

## RESEARCH ARTICLE

### Shift in Indian Cotton Scenario due to Shift in Cotton Production Technology

M. SABESH<sup>1\*</sup>, A. H. PRAKASH<sup>1</sup>, G. BHASKARAN<sup>2</sup>

<sup>1</sup>Central Institute for Cotton Research, Regional Station, Coimbatore (India)

<sup>2</sup>Assistant Professor, Department of Geography, University of Madras, Chennai (India)

#### Abstract

There are many expectations from all stakeholders locally and globally to know the future of the Indian cotton scenario especially after introduction of advanced technologies in the recent past. This paper examines the Indian cotton scenario in detail particularly the impact of Bt cotton in the Indian cotton basket. Empirical evidence shows that cotton area and productivity played a mixed influence on cotton production in India over the years. It is also found that adoption of Bt and Non-Bt cottons in equal proportion in larger domain would sustain cotton productivity along with reduced cost of cultivation. There was leap in insecticide consumption for sucking pest in 2006-07 and made a pair with Bt cotton adoption rate but on the contrary, the insecticide consumption for bollworm declined from 2003-04. 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 area under cotton especially irrigated area, low pest incidence, well distributed rainfall, and better market price.

**Keywords:** Cotton, Bt Cotton, Growth Rate, Cost of Cultivation, Productivity, India

[Paper Received on: 29/03/2014 and Accepted on: 14/06/2014]

\*For correspondence : E-mail : sabesh23@gmail.com

#### Introduction

Cotton is the livelihood for about 60 million Indians including farming, textile and trade sectors. With about 365 lakh bales of cotton production in 2012-13 in the country, it is the second largest in the world next to China and productivity at 500 kg lint/ha for the past six to seven years which is much lower compared to leading cotton growing countries like China, Brazil, and USA. Over the years, India has achieved significantly in quantitative and qualitative cotton production with the available technologies. The production and productivity of cotton in India has increased constantly with adoption of improved hybrids, advanced production practices and use of modern inputs since independence. Though, large portion of irrigated area under cotton went to Pakistan after partition (Christopher, 2007; Farnie, 2009), India retained three quarters of the cotton acreage and two thirds of the cotton production of undivided India (Farnie, 2009). Pakistan, however inherited a large portion of the irrigated area of Punjab. Partition separated the cotton manufacturing industry of India from the major source of supply of the best quality of raw cotton to feed domestic industry and found it difficult in the initial period after partition. Partition transformed India into a profound importer of raw cotton and stimulated it to develop its own source of cotton production. The expansion of cotton cultivation had been gradual during the 1950s and 1960s but became rapid during the 1970s

and 1980s particularly after introduction of high yielding hybrid cottons, doubling India's share of the world crop during the decade of 1970s. To strengthen the cotton production in the country, India had established composite research stations for cotton, oilseeds and millets in 17 regions in 1956 (Farnie, 2009). Subsequently, in 1976 India established a Central Institute for Cotton Research at Nagpur, in order to hasten the achievements of self sufficiency in cotton production.

Government launched special schemes like Intensive Cotton Development Programmes (ICDP) through successive five-year plans, so that cotton production received the necessary impetus through increase in area particularly irrigated area and development of improved hybrid cotton in 70s. Since then the country has become self-sufficient in cotton production. Besides, Govt. of India launched the Technology Mission on Cotton in the year 2000, to improve the yield and quality of cotton as well as through improved seeds, integrated water, nutrient and pest management technologies, proper transfer of technology to the growers and to improve the quality of processing of cotton, particularly to eradication of trash, contamination, etc. by improving the infrastructure in the market yards for cotton and by modernizing the existing ginning & pressing factories. Government policy and improved production and protection technologies developed by public sector and SAUs coupled with development of Bt Cotton

by private industries have resulted in remarkable cotton production in late 2000s, which not only met the demand of the domestic textile industries, but the surplus production were also steadily exported to importing countries. The present paper analyses the dominant factor influencing cotton production and also the impact of Bt cotton and the overall situation of cotton production in the country.

### Cotton Research in India

The Indian Council of Agricultural Research (ICAR) has launched the All India Coordinated Cotton Improvement Project (AICCCIP) in the year 1967. The initial stage of the AICCCIP emphasized on enhancement of yield of medium and long staple cotton for feeding the domestic textile industry. The introduction of hybrid cotton H4 in 1970 and further research and release of improved hybrid cotton in 1970s has brought about a sea change in cotton production, productivity and fibre quality parameters, especially under dryland cottons (Rajendran and Jain, 2004). Besides, an exclusive national institute, The Central Institute for Cotton Research at Nagpur and its regional stations at Coimbatore and Sirsa were instituted in 1976, which caters basic and advanced research on cotton. To standardise the development of test methods for different types of textile materials, Cotton Technology Institute, the Central Institute for Research on cotton technology, Mumbai was established in 1924. These two institutes played a pivotal role in the development of cotton production and its fibre technology to sustain global competitiveness.

The establishment of the Department of Biotechnology (DBT) in mid 80s, under the Ministry of Science and Technology, paved the beginning of public-sector biotechnology establishment in India. Numerous private Indian seed companies along with subsidiaries of multinational companies have heavily invested in crop biotechnology research, beginning in the late 1990s (Carl *et al.*, 2011). Besides, Department of Science and Technology has identified and supported more than 150 private as well as public research establishments, engaged in biotech research and another 40 firms use biotechnology tools, to produce biofertilizer and biopesticides in the last two decades (Carl *et al.*, 2011).

With concerted efforts of these institutions and AICCCIP, with a network of 16 agricultural universities, has released over 300 cotton varieties and hybrids for the different cotton growing tracts of the country and development of economical and eco-friendly package of practices for realizing enhanced cotton productivity. Four decades of research work by the public sector brought more than 50 prominent cultivars (Table 1) which are high yielding with biotic and abiotic stress tolerant, improved fibre qualities along with suitable low cost production technologies have also been released over the years. Besides, the research to identify suitability of soil for cotton; optimum seed rating for different agro-ecological conditions; optimum plant geometry; diversified cropping and inter cropping system; Integrated Nutrient Management (INM),

Integrated Pest Management (IPM), Insecticide Resistance Management (IRM), Integrated Diseases Management (IDM) modules, High Density Planting System (HDPS) were successfully developed and disseminated through demonstrations among cotton farmers.

**Table 1:** Prominent Cotton Cultivars with Special Qualities

Cultivars	Specific quality
F414, H.777 LH.900 LD.327, HD.123, RG.8, RS.810, RS.2023, P.1861, LH.1556, H.1098, HHH.223, CSHH.198 Khandwa 2	Adoption of cotton-wheat rotation Early duration, yield upto 45q/ha High yielding and resistance to leaf Curl Virus disease
G.Cot.21, G.Cot.23, G.Cot.DH.7, RAHS.14, RAHS.131, DB.3-12, PA.255, PA.405, Suraj AKA.5, AKA.7 MCU.5VT, Surabhi Suvrin LRA. 5166 PKV Hy.4, PKV Hy.5 DDHC.11, Suraj F.1861, HHH.287, G.Cot.Hy.12 RAHS.14, AAH.1, CICR.2, RAJ DH.9, G.Cot.21, G.Cot.23, DDHC.11 LAHH.4, SVPR.3, Sumangala, PA.405, AKA.8, NH.543, AKDH.5, Wagad kalyan, G.Cot.18	Jassid resistant, base for many cultivars Long lint  Rainfed tract of Maharashtra ELS, resistance to Verticillium wilt Long linted, Spin count upto 120s, Most adaptable, medium staple, CMS based with high yielding and superior fiber qualities Suitable for organic farming Tolerant to water logging  Saline tolerant  Drought tolerant

Source: Compiled from Achievements in Cotton Research, AICCCIP, 2004 & In the service of cotton, AICCCIP, 2010

### Indian Cotton Scenario – an overall assessment

The impact on production of any agricultural commodity will be primarily based on the increase or decrease in area or productivity. On the other hand, the productivity which will be increased with the support of advanced technologies, in turn, will result in the increase of area under cultivation. There was a mixed influence of both area and productivity on cotton production in India over the years (Table 2). First leap in cotton production was experienced in the year 1971-72 with year to year growth rate<sup>1</sup> of 46% in production due to productivity growth rate of 43% over previous year; second leap during the year 1988-89 and 1989-90 witnessed area and productivity increase; and third leap in cotton production during 2003-04 (32%) and 2004-05 (35%) was due to both area and productivity enhancement. Although the production level was sustained in 2000, the real improvement in the production level in the later years of 2000 was due to enhancement in area under cotton triggered by large scale adoption of Bt cottons. Cluster of years where the cotton production was influenced by area and productivity in some pattern are given in the Table 2.

<sup>1</sup> Year to year growth rate =  $\left[ \frac{(X_a - X_b)}{X_b} \right]$  where, b=present year;  
a=past year.

**Table 2: Cotton Production in India: Area and Productivity**

Area/ Productivity	Years	Remarks
-1 / -1	68-69, 80-81, 82-83, 87-88, 97-98, 99-00, 00-01, 08-09, 12-13	These are the years where the production growth rate was negative due to both area and productivity having negative growth rates. Production growth rate ranges from -3.73 to -14.90%
-1 / -2	65-66, 70-71, 72-73, 75-76, 83-84, 86-87, 93-94	Negative production growth rate ranges from -11.96 to -20.88% mainly due to more than 10% negative productivity growth though meagre negative area growth rate.
-2 / -1	02-03	Production growth rate was -13.92% mainly due to negative growth rate (-11.84%) in area under cotton.
-1 / +1	66-67, 76-77, 90-91	Though the productivity growth rate was positive, the production level was negative due to area decrease particularly in the year 1976-77 from 73.50 lakh ha to 69 lakh ha.
-1 / +2	73-74, 74-75, 84-85, 92-93, 03-04	Production growth was remarkable ranging from 13.41 to 33.19% due to more than 10% productivity growth rate though negative area growth rate. In the year 1984-85 the productivity growth rate was 39% and the productivity increased from 141 kg/ha to 196 kg/ha.
+1 / -1	79-80, 91-92	Though there was positive growth rate in area, production growth rate was negative due to negative growth rate in productivity.
+1 / +1	67-68, 69-70, 78-79, 81-82, 85-86, 94-95, 98-99, 05-06, 06-07, 07-08	The area and productivity growth rate was up by 8% and 10% and most of the year the positive production growth rate was due to productivity enhancement rather than area enhancement. (sustained growth)
+1 / +2	71-72, 89-90, 96-97, 01-02	Alarming production level achieved due to more than 10% productivity growth rate with little area enhancement. The production growth ranges from 12.78 to 46.34%. Particularly in the year 1971-72 the cotton production went from 44.99 to 65.84 lakh bales and in 1989-90 it went from 87.43 to 115.21 lakh bales and subsequently the same scenario was experienced in the years 1996-97 and 2001-02.
+2 / -1	95-96, 09-10, 11-12	Remarkable increase in production chiefly due to area growth rate of more than 8% though negative growth rate in productivity. Interestingly, in the years 2009-10 and 2011-12 more than 90% of area was under Bt cotton but increase in production level was exclusively due to good and positive growth rate in cotton area but the productivity growth rate was negative.
+2 / +1	10-11	Here too the production increase was mainly due to more than 8% area growth rate and little appreciation of productivity growth rate compared to previous year.
+2 / +2	77-78, 88-89, 04-05	Win-win situation was experienced in production with the support of both area and productivity enhancement. Remarkable production growth rate ranged from 25.29 to 36.99 % during these years. Especially in the year 2004-05, cotton production in the country reached an all time high with 243 lakh bales from 179 lakh bales and thereafter cotton production level experienced constant increase for six to seven years and stagnating around 340 lakh bales in recent years (2010 to 2013) .

Note : (+1): small growth (if growth rate of 0 to 8% for area and 0 to 10% for productivity over previous year)  
 (+2): huge growth (if growth rate greater than 8% for area and greater than 10% for productivity over previous year)  
 (-1): small decline (if decline rate of 0 to -8% for area and 0 to -10% for productivity over previous year)  
 (-2): huge decline (if decline rate less than -8% for area and less than -10% for productivity over previous year)

Source: Estimated by M.Sabesh, 2013 based on data from Ministry of Agriculture, GOI and CAB

The decadal analysis of data for state wise picture shows that in the 1960s (between 1964-65 and 1969-70) the production trend was lower due to downward trends in both area and productivity across the states. In 1970s, the cotton production trends improved due to introduction of improved cotton hybrids. The states like Punjab, Haryana, Rajasthan had increased production level due to cotton area enhancement and states like Maharashtra, Andhra

Pradesh and Karnataka had enhanced cotton production level due to increase in cotton productivity levels (Table 4). The sustained cotton production system was maintained in 1980s with optimum area under cotton dovetailed with better productivity. Again in 2000 the cotton production was sustained between 2000-01 and 2009-10 with good production growth rate of 9% coupled with 2.1% and 6.8% growth rate of area and productivity,

respectively. But between 2010-11 and 2012-13, though the area under cotton expanded at the rate of 2.4%, the production growth rate was just 0.1% due to negative productivity growth rate (-2.6%).

### Genetically Modified Cotton

In 2011, there were 25 Genetically Modified (GM) crops cultivated in 1600 lakh ha in 29 countries. GM Cotton cultivated in 247 lakh ha worldwide and 106 lakh ha of GM Cotton was cultivated in India which is around 43% of the total GM cotton cultivation in the world (State of Indian agriculture 2012-13). The Government of India through Genetic Engineering Approval Committee (GEAC), Ministry of Environment and Forests, approved commercial cultivation of Bt cotton in 2002 which confers resistance to *lepidopteron* pests of cotton. Bt cotton was initially approved for commercial cultivation in South Zone (Tamil Nadu, Andhra Pradesh and Karnataka) and Central Zone (Gujarat, Maharashtra and Madhya Pradesh) in 2002-03 and later on in North Zone (Punjab, Haryana and Rajasthan) from the year 2005-06.

Bt cotton is the only Genetically Modified crop being cultivated in India so far. The immediate and spontaneous adoption of Bt cotton by the Indian farmers was due to success of Bt cotton in controlling bollworm, reduction in pesticide sprays and reduction in crop damage due to bollworm. The technology has allowed Indian farmers to benefit from a 39% reduction in pesticide use, a 31% increase in yield and a 88% increase in profitability (Mayee, 2012). Introduction of Bt cotton has played a pivotal role which brought down more than 50% insecticide usage on cotton and about 30-40% increase in productivity due to effective pest control and reduction in crop damage (Kranthi, 2012) and brought more area under cotton in India.

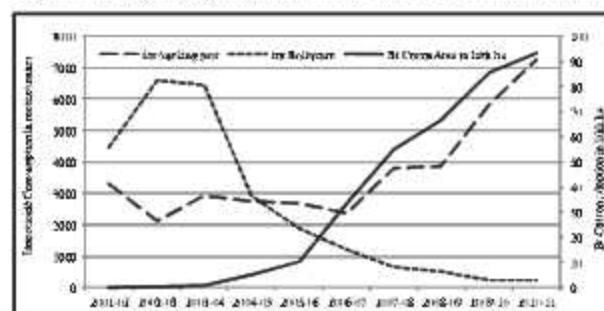
Though bollworm damage declined after introduction of Bt cotton, the introduction of several new Bt hybrids, has resulted in increased damage of sucking pests such as jassids, whiteflies, thrips, mealy and mirid bugs (CICR Vision 2030). There was a leap in insecticide consumption for sucking pest in 2006-07 and made a pair with Bt adoption rate but on the contrary the insecticide consumption for bollworm declined from 2003-04 (Figure 1).

### Impact of Bt Cotton on Cotton Production

Bt cotton was introduced in India in the year 2002, in the southern zone (Tamil Nadu, Andhra Pradesh and Karnataka). Primarily these southern states were cultivating cotton both under irrigated as well as rainfed condition. Later, it was introduced in the central

zone (Maharashtra, Madhya Pradesh and Gujarat) which has more rainfed cotton cultivation and the north zone (Punjab, Haryana and Rajasthan) with more of irrigated cotton cultivation. Many early studies found that Bt cotton was well suited for irrigated condition. Not all Bt cotton varieties are equally suitable for all climatic conditions. They can lead to Bt yields below the yields of conventional varieties grown by farmers (Kaphengat *et al.*, 2010).

Figure 1: Insecticide Consumption vis-a-vis Bt Cotton adoption



Note: Data adopted from the book, Kranthi, K R, 2012, Bt Cotton-Questions and Answers, ISCI, Mumbai

The relative returns from Bt cotton crop is expected to be less in rainfed zones, where the adoption of various yield-increasing inputs/practices is generally less due to uncertainty in crop output (Narayanamoorthy, 2006). Commercial cultivation of Bt cotton hybrids in irrigated zones showed significant reduction in pesticide application with increased net profit to cotton farmers and has become economically sustainable (Patil *et al.*, 2007). A survey by ISCI in 2013 found that just 24% of the Maharashtra farmers consider Bt cotton yield as a major benefit from adoption of Bt cotton and conversely, 79% and 100% farmers considered yield as a major benefit in Andhra Pradesh and Punjab, respectively (Mayee and Bhagirath, 2013). The same survey also found that bollworm control and reduction in number of sprays are major benefits from adoption of Bt cottons.

Compound Annual Growth Rate<sup>2</sup> (CAGR) of cotton area, production and productivity for different cotton growing states for different periods were estimated (Table 4), which shows that in India, the CAGR for cotton area was -0.2% before Bt cotton adoption took a significant position in India (1964-65 to 2003-04). India was able to achieve CAGR of 3% in production and 3.2% in productivity, respectively. Whereas the CAGR for area after large scale Bt cotton adoption between 2004-05 and 2012-13 was 3.7%, which fetched 4.3% and 0.5% of CAGR for production and productivity respectively. The simple correlation analyses<sup>3</sup> also

<sup>2</sup> Compound annual growth rate =  $\left[ \left( \frac{X_b}{X_a} \right)^{1/n} - 1 \right] \times 100$  where, a = past data; b = present data; n = no. of years

<sup>3</sup> Coefficient of Correlation (r) =  $\frac{\sum (n\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$  where, x and y are variables and n is no. of years

show that between 1964-65 and 2003-04 for production versus area was 0.57 and production versus productivity was 0.98 whereas, between 2004-05 and 2012-13, the correlation for production versus area was 0.93 and production versus productivity was 0.30 (Table 3). The valid increase in the cotton production in the country after Bt cotton adoption is due to enhancement in area under cotton, in contrary to the increase in cotton production before Bt cotton adoption was mainly due to enhancement in cotton productivity and not due to area enhancement. Gandhi and Nambudiri (2009) also observed in their study that growth in cotton production in India between 1990-01 to 2007-08 was mainly due to growth in area rather than growth in yield. A study by IFPRI found that increase in average yields occurred between 2002 and 2004, at a time when the official rates of adoption of Bt cotton were still low, which prompted them to believe that Bt cotton might have had no role in the years during 2003-05 yield leap and further hypothesized that Bt cotton contributed to a second yield leap in 2005 with increasing adoption rates (Guillaume and Sun, 2012).

**Table 3:** Correlation between production with area and productivity

Correlation between	1964-65 to 2003-04	2004-05 to 2012-13
Area and Production	0.57	0.93
Productivity and Production	0.98	0.30

Source: Estimated by M. Sabesh, 2014, based on Data from Deptt. of Agri., Maharashtra

#### Cost of Cultivation of Cotton in India

The cost of cultivation for production of one quintal of seed cotton in India, on an average was Rs. 2500 for the past ten years (1999 to 2010) based on data from Department of Agriculture and Cooperation. The seed consumption rate was high even in the year 2009-10, in states like Tamil Nadu and Rajasthan. It may be due to sizable area under Non-Bt cotton cultivation in these states (Table 5). The minimum seed consumption in Andhra Pradesh, Maharashtra, Madhya Pradesh and Gujarat divulges the extensive

**Table 4:** Compound Annual Growth Rate (CAGR) of Cotton in India

	64-65/ 69-70	70-71/ 79-80	80-81/ 89-90	90-91/ 99-00	00-01/ 09-10	10-11/ 12-13	64-65/ 03-04	04-05/ 12-13
<b>Area</b>								
Punjab	-3.4	5.3	1.4	-4.2	0.8	-2.3	-0.2	-0.1
Haryana	2.2	5.5	4.4	1.2	-1.0	11.7	2.9	-0.1
Rajasthan	-2.2	6.4	2.2	2.8	-1.5	15.9	0.7	0.3
Gujarat	-2.3	0.9	-3.1	5.9	5.5	-4.5	-0.3	2.9
Maharashtra	-0.1	-0.9	-0.1	2.0	1.5	2.6	0.0	4.8
Madhya Pradesh	-5.4	-1.3	-0.4	-1.6	2.1	-3.3	-1.1	0.7
Andhra Pradesh	-3.0	2.9	5.0	5.3	4.2	9.9	2.1	8.5
Karnataka	-0.1	1.3	-3.4	-1.1	-2.3	-5.7	-3.0	-0.9
Tamil Nadu	-1.7	-1.2	2.0	-4.0	-6.6	1.6	-3.3	-0.3
India	-1.6	0.7	-0.2	1.8	2.1	2.4	-0.2	3.7
<b>Production</b>								
Punjab	-0.1	4.4	8.5	-8.4	3.5	4.0	0.6	2.4
Haryana	3.2	5.8	3.0	-0.8	4.8	18.8	3.6	5.6
Rajasthan	2.7	8.7	10.9	3.5	1.2	25.9	5.7	4.8
Gujarat	0.0	1.4	0.3	7.0	17.0	-9.5	3.0	2.2
Maharashtra	-0.6	15.0	6.4	10.9	15.3	-8.2	2.4	4.5
Madhya Pradesh	-7.8	1.8	4.9	-0.4	-2.6	0.8	3.6	1.5
Andhra Pradesh	-7.4	21.5	2.4	2.0	8.9	13.0	7.8	11.2
Karnataka	-8.3	8.9	7.8	-1.5	5.2	8.2	-0.6	6.3
Tamil Nadu	2.1	1.3	7.6	1.1	-1.1	-8.7	0.1	1.1
India	-1.2	6.1	5.6	3.2	9.0	0.1	3.0	4.3
<b>Productivity</b>								
Punjab	3.6	-1.4	7.0	-4.3	2.7	6.4	0.6	2.5
Haryana	1.0	-0.4	2.3	-2.0	5.9	6.4	0.4	5.8
Rajasthan	-6.4	1.5	8.5	0.7	2.8	8.7	2.8	4.4
Gujarat	1.2	-0.1	3.4	1.0	10.9	-5.2	3.0	-0.7
Maharashtra	-0.5	15.2	4.6	8.8	13.6	-10.5	2.3	-0.3
Madhya Pradesh	-0.7	2.4	12.7	1.3	-4.6	4.4	4.3	0.8
Andhra Pradesh	-4.4	17.1	-2.4	-3.1	4.6	0.3	5.5	2.5
Karnataka	-11.3	6.8	6.2	-0.4	7.7	14.8	2.0	7.2
Tamil Nadu	4.0	1.8	5.4	4.0	6.0	-10.2	3.3	1.4
India	0.3	4.7	5.8	1.5	6.8	-2.6	3.2	0.5

Source: Estimated by M. Sabesh, 2013. Data sourced from Cotton Advisory Board and Department of Agriculture and Cooperation.

**Table 5:** Bt adoption category in different years

Bt cotton adoption category	1999-00	2009-10	1999-00	2009-10	1999-00	2009-10	1999-00	2009-10
	Seed Consumed (Kg/ha)		Total Seed Cost (Rs/ha)		Fertilizer consumed (Kg Nutrients/ha)		Total Fertilizer cost (Rs/ha)	
intensive	5.03	1.54	1016.52	2226.39	99.26	165.33	1178.17	2342.30
equal	11.87	2.58	548.10	3211.07	68.39	146.58	781.27	1917.27
less	12.82	9.23	559.02	1874.18	164.43	224.75	1818.18	3306.53
	Manure consumed (Qtl/ha)		Total Manure cost (Rs/ha)		Human Labour consumed (MH/ha)		Total Human labour cost (Rs/ha)	
intensive	14.77	19.37	281.25	909.53	697.23	809.19	4069.94	10746.79
equal	5.96	5.04	225.00	107.29	739.00	725.79	5704.68	13002.27
less	24.93	27.48	559.79	1354.58	938.60	952.83	7742.11	17506.30
	Total Animal labour cost (Rs/ha)		Total Machine labour cost (Rs/ha)		Total Insecticides cost (Rs/ha)		Yield Per hectare (Qtl/ha.)	
intensive	1235.71	3314.46	531.57	1375.03	1117.23	1449.02	7.30	15.69
equal	750.11	1092.79	1099.06	2750.22	2091.40	1625.45	8.87	16.83
less	582.54	43.44	541.97	2612.32	1097.42	1206.59	10.99	18.64

Note: Intensive states - Andhra Pradesh, Maharashtra, Madhya Pradesh and Gujarat; Equal intensive states - Karnataka, Punjab and Haryana; Less intensive states - Tamil Nadu and Rajasthan

Source: Estimated by M. Sabesh, 2013 based on Cost of cultivation data from Department of Agriculture and Cooperation, Govt of India

adoption of Bt cotton and states like Karnataka, Punjab and Haryana have shown very little area under Non-Bt cotton. The delineation of states for Bt cotton adoption category were based on seed consumption per unit area<sup>2</sup> in intensive Bt cotton adoption states (Andhra Pradesh, Maharashtra, Madhya Pradesh and Gujarat); Bt cotton equal intensive adoption states (Karnataka, Punjab and Haryana); and Bt cotton less Intensive adoption states (Tamil Nadu and Rajasthan).

The above delineation also brought out an interesting fact, that total seed cost in equal intensive states increased on an average of 80% more in 2009-10 compared to 1999-00 where it was 68% in less intensive states and 55% in intensive states (Table 6). Though the cost of Bt cotton seed is higher than that of Non-Bt cotton, the total seed cost was higher in less and equal intensive Bt cotton adoption states due to higher seed rate for Non-Bt cotton cultivation. All seeds of approved Bt cotton hybrids is sold in packets of 450 grams, calculated to be sufficient to plant one acre. The seeding rate for Bt Cotton hybrid is significantly less than that for conventional seed, so the high price of the hybrid is partially compensated by the low seeding rate (Lalitha *et al.*, 2009).

Total cost of cultivation of cotton per hectare in intensive Bt cotton growing states has increased on an average of 60.96% in 2009-10 compared to 1999-00 where it was 50.09% in less intensive states and 58.18% in equal intensive states (Table 6). Expenditure on insecticide for cotton in intensive Bt cotton growing states has increased on an average by 25.23% in 2009-10 compared to 1999-00 where it saw an increase of 10.69% in less intensive states and decrease of 8.59% in equal intensive states. Though the insecticide cost reduced for bollworm control for Bt cotton, there was an increased expenditure on insecticide in intensive Bt cotton

growing states, due to control of sucking pest infestation. It suggests that cost and consumption of insecticide in cotton cultivation can be minimised if 50% each of Bt and Non-Bt

**Table 6 :** Percentage change in cost of cultivation for different components from 1999-00 to 2009-10

Main Components	Bt cotton adoption category states		
	Intensive	Less	Equal
Seed unit consumed (Kg/ha)	-233.72	-39.78	-393.65
Total Seed cost (Rs/ha)	55.18	67.85	79.63
Fertilizer unit consumed (Kg Nutrients/ha)	29.14	13.66	46.78
Total Fertilizer cost (Rs/ha)	42.09	35.89	55.23
Human Labour unit consumed (Man h/ha)	9.16	6.50	-1.70
Human labour Total (Rs/ha)	60.69	56.74	57.14
Insecticides cost (Rs/ha)	25.23	10.69	-8.59
Machine labour Total (Rs/ha)	49.34	75.51	68.21
Yield (Qtl/ha.)	53.33	41.03	48.56
Cost of cultivation per hectare in Rs.	60.96	50.09	58.18

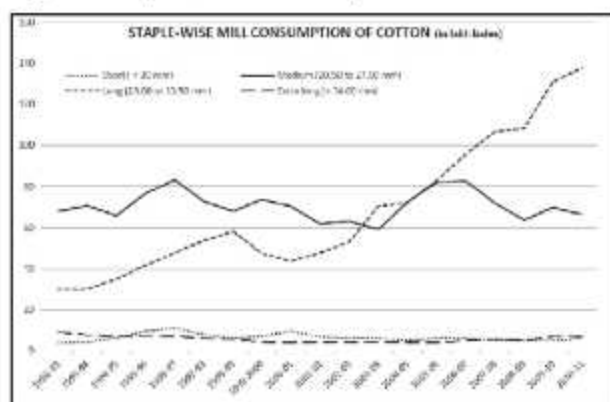
Source: Estimated by M. Sabesh, 2013 based on Cost of Cultivation data from Department of Agriculture and Cooperation, Govt of India.

cultivation practice followed in larger domain. Also equal blend of Non-Bt and Bt cotton cultivation prolong or sustain the resistance among the bollworm. Regarding productivity per hectare in intensive Bt cotton growing states, it has increased on an average by 53.33% in 2009-10 compared to 1999-00 and 41.03% and 48.56% respectively for less intensive and equal intensive Bt cotton growing states. Again it divulges that equal adoption of Bt and non-Bt cotton would sustain the productivity level considering other cost factors.

## Impact on Textile Industry and International Trade

In India, the fibre consumption ratio of cotton and non-cotton is at 63% and 37% respectively, and with over 3000 textile mills including spinning and composite; 5.18 lakh power loom units; installed capacity of 47.58 million spindles and 7.49 lakh rotors; thousands of hosiery, garments and processing units, the textile industry is the largest agro-based industry in the country which produces 3,490 million kg of cotton yarn and 31,718 million sq mt of cotton fabrics in 2010-11 (Official Indian Textile Statistics). Statistics on staple wise consumption of cotton by the mills from 1992 to 2011 reveals that consumption of medium staple class cotton was ruling till 2002-03 (Figure 2), but thereafter constant rate of increase in consumption of long staple cotton in Indian mills occurred because of the release of improved cotton cultivars with long staple class by both public and private sectors. There was an increase in long staple cotton consumption from 27% in 1992 to 63% in 2011 to overall staple classes, whereas in medium

Figure 2 : Staple wise Mill Consumption of Cotton



Source: Official India Textile Statistic, Ministry of Textiles, Government of India

staple class, the consumption decreased from 61% to 30% for the same period.

In the first half of 2000, the cotton yarn followed by Cotton fabrics dominated both the quantity and export value of cotton products from India, whereas the raw cotton export was 1-5% of the total export (raw cotton, cotton yarn, and cotton fabric). Share of cotton yarn and fabric export started to decline from the year 2005-06. Due to increased local production, cotton export policy change in 2005-06 increased the demand for raw cotton in foreign countries especially from China. Export of raw cotton increased from 36 lakh bales in 2005-06 to 118 lakh bales in 2011-12 (Table 7). Due to better international price for raw cotton in 2011-12, the remarkable foreign earning achieved through export of raw cotton to the tune of Rs. 21,624 crore compared to Rs. 12,979 crore in 2010-11.

There was a steady slump in the share of cotton fabrics export to the total exports and the data from the office of the Textile Commissioner shows that the share of cotton yarn export to total cotton export has come down from 94.04% in 1999-00 to 24.58 in 2011-12. The effect is mainly due to the volume of raw cotton export overtaking the fabric exports rather than a drop in the fabric exports. Conversely, the raw cotton export increased from 2.34% in 1999-00 to 53.85% in 2011-12 and raw cotton export boom took place particularly after 2005-06. As far as import is concerned, there was constant decrease in the proportion of raw cotton import to the total imports from 98.17% in 1999-00 to 35.52% in 2011-12. The reduction in import of raw cotton is mainly attributed to leap in cotton production particularly long staple cotton to meet the local mill consumption from 2005-06. It is explicit that our raw cotton imports are need-oriented and do not have any bearing on the domestic production of raw cotton (Rajendran and Jain, 2004). Remarkable cotton production in second half of 2000 and supply of quality and quantity of cotton was imported for domestic use were met with local production and surplus was exported to other countries.

Table 7 : Export and import of raw cotton

Year	Cotton Export					Cotton Import		
	Raw Cotton			Yarn	Fabrics	Raw Cotton	Yarn	Fabrics
	Qty	Qty (lakh bales)	Value	Qty	Qty	Qty	Qty	Qty
1999-00	15905	36.16	7707	443994	218861	237389	762	3675
2005-06	616488	68.37	291265	562120	632543	103934	4457	141839
2006-07	1164224	85.8	611747	624899	654819	87199	7737	190028
2007-08	1458591	26.92	886540	658544	658421	150258	6970	189671
2008-09	457562	79.88	286583	553533	687601	217616	4507	144861
2009-10	1357985	74.03	953709	586843	626933	170427	5254	125971
2010-11	1258443	117.86	1297993	693802	839151	58384	4045	147991
2011-12	2003589	118.52	2162427	749461	967923	77422	4951	135584

Note: Quantity in tones, Value in Re. Lakh; Fabrics quantity in '000 sq.mts  
Original Source: Monthly Statistics of the Foreign Trade of India DGCIS, Kolkata  
Source: Office of the textile commissioner Ministry of Textile, Government of India

## Conclusion

The overall picture of the Indian cotton scenario has brought mixed influence of cotton production technologies on cotton production over the years. The production level sustained in 80s and 2000s and the real raise in the production level in the later years of 2000 was due to enhancement in the area under cotton triggered by large scale adoption of Bt cotton. Based on the seed consumption rate, it was found that in states like Tamil Nadu and Rajasthan, the adoption rate of Bt cotton was less and in states like Andhra Pradesh, Maharashtra, Madhya Pradesh and Gujarat the adoption rate of Bt Cotton was intensive. It was also found that cost of cultivation of cotton in Andhra Pradesh, Maharashtra, Madhya Pradesh and Gujarat was intensive and higher than other cotton growing states. The study suggests that cost and insecticide consumption in cotton cultivation can be minimised if 50% each of Bt and Non-Bt cotton cultivation pattern is followed in larger domain. The states like Karnataka, Punjab and Haryana adopted Bt and Non-Bt cotton in equal proportion and resulted in the reduction of insecticide application. Though bollworm damage declined after the introduction of Bt cotton, the damage due to sucking pests increased after 2006-07 which escalated the consumption of insecticide in some of the Bt cotton growing states.

Research accomplishment and various special cotton programmes over the years from public sector institutions have brought improved cotton production technologies and many better cotton cultivars which are superior in fibre quality, as well as to overcome various biotic and abiotic stresses. The introduction of improved cotton hybrids from both public and private sectors in later part of 2000, resulted in huge production of long staple cotton which in turn increases consumption of long staple cotton by the local mills and minimises import of long staple cotton during the period. The production increased in recent years in India, not only because of Bt technology, but there are other parameters which augment the production leap with increased irrigation facilities, bringing more area under cotton, low pest incidence, well distributed rainfall, higher quality produce fetching better market price.

## References

Anonymous (2013) – *States of Indian Agriculture 2012-13*, Government of India, Ministry of Agriculture, New Delhi, 2013.  
Carl E. Pray, Latha, N., Jikun Huang, Rufa Hu and Bharat Ramaswami

- (2011) – *Impact of Bt Cotton, the Potential Future Benefits from Biotechnology in China and India*, in *Frontiers of Globalization: Genetically Modified Food and Global Welfare*, edited by G. Moschini, C. Carter and I. Sheldon, Emerald Books, 2011, pp. 83-114.
- Christopher Candland (2007) – *Labor, Democratization and Development in India and Pakistan*, Routledge-Taylor & Francis Group.
- Farnie, D. A. (2009) – *The cotton harvest of India and the world market - 1770-2005* is edited by A.J.H. Latham, Heita Kawakatsu Intra-Asian Trade and Industrialization: Essays in Memory of Yasukichi Yasuba, Routledge-Taylor & Francis Group.
- Gopalakrishnan, N., Manickam, S., Sabesh, M., Usharani, S., Pramod Pundhir, Nehra, P. L., Surulivelu, T. and Monga, D. (2010) – *In the service of Indian cotton Farmers*, Published by All India Coordinated Cotton Improvement Project, Technical bulletin 2/2010, pp.31. Available at [http://www.cicr.org.in/pdf/siccip\\_tech\\_bull.pdf](http://www.cicr.org.in/pdf/siccip_tech_bull.pdf)
- Guillaume P. Gruere, and Yan Sun (2012) – *Measuring the Contribution of Bt Cotton Adoption to India's Cotton Yields Leap*, IFPRI Discussion Paper 01170, April 2012.
- Gandhi P. Vesani and Namboodiri, N. V. (2009) – *Economics of Bt Cotton Vis-a-vis Non-Bt cotton in India: A study across four major cotton growing states*, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad, September 2009.
- Kaphengat, Timo, Nadja El Beani, Clive Evans, Robert Finger, Sophie Herbert, Stephen Morse and Nataliya Stupak (2010) – *Assessment of the economic performance of GM crops worldwide – Report to the European Commission*, March 2011.
- Kranthi, K. R., Venugopalan, M. V., Sabesh, M. and Yadav, M. S. (2011) – *Vision 2030*, CICR, Nagpur Available at [http://www.cicr.org.in/pdf/CICR\\_VISION\\_2030.pdf](http://www.cicr.org.in/pdf/CICR_VISION_2030.pdf)
- Kranthi, K. R. (2012) – *Bt Cotton-Questions and Answers*, Indian Society for Cotton Improvement, Mumbai, 2012, pp.71. Available at [http://www.cicr.org.in/pdf/Bt\\_book\\_Kranthi.pdf](http://www.cicr.org.in/pdf/Bt_book_Kranthi.pdf)
- Lalitha, N., Vishwanathan, P. K. and Bharat Ramaswami (2009) – *India's Experience with Bt Cotton: Case Studies from Gujarat and Maharashtra, in Biotechnology and Agricultural Development: Transgenic Cotton, Rural Institutions and Resource-Poor Farmers*, edited by R. Tripp, Routledge, London, 2009, pp. 135-167.
- Mayee, C. D. (2012) – *Bt Cotton success and the progress of GM crops in India*, *Cotton Research Journal*, July-December, 2012, pp. 131-134
- Mayee, C. D. and Bhagirath Choudhary (2013) – *Adoption and uptake pathways of Bt Cotton in India*, *Indian Society for Cotton Improvement*, 2013 pp. 142
- Narayanamoorthy, A. and Kalamkar, S. S. (2006) – *Is Bt Cotton Cultivation Economically Viable for Indian Farmers? An Empirical Analysis*, *Economic and Political Weekly* June 30, 2006, pp 2716-2724
- Official India Textile statistic, 2012-13, Ministry of textiles, Government of India (<http://www.texindia.gov.in/>)
- Patil, B. V., Bheemanna, M. and Shivanaad G. Hanchinal (2007) – *Insect Pest Status and Economics of Bt Cotton Cultivation under Irrigated Ecosystem*, WCRC-4, 2007
- Rajendran, T. P. and Jain, K. C. (2004) – *Achievement in Cotton Research*, Published by All India Coordinated Cotton Improvement Project, 2004, pp.104.