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Growth and instability of cotton crop in major cotton growing states in India

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Abstract
Cotton plays a key role in the Indian economy in terms of income generation in the agricultural and industrial sectors by providing substantial employment and making significant contributions to export earnings. It also plays very important role in the State's economy of India. The present study examines the growth and instability of cotton in terms of area, production and productivity of cotton in major cotton growing states of India during the different periods since 1970-71 to 2013-14. For this purpose compound growth rates were estimated by fitting the exponential function and coefficient of variation was worked out to find out instability associated. From the analysis, it was establish that that the area under cotton in Andhra Pradesh, Gujarat, Haryana, Maharashtra, Rajasthan and all-India witnesses a positive annual growth rate but Karnataka and Tamil Nadu show a negative significant growth Considering the production of cotton, Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and All-India noticed a significant positive growth where as Tamil Nadu shows insignificant negative growth. The productivity scenario revealed that all the states and the country as a whole increased significantly. The instability analysis indicates that Andhra Pradesh witness high instability in area, production and productivity of cotton when compared to major cotton growing states and all-India during the different periods.

Keywords: Cotton Crop, Growth, Instability, Major Cotton Growing States, India

Introduction

Cotton is one of the important fiber and cash crop in India and it plays a dominant role in the economy of the country and hence known as "white gold" and "king of fibres". India has emerged as the second largest producer of cotton in the world after China and occupies the first position in terms of total area under cotton cultivation. India contributes to the world accounting for about 23 percent of the world cotton production and about 17 percent of the total world supply. Besides, about 14 percent of the exports from in India and its share in the global Mill use are about 18 percent. However, the productivity level is still below the world average. Efforts are in place to increase the current productivity to bring it closer to the world average. In addition to meeting the cotton consumption demands of the domestic textile industry, India has surplus cotton available for exports.

Cotton plays a key role in the Indian economy in terms of income generation in the agricultural and industrial sectors by providing substantial employment and making significant contributions to export earnings. It plays very important role in the State's economy also. Every year around 16 million cotton bales are being produced (Sharma P.K. and *et al*., 2007). It is an important raw material for the Indian textile industry, constituting about 65 per cent of its requirements. The Indian textile industry occupies a significant place in the country's economy, with 1500 mills, 4 million handlooms, 1.7 million power looms and thousands of garment, hosiery and processing units, providing employment directly or indirectly to around 35 million people (Cotton Seasonal Report, 2009). Textiles and related exports account for the nearly 33per cent of the total foreign exchange earnings (~12 billion dollars) of India and it is projected that there will be a significant increase in the coming years (http://www.cicr.org.in/pdf/ CICR_VISION_2030.pdf, accessed 25 March, 2014).

The Present Study

Policy decisions are often made based on the growth rates, which depend on the nature and structure of the data and instability in farm production. Being a commercial crop, cotton is so remunerative that it is being grown by farmers even in agro-climatic zones not suitable for cotton cultivation. The cotton area and production has shown improvement over the years since 1990 in the major cotton growing states in India. Cotton is grown extensively in Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Rajasthan, Gujarat, Haryana, and Punjab states in India. Cotton crop has the prominent position among the commercial crops in these states, in view of the fact that the area under cotton has been increasing over the years. The growth of area, production and productivity of cotton has not been equal across the different States in India. In this context, this study was analyzing the growth and instability of cotton in the major cotton growing states in India.

Selection of Time Periods

After the "Green Revolution", seeds, fertilizer, modern farm technology etc. have spread gradually. An attempt is made here to study the changes in the instability and inequality in area, production and yield of cotton over a period of time across regions. The necessary data for the area, production and yield of cotton are collected for the period from 1970-71 to 2013-14 and broadly divide into the following three periods namely:

1. Period-I (1970-71 to 1984-85) - Initial period of new seed, fertilizers, new technology and impact of hybrid varieties of cotton,
2. Period-II (1985-86 to 1999-2000) - Spread of new agricultural technology and impact of hybrid varieties of cotton, impact of new economic policy, and

3. Period-III (2000-01 to 2013-14) - Impact of Bt technology and open market policy.

Analytical Tools and Techniques

The annual compound growth rate (CAGR) for an area, production and productivity of cotton were estimated by using the formula of the exponential equation of use as:

$$Yt = a.bt$$
(or)
$$\log_e Yt = \log_e a + (\log_e b)\, t$$

Where,

Y = Value of the variable under study, i.e., area under cotton, production of cotton and per hectare productivity of cotton,

t = Time variable, a = Intercept, and

b = (Anti log b –1) × 100.

To test the significance of growth rates, the following 't' test has been used:

't' test = $\hat{\beta}$ / Standard Error of $\hat{\beta}$, t(n-2, α %)

Further, the Coefficient of Variation (CV) is the indicator of Instability and it is estimated by using the following formula:

$$CV = (\sigma / \mu) * 100$$

Where,

σ = Standard deviation

μ = Mean

Results and Discussion

Growth Rates of Cotton Crop in Major Cotton Growing States in India

In order to study the annual compound growth rates of area, production and productivity of cotton in nine major cotton producing states in India for the different periods are presented in Tables-1, 2, 3&4. It is observed from the Table1- during an initial period of new seed, fertilizers, new technology and impact of hybrid varieties of cotton (Period I), the area under cotton in Andhra Pradesh, Haryana, Punjab and Rajasthan witness highly positive annual growth rate and Maharashtra and all-India also positive growth but not significantly. Whereas Gujarat, Madhya Pradesh and Tamil Nadu shows a negative highly significant annual growth rate and Karnataka also shows negative insignificant annual growth. In the case of production of cotton, Andhra Pradesh, Haryana, Maharashtra, Rajasthan and All-India registered significant positive annual growth. Besides, Madhya Pradesh and Tamil Nadu showed negative significant growth. Considering the productivity, Andhra Pradesh and all-India shows highly positive significant growth where as Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan also noticed an insignificant growth. Interestingly Punjab only the state in India registered a significant negative growth rate during this period.

Table 1: Compound Annual Growth Rates (CAGR) of Area, Production and Productivity of Cotton in Major Cotton Producing States in India during the Period I (1970-71 to 1984-85)

States	Area		Production		Productivity	
	CAGR	t- value	CAGR	t- value	CAGR	t- value
Andhra Pradesh	3.2192*	3.306	15.3691*	6.043	12.1645*	5.338
Gujarat	-1.3453*	2.8200	0.0626 NS	0.059	1.4188 NS	1.567
Haryana	4.5300*	8.440	4.9263*	6.620	0.3970 NS	0.518
Karnataka	-0.394 NS	0.582	1.9776 NS	1.124	2.3393 NS	1.608
Madhya Pradesh	-1.3691*	3.804	-0.2929 NS	-0.182	1.0737 NS	0.714
Maharashtra	0.6376 NS	1.191	4.2812**	1.976	3.6429 NS	1.598
Punjab	3.5821*	9.022	0.6729 NS	0.547	-2.1909*	3.194
Rajasthan	4.1454*	5.662	5.3395*	4.869	1.1993 NS	1.029
Tamil Nadu	-3.0666**	2.680	-1.4072 NS	-0.799	1.6575	2.047
All-India	0.3631 NS	1.330	2.5268*	3.004	2.1692*	2.961

Note: ** and * indicates significant at 1 per cent and 5 per cent level respectively
NS indicates not significant, CAGR: Compound Annual Growth Rate

Table 2: CAGR of Area, Production and Productivity of Cotton in Major Cotton Producing States in India during the Period II (1985-86 to 1999-2000)

States	Area		Production		Productivity	
	CAGR	t- value	CAGR	t- value	CAGR	t- value
Andhra Pradesh	6.0094*	6.257	13.6598*	6.615	7.6449*	3.271
Gujarat	2.6711**	1.918	12.456*	4.011	9.9406*	4.629
Haryana	4.4475*	9.613	2.6592 NS	1.512	-1.7877 NS	-1.215
Karnataka	0.7290 NS	0.748	3.7964*	2.735	3.0832*	2.991
Madhya Pradesh	-0.2394 NS	0.463	17.8615*	8.080	18.1121*	8.914
Maharashtra	1.4727*	4.005	5.6624*	2.987	4.1973**	2.227
Punjab	-0.7564NS	1.011	-6.543*	2.773	-7.3088*	-3.782
Rajasthan	5.6998*	8.412	8.8099*	3.802	3.1115 NS	1.434
Tamil Nadu	0.8655 NS	1.391	2.7671*	2.704	1.9072*	3.235
All-India	2.2437*	5.723	6.9902*	7.768	4.7492*	6.199

Note: ** and * indicates significant at 1 per cent and 5 per cent level respectively
NS indicates not significant, CAGR: Compound Annual Growth Rate

It can be seen from Table-2 that during spread of new agricultural technology and impact of hybrid varieties of cotton, impact of new economic policy (Period II), the cotton area fetched with positive, highly significant annual compound growth rate in Andhra Pradesh, Haryana, Maharashtra, Rajasthan and all-India while Madhya Pradesh and Punjab showed a negative insignificant growth. In case of production of cotton Andhra Pradesh, Gujarat, Haryana, Maharashtra, Rajasthan and all-India, where as Karnataka and Tamil Nadu registered positive annual compound growth rate but insignificant. But, Madhya Pradesh and Punjab showed a negative insignificant growth.

Table 3: CAGR of Area, Production and Productivity of Cotton in Major Cotton Producing States in India during the Period III (2000-01 to 2013-14)

States	Area		Production		Productivity	
	CAGR	t- value	CAGR	t- value	CAGR	t- value
Andhra Pradesh	7.8419*	7.144	9.4389*	10.39	1.5959 NS	1.616
Gujarat	4.7353*	8.853	11.1533*	5.702	6.0062*	3.275
Haryana	-0.0186 NS	0.26	7.5141*	5.176	7.5384*	5.138
Karnataka	1.1350 NS	0.838	8.5959*	5.028	7.4732*	8.843
Madhya Pradesh	1.2358*	2.924	-0.6977 NS	1.374	-1.9252*	3.095
Maharashtra	3.0589*	6.003	10.1032*	7.78	7.0487*	4.639
Punjab	0.2901 NS	0.416	5.4862*	2.807	5.1935*	3.227
Rajasthan	-0.7528 NS	0.652	4.7436*	2.659	5.4990*	4.698
Tamil Nadu	-1.3726 NS	0.848	-1.6544 NS	1.139	-0.28 NS	0.166
All-India	3.4058*	7.464	8.2818*	10.607	4.8789*	5.433

Note: ** and * indicates significant at 1 per cent and 5 per cent level respectively
NS indicates not significant, CAGR: Compound Annual Growth Rate

A close perusal of Table-3 reveals that, the area under cotton increased significantly in Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra and all-India while Haryana, Rajasthan and Tamil Nadu showed negative insignificant growth. In case of production and productivity, all states and the country as a whole recorded a positive significant annual compound growth rate in while Madhya Pradesh and Tamil Nadu registered decrement but insignificant during the period impact of Bt technology and open market policy (Period III). From the Table-4, it was noticed that during the overall period (1970-71 to 2013-14), the area under cotton in Andhra Pradesh, Gujarat, Haryana, Maharashtra, Rajasthan and all-India witnesses a positive annual growth rate which were statistically significant at 1 per cent level. But Karnataka and Tamil Nadu show a negative significant growth rate while Madhya Pradesh and Punjab show negative insignificant growth. Considering the production of cotton, Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and All-India noticed a significant positive growth whereas Tamil Nadu shows insignificant negative growth. The productivity scenario revealed that all the states and the country as a whole increased significantly.

Table 4: CAGR of Area, Production and Productivity of Cotton in Major Cotton Producing States in India during the Overall Period (1970-71 to 2013-14)

States	Area		Production		Productivity	
	CAGR	t- value	CAGR	t- value	CAGR	t- value
Andhra Pradesh	4.2765*	20.721	8.7238*	20.132	4.4510*	10.354
Gujarat	0.9914*	3.058	5.0193*	8.544	4.0776*	11.413
Haryana	2.3337*	11.482	3.4336*	12.595	1.1001*	3.701
Karnataka	-2.1671*	8.92	1.7149*	4.492	3.8805*	14.056
Madhya Pradesh	-0.1609 NS	1.226	6.1102*	11.967	6.2659*	12.044
Maharashtra	0.9941*	9.814	5.1536*	14.466	4.1557*	12.014
Punjab	-0.1342NS	0.692	0.8274**	1.951	0.9605*	2.458
Rajasthan	0.8411*	3.057	3.4181*	8.64	2.5758*	9.207
Tamil Nadu	-2.2905*	8.103	0.8124**	2.617	3.1031*	13.446
All-India	0.8512*	7.275	4.6122*	22.683	3.7571*	25.496

Note: ** and * indicates significant at 1 per cent and 5 per cent level respectively
NS indicates not significant, CAGR: Compound Annual Growth Rate

Instability of Cotton Crop in Major Cotton Growing States in India

The Coefficient of Variation (CV) of area, production and productivity of cotton for nine major cotton producing states and all-India during the different periods were computed and presented in Table-5. It is clear from the Table-5 that the Andhra Pradesh has highest instability in the area (20.77 percent), production (67.04 per cent) and productivity (51.78 per cent) of cotton while All-India shows lowest instability in the area (4.15 percent), production (15.91 per cent) of cotton and Haryana shows lowest instability in productivity (10.63 per cent) of cotton when compared to remaining major cotton

growing states and all-India during the period I. During the period II, Andhra Pradesh witness highest instability (29.72) and Madhya Pradesh shows lowest instability (7.39) in the area under cotton while production and productivity (62.13 per cent, 64.3 per cent respectively) show highest instability in Madhya Pradesh and lowest instability in Tamil Nadu (15.10 per cent, 15.84 per cent respectively) when compared to major cotton growing states in India. Andhra Pradesh (38.72 per cent), Gujarat (41.00 per cent) and Haryana (29.91 per cent) registered highest instability in area, production and productivity of cotton while Madhya Pradesh witness lowest instability in area, production and productivity of cotton (7.81 per cent, 7.76 per cent, 12.36 per cent respectively) when compared to other cotton growing states and all-India during the period III. Considering the overall period, interestingly Madhya Pradesh registered lowest instability (11.38 per cent) in the area under cotton and shows highest instability (71.65 per cent) in the production of cotton. Andhra Pradesh shows highest instability in cotton area (62.12 per cent) and production (91.54 per cent) and Tamil Nadu (25.40 per cent) and Haryana (28.67 per cent) shows lowest instability in production and productivity of cotton when compared to major cotton cultivation states in India.

Table 5: Instability in Area, Production and Productivity of Cotton in Major Cotton Producing States in India

States	Period I			Period II		
	Area	Production	Productivity	Area	Production	Productivity
Andhra Pradesh	20.77	67.04	51.78	29.72	48.71	39.15
Gujarat	9.66	15.73	17.54	20.85	51.52	39.62
Haryana	20.54	23.67	10.63	18.46	26.18	20.94
Karnataka	15.58	29.3	21.46	13.19	21.79	17.14
Madhya Pradesh	10.84	44.6	32.69	7.39	62.13	64.3
Maharashtra	7.95	31.69	29.67	8.94	38.56	32.2
Punjab	15.62	15.55	16.51	13.23	36.81	33.36
Rajasthan	18.37	25.34	16.7	24.92	34.73	22.76
Tamil Nadu	19.41	31.73	23.33	11.04	15.1	15.84
All-India	4.15	15.91	14.75	10.97	28.39	20.21
States	**Period III**			**Overall Period**		
	Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
Andhra Pradesh	38.72	40.9	15.99	62.12	91.54	50.54
Gujarat	20.51	41	28.93	29.43	87.17	60.35
Haryana	10.44	33.25	29.91	30.79	49.77	28.67
Karnataka	19.55	47.3	35.33	34.54	41.44	53.69
Madhya Pradesh	7.81	7.76	12.36	11.38	69.16	71.65
Maharashtra	15.28	38.99	29.86	16.3	77.16	61.29
Punjab	10.2	33.26	28.4	16.09	35.12	32.36
Rajasthan	18.37	25.34	16.7	24.92	34.73	22.76
Tamil Nadu	19.41	31.73	23.33	11.04	15.1	15.84
All-India	4.15	15.91	14.75	10.97	28.39	20.21

Note: Coefficient of Variation (CV) in Percentage

The instability analysis indicates that Andhra Pradesh witness high instability in area, production and productivity of cotton when compared to major cotton growing states and all-India during the different periods. Besides, the area under cotton has been more stable than production and productivity in during different periods and overall periods in India. Thus, policies should be made to reduce the risk in cotton production and to make it profitable so as to sustain the high growth rate experienced during the past few years.

Conclusions

From the above analysis, it is noticed that the area under cotton in Andhra Pradesh, Gujarat, Haryana, Maharashtra, Rajasthan and all-India witnesses a positive annual growth rate which were statistically significant at 1 per cent level. But Karnataka and Tamil Nadu show a negative significant growth rate while Madhya Pradesh and Punjab show negative insignificant growth. Considering the production of cotton, Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and All-India noticed a significant positive growth where as Tamil Nadu shows insignificant negative growth. The productivity scenario revealed that all the states and the country as a whole increased significantly during the overall period.

The instability analysis indicates that Andhra Pradesh witness high instability in area, production and productivity of cotton when compared to major cotton growing states and all-India during the different periods. Besides, the area under cotton has been more stable than production and productivity in during different periods and overall periods in India. Thus, policies should be made to reduce the risk in cotton production and to make it profitable so as to sustain the high growth rate experienced during the past few years. Policy decisions are often made based on the growth rates, which depend on the nature and structure of the data and instability in farm production. Thus, policies should be made to reduce the risk in cotton production and to make it profitable so as to sustain the high growth rate experienced during the past few years.

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