

Original Research Article

Growth and Instability in Area, Production and Yield of Cotton in India

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ABSTRACT

Cotton is one of the important fiber and cash crop in India as well as world and it plays a dominant role in the Indian economy. Cotton is known as a "King of Fiber" crops due to its global importance in agriculture as well as industrial economy. Hence, the present paper analyzes the growth and instability in cotton area, production and yield during the period 1996-97 to 2017-18. The study was based on secondary data on area, production and productivity of cotton crop collected from various government publications. Performance of cotton was judged on 2 important parameters i.e. growth and instability. Compound growth rate was estimated by fitting non linear model to the area, production and productivity data. Model was estimated using Marquardt algorithm. Instability was assessed by constructing Cuddy Della Valle instability index. The result revealed that, compound growth rate of area production and yield of cotton was 2.20 per cent, 4.84 per cent and 2.78 per cent per annum in study period, respectively. The Co-efficient of variation and CDI with regards to area was 16 per cent and 9 per cent, respectively. In regards to production and productivity it was 34 per cent and 13 per cent and 23 per cent and 13 per cent, respectively. Therefore it is necessary to increase the sustainable cotton production in India and to take up productivity enhancing measures in cotton crop like varietal improvement, appropriate technologies.

Keywords

Cotton, Growth,
Instability and
Coefficient of
Variation

Introduction

Cotton is one of the important fiber and cash crop in India as well as world and it plays a dominant role in the Indian economy. It contributes significantly to both agriculture and industry in terms of farm income, employment and export earning. Cotton is known as a "King of Fiber" crop due to its global importance in agriculture as well as industrial economy. It is grown in more than 100 countries and it is estimated that, the crop is planted on about 2.5 per cent of the world cultivable land (Shiv Sankar and Naidu, 2015). It is commonly known as "White Gold" in farming community. It is a

multipurpose crop that supplies 5 basic products viz; lint, oil, seed meal, hulls and linters. Due to its multipurpose nature and use, it has huge demand from industry side, which makes this crop popular among the farming community. Cotton (*Gossypium sp.*) belongs to *Malvaceae* family and is oldest of the all fibers used by human beings and it is one of the most important commercial and domesticated plants in the world. It was domesticated independently both in the Old World and in the New World. Cultivation of cotton started approximately 7000 years ago in Mexico (New world) and in India and Pakistan (Old world). Cotton grows in tropical and subtropical parts of Asia, Africa,

Australia and America. People cultivate cotton because of the seed represent valuable source of fibers and oil. India is the only country which grows all the four species of cultivated cotton i.e. *Gossypium arboreum* and *G. herbaceum* (Asiatic cotton), *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American upland cotton) besides hybrid cotton. The area covered under cotton during 2017-18 was 124.44 lakh hectares, which was 108.26 lakh hectares during period 2016-17. Based on last year's average productivity, the estimated cotton production during 2017-18 would be 370.00 lakh bales. Among the states, Gujarat may stand first with 104.00 lakh bales followed by Maharashtra (85.00 lakh bales) and Telangana (55.00 lakh bales), above three states combined contributing nearly 67 per cent to total cotton production during 2017-18. Hence this particular study carried out to estimate the magnitude of growth and instability in area, production and yield of cotton in India.

Materials and Methods

In order to fulfill the objectives of the study, secondary data pertaining to area, production and yield of cotton was collected from the Cotton Advisory Board for the period 1996-97 to 2017-18. In order to examine the growth rate, coefficient of variation and instability index in area, production and productivity of cotton crop in India, various statistical measures such as mean, compound growth rate, coefficient of variation and instability index were estimated and analyzed for the overall study period also.

Growth rate

To examine the growth in area, production and productivity of cotton from India compound growth rate (CGR) was computed based on its fit using non-linear models,

especially the exponential model. Conventionally, the compound growth rate were estimated after the converting the growth model to semi-log form and estimated through Ordinary Least Square (OLS) technique assuming multiplicative errors term. However, there are several problems associated with this technique including the difficulty in estimating standard error of estimates of original parameters. Hence, a non-linear estimation technique for solving exponential model assuming additive error terms was used to estimate compound growth rate by using exponential growth function as given below:

$$Y^t = \text{constant} * (1 + \text{CGR})^t + E_t(1)$$

Where,

Y^t = time series data for area/ Production/ Productivity for year t

t = Time trends for years of interest

E_t = error terms

CGR is compound growth rate for the period under consideration.

The Marquardt algorithm was used to estimate parameters of equation. The significance of regression coefficient were tested by applying standard 't' test procedure.

Instability analysis

Cuddy-Della Valle Instability Index were used to estimate the instability in area, production and yield of cotton data. This index is modification of coefficient of variation (CV) to accommodate for trend which is commonly present in time series economic data. It is superior over other scale dependent measure such as Standard Deviation or Root mean Square of the residuals (RMSE) obtained from the fitted trend lines of raw data and hence suitable for

cross comparison. The Cuddy-Della Instability Index calculated as follows:

$$I_x = CV \sqrt{1 - R^2}$$

Where,

CV = coefficient of variation (σ/x)

R^2 = adjusted coefficient of multiple determination

Where, ever trend in time series data is non-significant, instability of that particular was analyzed with the help of conventional statistical tool of instability i.e. coefficient of variation. The coefficient of variation was calculated by using formula,

$$CV (\%) = \frac{\text{Standard deviation (a)}}{\text{Mean (x)}} \times 100$$

Results and Discussions

The growth rate analysis of area, production and productivity is necessary to examine the performance of individual commodities contributing to agricultural production. The compound growth rate of area, production and yield of cotton during the period from 1996-97 to 2017-18 were computed and presented in the table 1.

The area under cotton was increased from 91.7 hectare to 124.44 hectare in the study period which indicates positive and significant growth. The compound growth rate of area was estimated to be at 2.20 per cent per annum. The production of cotton was observed 176.5 lakh bales in 1996-97 which was increased to the level of 370 lakh bales in end year. The growth rate of production in study period was estimated to be 4.84 per cent per annum. Total cotton yield in India was observed 330 kg per hectare in 1996-97 and it was increased to the level of 505.46 kg per hectare in 2017-18.

The growth rate of yield in overall period was estimated to be at 2.78 per cent per annum.

The results showed positive growth in the production of cotton during study period. This increase in production of cotton was mainly due to increased area under the crop during the study period. Though yield also contributed some extent by showing positive growth trend. The area expansion during the study period was mainly due to introduction of Bt cotton and implementation of crop development programs, supply of large scale Bt cotton varieties to the farmers and increased MSP lead to further expansion in area under cotton cultivation. This results are similar to (Shaikh and Joshi, 2013; Bhovi and Pushpa, 2017) mentioned there is significantly increased in cotton growing area but less yield appear to other state districts.

In order to know the level of instability in the area of cotton in India, the fluctuation in cotton area was assess with the help of Cuddy-Della Valle Instability. The instability indices of area, production and productivity of cotton crop in India during the study period were presented in table 2.

It can be revealed from table 2. that, the coefficient of variation of cotton in area was found to be 16.00 per cent and Cuddy-Della Valle instability index (CDI) was 9.00 per cent during the study period. As regard the production of cotton, coefficient of variation of cotton production and yield was observed to be 34.00 per cent and 23.00 per cent respectively. Cuddy-Della Valle instability index (CDI) was 13.00 per cent for both.

Table 2 revealed that, during study period, coefficient of variation for area was very low as compared to production and yield. During the study period, instability in cotton production is higher than the instability in the area and similar to yield at all India level.

Sankar and Naidu (2016) reported that, the area under cotton has been more stable than production and productivity during study period 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. Similar finding also reported by Sankar and Naidu (2016). This gives confirmation to our result.

Table.1 Growth in area, production and yield of cotton in India

Particulars	Area	Production	Yield
Beginning year (1996-97)	91.7	176.5	330
End year (2017-18)	124.44	370	505.46
Observation	22	22	22
Mean	100.13	265.66	441.55
CGR	2.20**	4.84**	2.78**
SE	0.31	0.55	0.49
“t” Value	7.00	8.67	5.60

Note: Area in Lakhs ha; Production in Lakhs bales and Yield kg per ha.

Table.2 Instability in area, production and yield of cotton in India

Particulars	Area	Production	Yield
CV	0.16	0.34	0.23
CDI	0.09	0.13	0.13

Figure.1 Time Sequence plot of area, production and yield of cotton in India

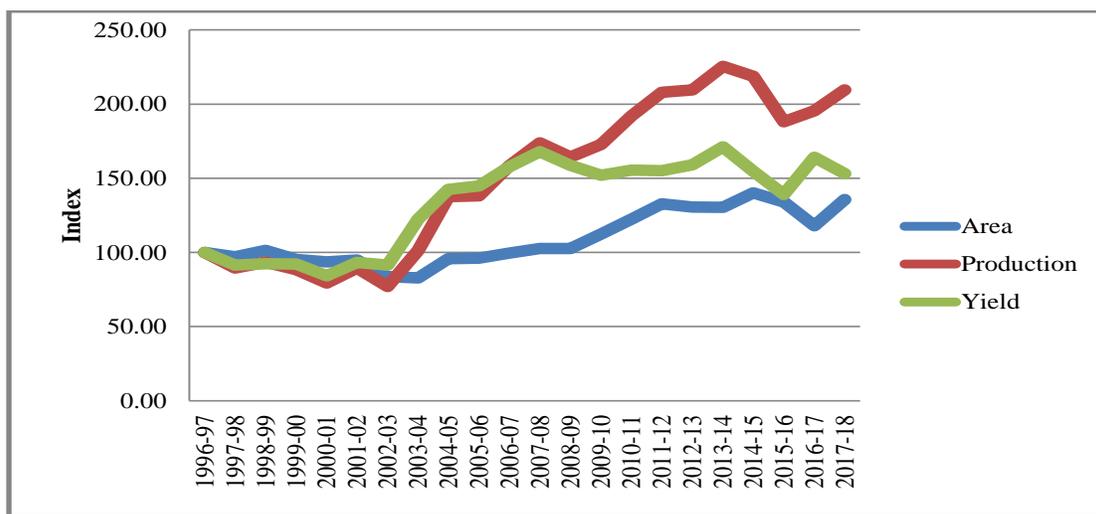


Figure.2 Time sequence plot of area of cotton in India

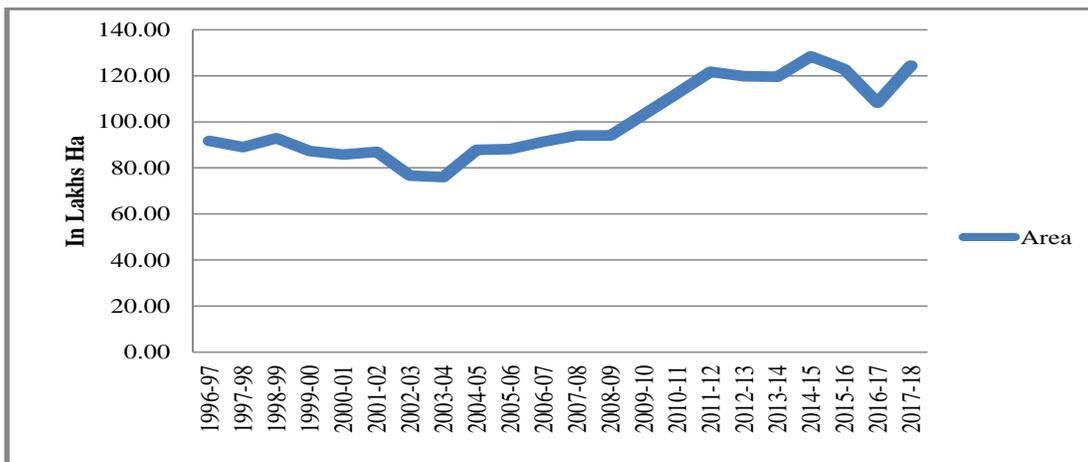


Figure.3 Time Sequence plot of Production of Cotton in India

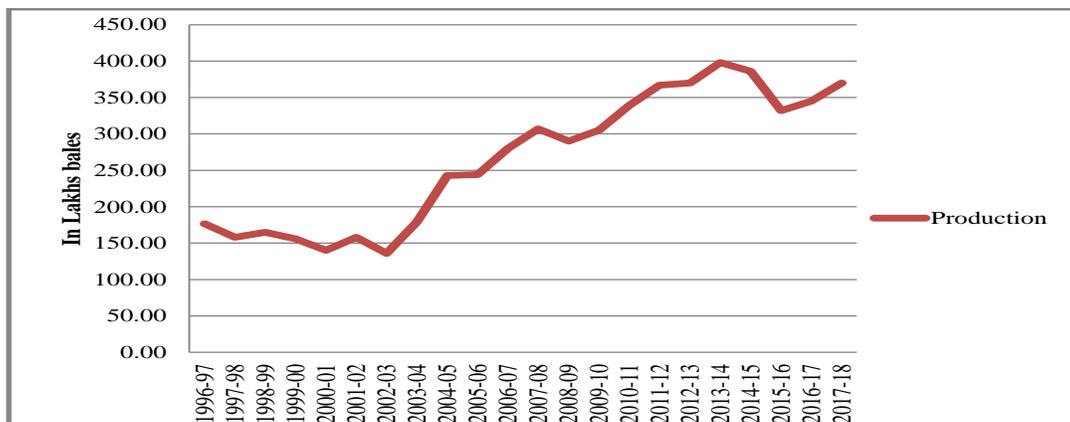
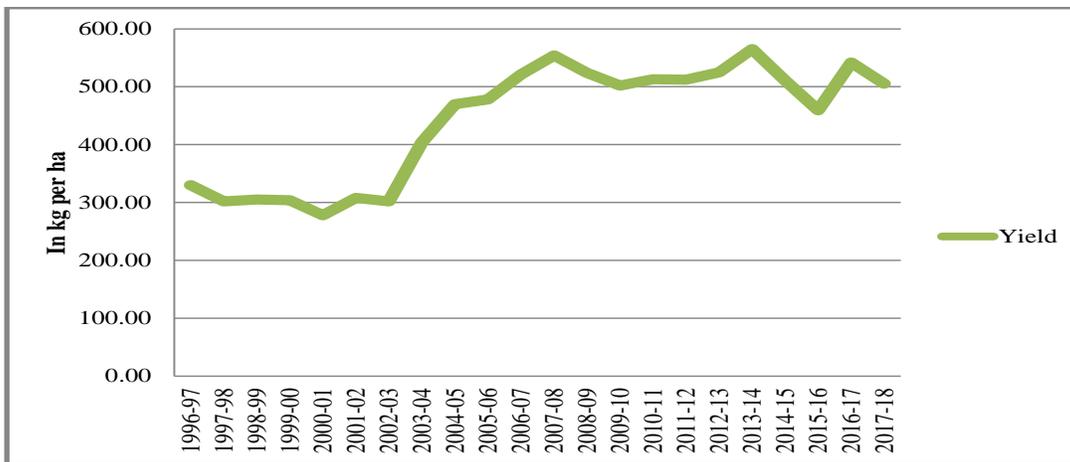


Figure.4 Time Sequence plot of Yield of Cotton in India



Trends in the area under cotton cultivation and production and yield of cotton in India from 1996-97 to 2017-18 was shown in Figure 1. There was an increase in the yield and production of cotton during the entire period under analysis, with a sharp increase after the introduction of Bt cotton. Before the introduction of Bt cotton yield is lower but after that yield of cotton gradually increased till the end of study period with that production of cotton observed in increasing trend. But in terms of productivity, India's yield is much lower than other top cotton growing countries as around 62 per cent of India's cotton is produced on rain-fed areas and 38 per cent on irrigated lands, poor managerial attention towards cotton was timely sowing, proper seed rate and pre-sowing treatment and lack of new varieties of cotton which are resistant to bollworm pests and diseases.

The time sequence plot of area, production and yield of cotton in India from 1996-97 to 2017-18 presented in Figure 1, Figure 2, Figure 3 respectively. It is clear from of this figure the highest area under cotton cultivation in the year 2014-15 i.e. 128.46 lakh ha. and lowest area found in the year 2003-04 i.e.76.00 lakh ha. India is the largest producer of cotton accounting for one-fourth of the global cotton production. The production of cotton was higher in the year 2013-14 i.e. 398 lakh bales and lower production found in the year 2002-03. During the study period highest yield observed in the year 2013-14 i.e. 565 kg per ha. and lowest yield found in the year 2000-01 i.e.278 kg per ha.

It is clear from the Fig 2 that, there has been gradually decrease in area under cotton up to year 2003-04 except in the year 1998-99 and 2001-02. It was slightly increased after that increase in area under cotton cultivation was recorded in 2004-05 and it reached the

maximum of 128.46 lakh ha in 2014-15 except 2012-13 and 2013-14. It was normally decline i.e. 119 lakh ha. In last three year of study period lowest area under cotton cultivation recorded in 2016-17 i.e. 108.26 lakh ha. However, there have been two and a half-fold increase in production and one and a half-fold increase in yield between 1996-97 and 2017-18. This clearly depicts the success in efforts to increase production and productivity without any addition to area under cotton cultivation.

This has been made possible due to large scale commercial cultivation of high yielding hybrid varieties in long and extra long staples. In spite of the two fold increase in the yield; our average yield of 441 kg/hectare is just half of the world average and far below the yield of 1561 kg/hectare in the Brazil, 1558 kg/hectare in the China, 999 kg/hectare in USA and 717 kg/hectare in Pakistan (Source: ICAC, 2017-18). Almost 62 per cent of the area under cotton is rainfed with erratic and poorly distributed rains during the cropping season. It is subjected to severe attack of pests and diseases. Despite the increase in production, cotton for quite some time is experiencing a plateau in productivity which needs to be broken.

Hence concluded, the above discussion throws light on the fact that the growth performance of area, production and productivity of cotton crop in India was positive and statistically significant (i.e., 2.20, 4.84 and 2.78 per cent respectively). Coefficient of variation for area was very low as compared to production and yield. During the study period, instability in cotton production is higher than the instability in the area and similar to yield at all India level. Therefore it is necessary to increase the sustainable cotton production in India and to take up productivity enhancing

measures in cotton crop like varietal improvement, appropriate technologies.

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