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Dimensions of growth and development of cotton in India : An economic analysis

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ABSTRACT : The study analysed the growth trends in area, production and productivity of cotton across different zones and states in India. The study is based on the time series data analysed in two sub period's *viz.,* Period I and II to analyse the impact of introduction of *Bt* cotton in India. To explore the factors determining the growth in cotton, the Cobb Douglas function has been fitted. The introduction *Bt* cotton has significantly enhanced the area and productivity growth across the country while cotton area under irrigation, the government support in terms of MSP played a limited role in enhancing overall production. The export of long staple cotton has tremendously increased from 2002 onwards.

Key words: *Bt* cotton, CAGR, Cobb Douglas function, cotton production, staple length

Cotton is considered as 'White Gold' being in cultivation in India for more than five thousand years. India is the major producer, consumer and exporter of cotton in the world. India ranks first in area and second largest producer of cotton in the world next to China accounting for 18 per cent of the total world production. Cotton is grown in three distinct agro climatic zones. The northern zone comprising of Punjab, Haryana and Rajasthan, central zone comprising of Madhya Pradesh, Gujarat and Maharashtra and southern zone comprising of Karnataka, Andhra Pradesh and Tamil Nadu. Besides these nine states, cotton cultivation in the country has gained momentum in Odisha and in non traditional states of Uttar Pradesh, West Bengal and Tripura.

The trends in area, production and productivity of cotton across the country are increasing alarmingly. There are quite a few reasons attributed to increased growth in area, production and productivity of cotton in India. Introduction of Technology Mission on Cotton (TMC) during 2000 is an initial attempt to enhance the growth in cotton fallowed by introduction of *Bt* cotton during 2002, increased area under irrigation, modernization of market yards along with increased number of ginning mills across the country, operation of Minimum Support Price (MSP) programme by Government of India through Cotton Corporation of India (CCI) significantly increased all the sources of growth in cotton in India and across different zones in the country. Similar observations were recorded stating that the increase in cotton production in the country after the introduction of *Bt* cotton is not merely by GM technology alone but there are other factors like enhancement of irrigated area under cotton, low pest incidence, well distributed rainfall and better market price (Sabesh, 2014). The contribution of all these factors towards the sources of growth is a researchable issue needs to be addressed by researchers, institutions and policy makers for enhancing growth and development of cotton and in turn the trade at large. Off late, the trends in cotton exports both in physical and value terms is increasing specially after introduction of *Bt* cotton. In view of these developments, a study on dimensions of growth and development of cotton before and after the introduction of *Bt* cotton has been initiated. A special attempt has been made to study the factors determining sources of growth of cotton in India.

MATERIALS AND METHODS

The study is based on secondary data compiled from official websites of various Departments. The data pertains to area, production and productivity cotton were collected from of Directorate of Economics and Statistics (DES), Ministry of Agriculture, Cotton Corporation of India Ltd., Ministry of Textiles and All India Co-ordinated Cotton Improvement Project. The time series data for the period from 1992-1993 to 2011-2012 were collected and analysed between two periods *viz.,* period I (1992-1993 to 2001-2002) *i.e.*, before introduction of *Bt* cotton and period II (2002-2003 to 2011-2012) *i.e.*, after introduction of *Bt* cotton for major cotton growing states in India. The Compound Annual Growth Rates (GAGR) was worked out using the semi log growth model. Triennium averages were worked out to even out the inter year fluctuations in data. The zone wise CAGR of area, production and productivity of cotton was computed using the exponential growth functions of the form.

$Y = ABtV^t$

Where, Y_t = Dependent variable for which growth rate is estimated

A = Intercept indicating Y in the base period (t = 0)

B = Regression coefficient (1 + g) and g = CGR

T_i = Time period (i = 1 to 10)

V_t = Random error

The growth equation was converted into the logarithmic form in order to facilitate the use of Ordinary Least Square for estimation of parameters. To explore the factors determining growth in cotton, Cobb Douglas production function was fitted for the data. The functional form of regression analysis is expressed as

$$Y = \hat{a}_0 \; X_1^{\hat{a}1} \; X_2^{\hat{a}2} \; X_3^{\hat{a}3} \; X_4^{\hat{a}4} \; e^u$$

Where, Y= Production (Qtl.)

$\hat{a}_0$ = Intercept

X_1 = Area under cotton (ha)

X_2 = Yield of cotton (q/ha)

X_3 = MSP for cotton (Rs/q)

X_4 = Rainfall (mm)

$\hat{a}_1$, $\hat{a}_2$, $\hat{a}_3$ and $\hat{a}_4$= Regression co efficients

u = Random error term

The Cobb Douglas production function was converted into log linear form and co efficient were estimated using Ordinary Least Square (OLS) as given below.

$\ln Y = \ln \hat{a}_0 + \hat{a}1 \ln X_1 + \hat{a}2 \ln X_2 + \hat{a}3 \ln X_3 + \hat{a}4 \ln X_4 + u \ln e$

The regression co efficient (â's) were tested using't' test at chosen level of significance.

RESULTS AND DISCUSSION

Growth in area, production and productivity of cotton in India : The CAGR computed for two sub periods *i.e.*, period I (1992-1993 to 2001-2002) and period II (2002-2003 to 2011-2012) is presented below (Table 1 and Fig. 1). The CAGR of cotton area has increased significantly from 2.29 to 4.69 per cent from period I to period II. Similarly, the CAGR of cotton production has increased remarkably from -0.42 to 11.44 per cent from period I to period II. The growth in productivity has also increased significantly from -2.66 to 6.48 per cent from period I to period II.

There was a significant increase in growth in area, production and productivity of cotton in period II in comparison with period I which is mainly attributed to introduction of *Bt* cotton wherein the average yield in cotton increased from 304 kg/ha in period I to 473 kg/ha in period II. Though TMC was introduced much earlier, could not able to push the sources of growth in cotton initially to the expected level. In addition, increased irrigated area under cotton, support price programme initiated by Government of India, modernization of market yards and ginning mills enhanced the sources of growth in cotton. These findings are in similar lines with the findings of Puran Mal, 2007 and Sabesh *et al.,* 2014 reported that the CAGR for

Table 1. CAGR of area, production and productivity of cotton in India for the triennium ending from 1992-1993 to 2001-2002 and 2002-2003 to 2011-2012

Sl. No.	Sources of growth	Period I (1992-1993 to 2001-2002)	Period II (2002-2003 to 2011-2012)
1	Area (%)	2.29**	4.69**
2	Production (%)	-0.42^{NS}	11.44**
3	Productivity (%)	-2.66**	6.48**

** Significant at 1 %, NS- Non Significant

area, production and productivity of cotton had increased significantly between 2002-2003 to 2009-2010. Similar findings also reported by Kannan, 2011 stating that the wide spread cultivation of *Bt* cotton was the major reason for the rise in production of cotton in India. The significant increase in cotton area and production in India is attributed to better returns realized by farmers due to introduction and rapid spread of *Bt* cotton technology (Khadi *et al.,* 2007)

Growth in area, production and productivity of cotton across different zones in India : The CAGR of area, production and productivity of cotton across northern, central and southern zones in India is presented here under (Table 2). The CAGR of area has increased significantly both in central and southern zone from 2.59 to 5.01 per cent and 1.97 to 6.62 per cent from period I to period II while in northern zone, no significant increase in area under cotton. Similarly central and southern zones exhibited a significant increase in production growth while there was no much increase in production in northern zone. The production growth in cotton increased from 4.97 to 8.20 per cent and -0.76 to 10.17 per cent from period I to period II in central and southern zone, respectively. The growth in cotton productivity has increased significantly in all the three zones in India. In northern zone, the cotton productivity increased from -4.6 to 3.09 per cent from period I to period II. While in central zone cotton productivity increased from -2.22 to 3.16 per cent. Similarly, in southern zone cotton productivity increased from -1.74 to 3.43 per cent.

There was a significant increase in growth in area and production of cotton in states of both central and southern zones while the productivity growth was significant in all the three zones across the country (Fig 3 and 4). Introduction of *Bt* cotton had significantly increased all the sources of growth even though the technology mission on cotton was introduced much earlier. In addition, increased area under irrigation under cotton coupled with successful operation of MSP by Government of India through CCI enhanced the area and production growth in cotton. As a result, the states belonging to Central, Southern and Northern zones experienced an increase in productivity by 62, 60.55 and 40.77 per cent, respectively. The above findings are in conformity with findings of Sabesh *et al.,* 2014 reported that the states like Punjab, Haryana, Rajasthan had increased the production level due to cotton area enhancement

Table 2. Zone wise CAGR of area, production and productivity of cotton India for the triennium ending from 1992-1993 to 2001-2002 and 2002-2003 to 2011-2012

Zones	Period I (1992-1993 to 2001-2002)			Period II (2002-2003 to 2011-2012)		
	Area (%)	Production (%)	Productivity (%)	Area (%)	Production (%)	Productivity (%)
North	-0.63 ^{NS}	-5.73**	-4.60*	-0.50 ^{NS}	2.48 ^{NS}	3.09*
Central	2.59**	4.97*	-2.22*	5.01**	8.20**	3.16 ^{NS}
South	1.97 ^{NS}	-0.76 ^{NS}	-1.74**	6.62**	10.17**	3.43*

* Significant at 5% ** Significant at 1 % NS Non Significant

and states like Maharashtra, Andhra Pradesh and Karnataka enhanced cotton production level due to increase in cotton productivity levels

Factors determining growth in cotton production : The factors determining cotton production is regressed on the contributing factors such as area under cotton, yield, MSP and Rainfall (Table 3). The multiple regression analysis revealed that the area under cotton (0.62) and yield (1.05) significantly influenced the cotton production in northern zone while operation of support price programme (-0.08) negatively contributed towards cotton production. Similarly in southern zone, area under cotton (1.07) and yield (1.05) significantly increased cotton production while MSP (-0.09) contributed negatively towards the cotton production. In central zone, the area under cotton (0.83), yield (0.93) and MSP (0.31) significantly contributed towards the cotton production. In overall, the variables area under cotton (0.99) and yield (1.01) significantly increased the cotton production whereas operation of MSP not contributed much towards the cotton production in the country. The variables included in the regression analysis explain the variation in cotton production to the extent of 0.97 in both northern and central zones, 0.99 each in southern and overall situation.

The regression analysis revealed that

Table 3. Regression estimates of factors determining cotton production in India

Zone	Intercept (b_0)	Area (X_1)	Yield (X_2)	MSP (X_3)	Rainfall (X_5)	R^2
North	-4.54**(7.63)	0.62**(6.41)	1.05**(23.42)	-0.08*(2.10)	0.12^{NS}(1.38)	0.97
Central	-6.02**(4.15)	0.83*(2.48)	0.93**(7.85)	0.31*(2.07)	-0.06 ^{NS}(0.33)	0.97
South	-4.83**(14.99)	1.07**(25.79)	1.05*(27.22)	-0.09**(3.30)	-0.02 ^{NS}(0.58)	0.99
India	**-5.14**(345.94)**	**0.99**(326.66)**	**1.01**(1005.87)**	**-0.0004 ^{NS}(0.57)**	**0.0002 ^{NS}(0.11)**	**0.99**

Note: Figures in the parenthesis indicate 't' values
* Significant at 5% ** Significant at 1 % NS- Non Significant

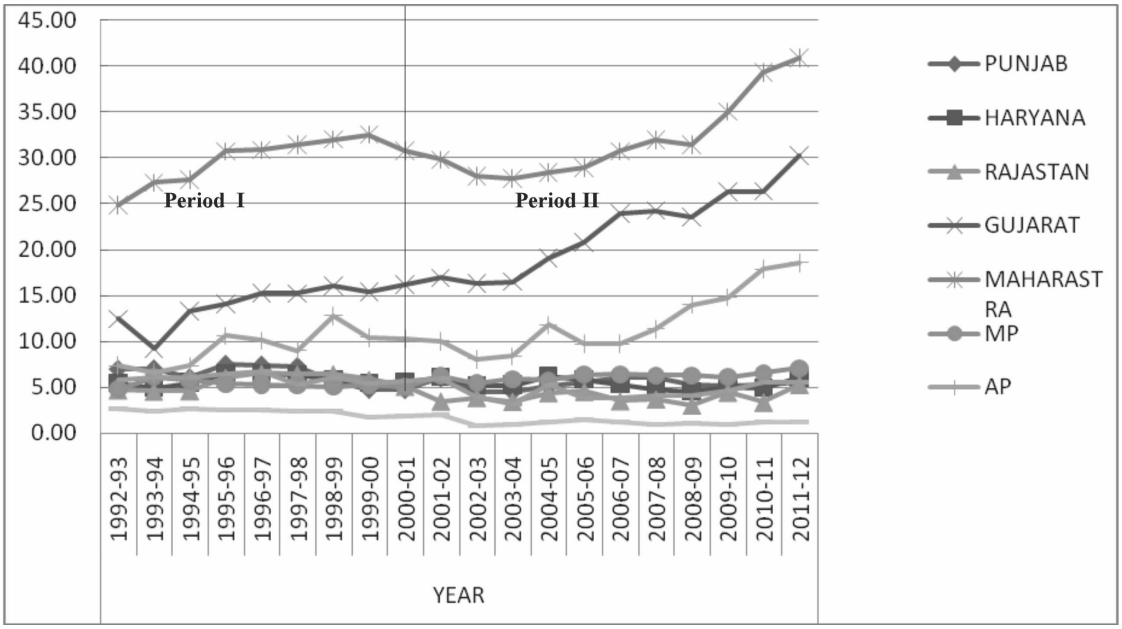

Fig 3. State wise area under cotton in India during period I and period II

area under cotton and yield significantly influenced the cotton production in all three zones and across the country. This is mainly attributed to large scale adoption of *Bt*-cotton in the country. The government of India approved the commercial cultivation of *Bt* cotton initially in 2002-2003 in south and central zone and later on in northern zone in 2005-2006. Introduction of *Bt* cotton initially increased the yield level followed by area expansion in the country. The operation of MSP significantly contributed towards cotton production in central zone alone but not in northern, southern zone and in overall situation. This is implied from the fact that procurement of cotton under MSP by CCI was highest in central zone. Similar observations were recorded by Puran Mal, 2014, reported that North India had a poorer performance of *Bt* cotton than other regions. The rate of adoption of *Bt* cotton in the region was 35 per cent during 2009, whereas it was 80 per cent in states of southern and central region.

Government support for cotton production in India : The government of India has introduced Technology Mission on cotton with the objective of enhancing production, productivity and improving the quality of cotton in the country through research, transfer of technology, modernization of existing market yards and processing units. The Government of India is also encouraging cotton production by enhancing the MSP over the years. MSP for medium and long staple cotton marginally increased from 1993-1994 to 2012-2013 while there was a quantum jump in MSP during 1995-96, 1997-1998, 2008-2009 and 2012-2013 with 15.00 and 12.50 per cent, 12.71 and 10.87 per cent, 38.89 and 47.78 per cent, and 28,57 and 18.87 per cent, respectively for medium and long staple cotton (Table.4). The operation of MSP has made a significant impact on cotton production in central zone in comparison with southern and northern zone. The findings are in contrast with the findings of Arora and Bansal (2011) reported that Government policies, especially price intervention helped in adoption of *Bt* cotton in India.

Export and import trends of cotton : There are several cotton varieties cultivated across the country. The short, medium and medium to long staple cotton verities are sold in domestic market while long staple cotton varieties are sold in international market. The Government of India has liberalized the cotton exports from the country with effect from 2001 and placed it under Open General Licence (OGL) by dispensing the allocation of cotton export quotas to different agencies including CCI. India is having better comparative advantage for export of cotton. It is exported in the form of lint packed in full pressed bales (FP bales) weighing exactly

Table 4. Trends in MSP for cotton in India (1992-1993 to 2012-2013)

Sl. No.	Crop Year	Medium staple		Long staple	
		MSP (Rs/q)	Percentage over previous	MSP (Rs/q)	Percentage over previous
1	1992-1993	800	-	950	-
2	1993-1994	900	12.50	1,050	10.53
3	1994-1995	1,000	11.11	1,200	14.29
4	1995-1996	1,150	15.00	1,350	12.50
5	1996-1997	1,180	02.61	1,380	02.22
6	1997-1998	1,330	12.71	1,530	10.87
7	1998-1999	1,440	08.27	1,650	07.84
8	1999-2000	1,575	09.38	1,775	07.58
9	2000-2001	1,625	03.17	1,825	02.82
10	2001-2002	1,675	03.08	1,875	02.74
11	2002-2003	1,675	00.00	1,875	00.00
12	2003-2004	1,725	02.99	1,925	02.67
13	2004-2005	1,760	02.03	1,960	01.81
14	2005-2006	1,760	00.00	1,980	01.02
15	2006-2007	1,770	00.57	1,990	00.50
16	2007-2008	1,800	01.69	2,030	02.01
17	2008-2009	2,500	38.89	3,000	47.78
18	2009-2010	2,500	00.00	3,000	00.00
19	2010-2011	2,500	00.00	3,000	00.00
20	2011-2012	2,800	12.00	3,300	10.00
21	2012-2013	3,600	28.57	3,900	18.18

(Source: www.cacp.dacnet.nic.in)

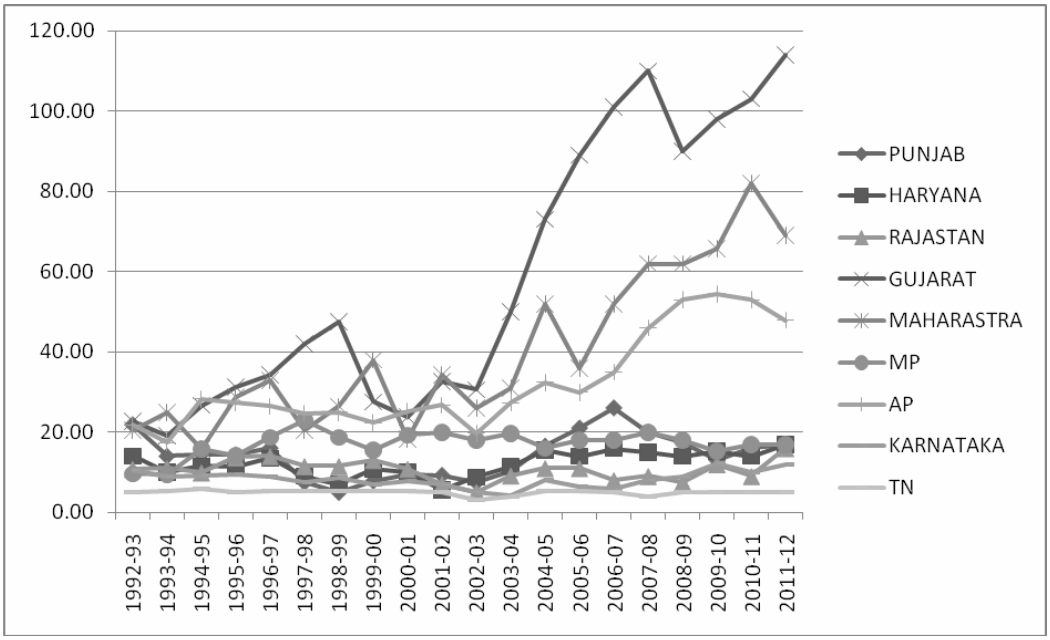

Fig 4. State wise production of cotton in India during period I and period II

170 kgs. At present, India is the leading exporter of long staple cotton to several countries. The export of cotton has tremendously picked up from 2003-2004 and India has emerged as one of the top exporter of raw cotton in the world. The export of cotton from India has steadily increased from 13.25 to 84.00 lakh bales (one bale = 170 kg) from 2003-2004 to 2011-2012 (Table 5 and Fig 5). India is exporting long staple cotton to China, Pakistan, Bangladesh, Indonesia, Thailand, Hongkong, Vietnam, Taiwan, Malaysia and Belgium. The major long staple cotton varieties exported from India were Shankar 06, MECH 1, Hybrid 4, MCU 5, DCH 32, J 34 and Bunny Brahma. India is importing extra long staple (ELS) cotton from Egypt and USA to produce super fine yarn with a counts of 60 and above. Made ups and other textile articles are also manufactured from ELS cotton. India's production of ELS cotton is far below the local requirements of textile mills. The import of cotton was almost stagnant after 2003-2004 onwards while it was much higher during 1999-2000 to 2002-2003. During 20011-2012, the cotton imports stood at 12 lakh bales.

Specifications for export of cotton from India: The cotton produced is subjected to processing to get the lint. The recovery percentage of lint and cotton seed is in the ratio of 33:65. The specifications considered for export of cotton vary across different varieties (Table 6). The major specifications considered for export of cotton include staple length, micronaire value and tenacity. The cotton with a staple length of 27.4 mm and above, micronaire value of 3.8 to 4.4 NCL and fibre tenacity of more than 28g/tex is preferred in the international market. In addition, colour reflectness (Rd e"75), yellowness (d"10), nep content (< 200/g), uniformity ratio (e" 83%), maturity ratio (e" 80%), elongation (e" 6%), short fibre content (d" 5% index) and seed coat fragments (d" 15/g) are the important quality parameters considered in international market. Indian cotton is very much in demand in international market because of its superiority in terms of high spinning value due to manual harvest and roller ginning. The

Table 5. Trends in import and export of cotton in India

Year	Import (lakh bales)	Export (lakh bales)
1992-1993	1.15	13.77
1993-1994	3.00	3.90
1994-1995	5.89	1.08
1995-1996	0.50	8.00
1996-1997	0.30	16.82
1997-1998	4.13	3.50
1998-1999	7.87	1.01
1999-2000	22.01	0.65
2000-2001	22.13	0.60
2001-2002	25.26	0.50
2002-2003	17.67	0.84
2003-2004	**7.21**	**12.11**
2004-2005	12.17	9.14
2005-2006	5.00	47.00
2006-2007	5.53	58.00
2007-2008	6.38	88.50
2008-2009	10.00	35.00
2009-2010	7.00	83.00
2010-2011	2.38	76.50
2011-2012	7.51	129.57
2012-2013	14.59	101.43

(Source: www.cotcorp.gov.in)

cotton with wide length between 22 to 36 mm and above is available throughout the year in India.

There is a tremendous increase in growth in area, productivity and production of cotton due to introduction of *Bt* cotton in India and across different zones. Though the Technology Mission on Cotton was introduced much earlier, it couldn't able to bring about noticeable changes in growth in area and production of cotton. At the same time, increase in area under irrigated cotton, government support and modernization of regulated markets enhanced the growth to a limited extent. In view of these developments, the export of cotton has picked up especially from 2003-2004 onwards. India is exporting medium and long staple cotton to several countries which is expected to increase in the near future. Therefore, there is need to enhance the productivity and in turn production of cotton in order to meet the growing demand for cotton by

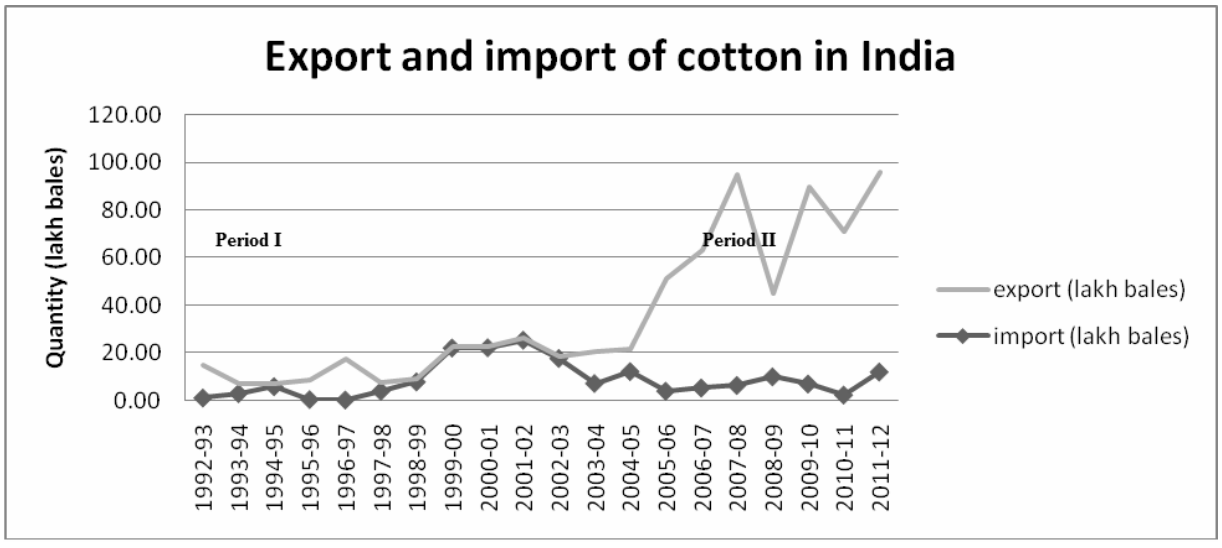

Fig 5. Export and Import of cotton from India during period I and period II

domestic textile industry followed by international market. Therefore, based on the above findings, the following implications have been drawn to enhance the productivity and production of cotton in the country on sustainable basis.

- The growth in area and production of cotton has picked up in few states of central and southern zone while there is enough scope to expand the area and productivity of cotton.

Table 6. Major Indian cotton varieties as/international specification

Sl.No	Classes of cotton and variety	International specifications			
		Staple length (mm)	Micronaire value	Strength G/Tex(ICC)	Strength GPT (HVI)
Short Staple (20 and below)					
1	Bengal *Deshi*	15-18	5.5-7.0	15	19
Medium (20.5-24.5mm)					
1	V 797	22-24	4.9 – 6.0	16-17	22
2	Jayadhar	22-24	4.0-5.0	17-18	23
3	Y 1	23-25	3.5-4.9	18-20	24
4	NHH 44	24-26	3.5-4.9	19-20	25+
Medium long staple (25–27 mm)					
1	LRA	25-27	3.5-4.9	19-21	25+
2	J 34	25-28	4.0-4.9	20-22	27-29
3	H4/MECH	27-29	3.5-4.9	20-22	27-29
Long staple (27.5 – 32.0mm)					
1	SHANKAR -6	27.5-29.5	3.5-4.9	21-23	27-29
2	Bunny/Brahma	29-32	3.5-4.5	22-24	29+
3	MCU 5	32-34	3.5-3.7	23-25	30
Extra Long Staple (32.5 and above)					
1	DCH 32	34-36	2.8-3.3	24-29	32
2	Suvin	38-40	2.9-3.2	30-32	38

(Source: www.acmeintl.com)

- The government support in procuring cotton under MSP is concentrated in central zone. Therefore, there is a need to extend MSP operations to all the cotton growing areas
- There is enough potential to produce ELS cotton to meet the growing demands of domestic spinning mills.

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