1.86	0.72	2.23	1.49	-1.28	-1.42	-0.14 [#]
	CV (%)	28.11	33.83	19.88	13.66	18.88	10.23	13.87	16.76	12.22
Period-III (2001-02 to 2015-16)	Mean	1563.40	3887.67	433.00	510.73	1027.53	322.47	126.95	314.58	314.73
	CGR (%)	8.90	12.93	5.71	3.75	13.69	9.58	2.13	10.86	1.40
	CV (%)	40.46	53.38	32.31	28.19	59.82	38.22	24.79	53.52	41.45
Period-IV (1971-72 to 2015-16)	Mean	932.35	1872.98	293.31	684.53		220.51	206.87	361.32	282.34
	CGR (%)	4.60	7.71	3.21	-1.80	1.56	3.42	-2.18	-0.44 [#]	0.81
	CV (%)	66.08	101.62	48.19	33.25	48.91	50.87	33.60	35.17	31.25

Note: Area (A) in '000' ha, Production (P) in '000' bales each of 170 kg and Yield (Y) in kg/ha

All CGRs are significant at 1 per cent probability level

[MS received : August 23, 2017]

[MS accepted : September 07, 2017]