Research Paper

An economic analysis of production of Bt cotton in Adilabad district of Telangana state

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ABSTRACT : This study is aimed at economic analysis of production of BT cotton in Adilabad district of Telangana state with specific objectives of determining the production trend and estimating the cost of production and farm profitability of Bt cotton in the study area. A total of six villages in the three sampled blocks *viz.*, Koutala, Dahegoan, Bejjure mandals (Blocks) were selected randomly for the study. Altogether, 100 Bt cotton farmers which were classified in to small, medium and large farmers, in these 57, 25 and 18 respondents were sampled, respectively. Compound growth rate, cost concepts and farm profitability measures was used to analyze the primary data. The study reveals that the growth rates in area, production and productivity is positive (7.20 %, 11.30 % and 3.80%), respectively. The sample average for total cost of cultivation was Rs.52921.32/ha in Bt cotton in different size of farms group. Per hectare gross returns and net profit was Rs.86562/ha and Rs.33640/ ha, respectively. Output-input ratio was 1.92.The study indicated that, Bt cotton production is highly profitable in both study areas of India and Nigeria.The major constrains in the cultivation of cotton were poor quality of seed, labour scarcity, higher cost of fertilizer and pesticides and rainfall deficiency.

KEY WORDS : Bt cotton, Cost, Gross return, Net profit, Compound growth rate, Instability analysis, Benefit cost ratio (BCR)

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INTRODUCTION :

Cotton (*Gossypium* sp.) the "white gold" and "king of fibres", is animportant commercial crop of India. Cotton plays a key role in the national economy in terms of both employment generation and foreign exchange earnings. Cotton contributes around 30 per cent to the gross domestic product of Indian agriculture. India is an important grower of cotton on a global scale. It ranks third in global cotton production after the United States and China; with 8-9 million hectares grown each year,

India accounts for approximately 25 per cent of the world's total cotton area and 16 per cent of global cotton production (Reddy *et al.*, 2011).India also sustained the position of being the second largest consumer and exporter of cotton and is expected to export 7.5 million bales and expected to consume 23 million bales in 2013-14. However, yields of cotton in India are low, with an average yield of 300 kg/ha compared to the world average of 580 kg/ha. The area, production and productivity of cotton in India during 2015-16 was 118.81 lakh hectares, 352 lakh bales and 504 kg/ha, respectively. The yield per hectare (*i.e.*504 kg to 566 kg per hectare) is however, still lower

against the worldaverage of about 701 kg to 766 kg per hectare (CAB, 2016).

One of the main factors showing impact on the productivity is the fact that the cost on pesticides accounts for major portion of total cost of cultivation.Cotton is highly at risk to insects which impacts cotton production. In fact, cotton alone accounts for more than half of the money spent on pesticides in India (Jamail and Kaushik, 2007). Most of the cotton in India is grown under rainfed conditions, and about a third is grown under irrigation (Sundaram *et al.,* 1999). Kranthi (2012) mentioned that Bt cotton technology is highly suited for all conditions including rainfed and irrigated. In general Bt cotton hybrids are suitable for irrigated conditions and it has been proved from production and productivity levels of Gujarat, Punjab and Haryana (Sabesh *et al.,* 2014). In Telangana, cotton occupies an area of 16.93 lakh hectares with a production of 35.83 lakh tonnes and with a productivity of 360 kg lint per hectare during 2014-15 (Anonymous, 2016). Area under Bt cotton in Telangana increased from 6321 thousand acres during 2002-03 to 16.93 lakh hectare during 2015-16. Major districts involved in the production of Bt cotton in Telangana are Nalgonda, Adilabad, Mahabubnagar, Warangal and Khammam.

Since the introduction of Bt cotton in India, there has been a serious debate going on its impact on cost, returns and productivity. Many studies have shown potential gains to producers from growing Bt cotton in a number of developing countries (James, 2002), including South Africa (Bennett *et al.,* 2003); Argentina (Qaim and De Janvry, 2002); Mexico (Traxler *et al.,* 2001); China (Pray *et al.,* 2002) and India (Naik, 2001; Qaim and Zilberman, 2003 and Bennett *et al.,* 2004). Bt cotton has been found a superior technology to hybrid cotton, as it gives higher yield and has low cost of production.The total cost per hectare is higher in Bt cotton than hybrid cotton. The cost of seeds has been found higher in Bt cotton, whereas hybrid cotton growers incur more cost on insecticides/ pesticides. This shows the effectiveness of the new technology (Bt cotton) for insect resistance (Visawadia *et al.,* 2006). Subjective assessment indicates that farmers see advantage in Bt cotton in pest incidence, pesticide cost, cotton quality, yield and profit (Gandhi and Namboodri, 2006). Bt cotton being a GM crop it is not considered as normal cotton crop. Though the yield is high, pest incidence is low but the quality of the cotton we need to check whether it have any side effects on cultivation, processing and finally usage (Panchali *et al.,*

2017). In an study on socio-economic impact of Bt cotton in Andhra Pradesh revealed that introduction of Bt cotton reduced number of sprays on cotton from 8.9 to 4.6 and the share of plant protection from 32.16 to 11.84 per cent in total costs. Productivity increase is significant that 51.16 per cent more yield with the introduction of Bt cotton. The percentage increase in net returns is 291 resulted in relief from debts, more spending on education, health and social functions. The amount of time spent in the field reduced. This makes them perceive better life after Bt introduction (Reddy *et al.,* 2011). With this back drop, the present study attempts to determine the cost and returns and profitability of BT cotton in Adlabad district.

Indian cotton production has undergone a metaphoric changes from 2002-03, after Bt cotton was introduced in the country. Bt cotton now occupies 95 per cent of the total cotton area in the country (Narala and Reddy, 2010). These dynamic changes underline the importance of studying the growth performance and instability of cotton before and after Bt cotton introduction as policy decisions are often made based on the growth rate which depends on the nature of the data and instability in farm production. The present paper analyzes the growth and instability in Bt cotton area, production and productivity during the period 2005-06 to 2015-16in Adilabad district.

Objectives :
  –To estimate the growth and instability in area, production and productivity of Bt Cotton in Adlabad district.
  –To estimate the cost of production per quintal and farm profitability of Bt cotton in different size of farm groups.
  –To find out the constraints in the production of Bt. cotton and suggest suitable measures.

MATERIALS AND METHODS :

Multi stage sampling design was adopted for selection of district, tehsils, villages, as well as grower of Bt-cotton. In the first stage, Adilabad district was purposively selected on the basis of area under the Bt cotton production. In the second stage, Koutala, Dahegoan, Bejjure mandals (Blocks) were selected purposively on the of basis higher area under Bt cotton. In third stage, a complete list of all villages were obtained from sampled blocks office. Therefore, the villages were arranged in ascending order on the basis of Bt cotton

cultivation area, and then 2 per cent villages were selected randomly. As a result, six sample villages were selected for the present study. The villages are given in the Table A.

Table A : Details of selected farm villages		
Sr. No.	Block	Villages
1.	Koutala	Babasagar
		Manepally
2.	Dahegaon	Sichchala
		Oddugudem
3.	Bejjure	Dimda
		Gudem
Total	3 (Blocks)	6 (Villages)

In the fourth stage, a complete list of all the respondents were growing Bt cotton was obtained from the Gram Pradhan in all the selected villages. Therefore, the respondents were arranged in ascending order of area under maize cultivation and then respondents were classified into three different size farm groups on the basis of area under cultivation *viz.,*

First group :   Small respondents– less than 1 ha;
Second group: Medium respondents – 1 ha to less
              than 2 ha and
Third group : Large respondents – More than 2 ha
Thereafter, 10 per cent respondents were selected in the entire three size of farms group in each selected village. All together total respondents were 100 *viz.,* 57 small size of farms group, 25 medium size of farms group and 18 large size of farms group, respectively.

Analytical tools and techniques :
The analytical tools employed in the present study are explained in detail under the following headings.

Growth and instability analysis :
The trend analysis is based on the secondary data sourced from Cotton Advisory Board, Ministry of Agriculture and Government of India. The period of analysis is 2005-06 to 2014-15.Compound growth rates (CGR) of area, production and productivity of Bt cotton was worked by fitting exponential function as given below:

LnY= a+bt

CGR(r) = [Antilog b-1]*100

To know the variation in area, production and productivity of pomegranate over the years, the co-efficient of variation (CV) was worked out by employing the following formula:

CV= (Standard deviation / Mean) * 100

Cost, returns and profitability analysis :
E*stimation of cost of cultivation*:
For that, cost concept of cost-A_1, A_2,cost-B and cost-C was used.The analytical techniques such as tabular analysis, arithmetic mean and ratio were used to analyze the data and per hectare costs, returns and profit of Bt-cotton were estimated.

– Cost A_1: It includes the value of expenditure on seedmanures and fertilizers hired human labour, bullock labour, land revenues, irrigation charges, machinery charges, interest on working capital and depreciation on farm implements.

– Cost A_2 = Cost A_1+ Rent paid for leased-in land, if any.

– Cost B = Cost A_2 + Imputed rental value of owned land + interest on owned fixed capital

– Cost C = Cost B + Imputed value of family labour. Cost C is the total cost of cultivation or gross cost.

Measures of farm profitability :
– Gross income = Per quintal price* yield per hectare in quintal

– Farm business income = Gross income – Cost A_2

– Farm investment income = Net income + Rental value of owned land + Interest on fixed capital

– Net income = Gross income – Cost C

– Input output ratio (cost benefit ratio) = Cost C: gross income

RESULTS AND DATA ANALYSIS :

The findings of the present study as well as relevant discussion have been presented under following heads:

Growth rates in area, production and productivity of Bt cotton :
The Table 1 presented below clearly suggest that the area, production and productivity of cotton stood in India grew at CAGR of 3.97 per cent, 4.65 per cent and 0.65 per cent, respectively which is lesser than the CAGR of Telangana and Adilabad district. Maximum CAGR was recorded in the Adilabad district whose area, production and productivity grew at 8.93 per cent. 9.74 per cent and 1.44 per cent, respectively as compared to the state with CAGR of 7.17 per cent, 11.30 per cent and 3.81 per

cent, respectively. This clearly indicates that the prospects of cotton in Adilabad district is growing very rapidly in the state.

Insatiability analysis :

It is clear from Table 1 that the instability in the cotton production was found high as compared to the area and the productivity in the district, state and India level whereas highest instability in production was recorded at the state level (36.7 %). Instability in cotton area was found high (32.9%) in Adilabad district when compared to India (13.9 %) and the state level (28.8%). Instability in the yield of cotton was found high at the state level (18.1 %) followed by yield of Adilabad (16.7 %) and the state (5.08%).

Factor wise distribution of cost per hectare in different size groups :

All cost realized by the farmers during BT cotton cultivation were computed within all the different farm size groups from study area and the contribution of each input used in the total cost was also computed in percentage as revealed on the Table 2. The table revealed that the cost of BT cotton production per hectare for the small scale farmers is greater than that of the medium farmers followed by large farmers group in the study area. The cost of cultivating Bt cotton for small, medium and large groups of farmers was found to be 54036.25 Rs. /ha, 51725.75 Rs./ha, 51051.20 Rs./ ha with sample average calculated at 52921.32 Rs./ha. Maximum cost incurred common to all the farm group was in hired human labour followed by chemical fertilizers and cost of seedling

Table 1: Compound growth rates and instability in area, production and productivity of Bt cotton (2005-06 to 2015-16)

Sr. No.	Particulars	Compound growth rate (%)		
		Adilabad	Telangana	India
1.	Area	8.93	7.17	3.97
2.	Production	9.74	11.30	4.65
3.	Yield	1.44	3.81	0.65
Co-efficient of variation (%)				
4.	Area	32.9	28.8	13.9
5.	Production	35.4	36.7	15.5
6.	Yield	16.7	18.1	5.08

Source: Cotton advisory board

Table 2 : Cost of cultivation of Bt cotton crop per hectare in different size of farms group (Value in rupees) S M L= 57+ 25+ 18 = 100

Sr. No.	Particulars of farm operations	Bt cotton farm house hold			
		Small	Medium	Large	Sample average
1.	Hired Human labour charges	7950 (14.71)	8400 (16.24)	8700 (17.04)	8197.50 (15.49)
2.	Bullock labour charges	3300 (6.11)	2400 (4.26)	2100 (3.74)	2859.00 (5.40)
3.	Machinery labour charges	2300 (4.25)	3290 (6.36)	4230 (8.29)	2923.40 (5.53)
4.	Cost of seedlings	4750 (8.79)	4650 (8.99)	4500 (8.81)	4680.00 (8.85)
5.	Cost of farm yard manure	1200 (2.22)	1100 (2.13)	1000 (1.96)	1139.00 (2.15)
6.	Cost of chemical fertilizers	7650 (14.16)	7284 (14.08)	7064 (13.84)	7453.02 (14.08)
7.	Cost of plant protection	3450 (6.39)	3175 (6.13)	2900 (5.86)	3282.25 (6.20)
8.	Miscellaneous charges	613 (1.13)	606 (1.17)	610 (1.20)	610.71 (1.15)
9.	Interest on working capital @ 5%	1563.15 (2.89)	1545.25 (2.99)	1555.20 (3.05)	1557.24 (2.95)
10.	Deprecation on fixed resources	131 (0.24)	145 (0.28)	160 (0.31)	139.72 (0.26)
11.	Land revenue raid to govt.	60 (0.11)	60 (0.12)	60 (0.12)	60 (0.11)
12.	Interest on fixed capital@ 10%	769.10 (1.42)	770.50 (1.49)	772 (1.51)	769.97 (1.46)
13.	Rental value of own land	7500 (13.88)	7500 (14.50)	7500 (14.69)	7500 (14.17)
14.	Imputed value of family labour charges	12750 (23.60)	10800 (20.21)	9900 (19.39)	11749.50 (22.20)
	Total cost of cultivation	54036.25 (100)	51725.75 (100)	51051.20 (100)	52921.32 (100)

Note: Figures in the parenthesis indicates percentage to the column total

with sample average of 8197.50 Rs./ha, 7453.02 Rs./ha and 4680.00Rs./ha, respectively because most of the operations like harvesting, and weeding were human labour intensive operations.

Cost and returns in Bt cotton :

Table 3 reveals that the net returns per hectare obtained by large size farms were high (Rs. 41348.80/ha) as followed by medium and small size farms (Rs.36474.25/ha and Rs. 29963.75/ha), respectively. The cost of production per quintal was highest for small farmers (Rs.2701.81/qtl) followed by medium (Rs. 2463.13/qtl) and small farmers (Rs.2320.51/qtl) and the average cost of production falls out to be Rs. 2573.51/qtl.

Cost concepts of the different sample farms in different size groups :

Table 4 reveals that the cost concepts on different

size of farms group per hectare. Cost A_1 was highest in small size farms (Rs.33017.15/ha) followed by large size farms (Rs.32879.20/ha) and lowest in medium size farms (Rs.32655.25/ha), respectively. Cost A_2 in small, medium and large size of farms groups was Rs. 40517.15/ha, Rs.40155.25/ha and Rs.40379.20/ha, respectively. Cost B was highest in small size farms (Rs. 41286.25/ha) as followed by large size farms (Rs.41151.20/ha) and lowest in medium size of farms (Rs.40925.75/ha), respectively. Cost C was highest in small size farms (Rs.54036.25/ha), lowest in large size farms and medium size farms (Rs.51051.20/ha and Rs.51725.75/ha).

Table 5 reveals that the gross returns obtained per hectare by large size farms were high (Rs.92400/ha) as compare to medium and small size farms (Rs.88200/ha and Rs.84000/ha), respectively. Farm business income was also found higher in large farm group followed by medium and small size of farms group was Rs.52020.80/ha, Rs.48044.75/ha and Rs.43482.85/ha, respectively.

Table 3: Cost and returns in Bt cotton crop per hectare in different size of farms group (Values in rupees) S M L= 57+ 25+ 18 =100

Sr. No.	Particulars of farm operations	Bt cotton farm house hold			
		Small	Medium	Large	Sample average
1.	Total cost of cultivation	54036.25	51725.75	51051.20	52921.32
2.	Yield in quintal per hectare	20	21	22	20.61
3.	Gross returns per hectare	84000	88200	92400	86562.00
4.	Net returns per hectare	29963.75	36474.25	41348.80	33640.68
5.	Cost of production per quintal	2701.81	2463.13	2320.51	2573.51
6.	Price per quintal	4200	4200	4200	4200.00

Table 4 : Cost concepts in Bt cotton per hectare in different size of farms group (Value in rupees) S M L= 57+ 25+ 18 =100

Sr. No.	Cost concepts	Bt cotton farms group			
		Small	Medium	Large	Sample average
1.	Cost A_1	33017.15	32655.25	32879.20	32901.84
2.	Cost A_2	40517.15	40155.25	40379.20	40401.84
3.	Cost B	41286.25	40925.75	41151.20	41171.81
4.	Cost C	54036.25	51725.75	51051.20	52921.32

Table 5 : Measures of profitability in Bt cotton per hectare in different size of farms groups S M L= 57+ 25+ 18 =100

Sr. No.	Particulars	Bt cotton farm house hold (Value in rupees)			
		Small	Medium	Large	Sample average
1.	Gross returns	84000	88200	92400	86562
2.	Farm business income	43482.85	48044.75	52020.80	46160.15
3.	Farm investment income	38232.85	44744.75	49620.80	41910.65
4.	Net returns	29963.75	36474.25	41348.80	33640.68
5.	Family labour income	12750	10800	9900	11749.50
6.	Benefit and cost ratio	1:1.55	1:1.70	1:1.80	1:1.63

Farm investment income in large size farms (Rs. 49620.80/ha) as highest compared to medium size farms (Rs.44744.75/ha) and lowest in small size farms (Rs. 38232.85/ha), respectively. Benefit and cost ratio was highest in large size farms (1:1.80) as followed by medium size farms (1: 1.70) and lowest in small size farms group (1: 1.55).

Constraints faced by farmers in production of Bt cotton :

Table 6 reveals that constraints faced by the different size of farms group in production of Bt cotton. Most of the farmers expressed that major constraint was identified that labour scarcity was assigned first rank followed by Inadequate credit supply by financial institution (II), high labour cost (III), high incidence pest and diseases (IV), low quality seeds (V), input supply centre is far away (VI), low productivity (VII), high cost of growth regulators (VIII), low yield (IX), scarcity of farm yard manure (X), non- availability of recommended pesticides (XI), finally shortage of fertilizers which assigned least rank *i.e.* (XII), respectively.

Conclusion :

It can be concluded that the compound growth rates in area, production and productivity in both district and state level percentages was positive, respectively. Instability analysis indicated that cotton production was more unstable than area and productivity. 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. The average cost of production falls out to be Rs. 2573.51/qtl. which was found highest for small farmers (Rs.2701.81/qtl) followed by medium (Rs.2463.13/qtl) and small farmers (Rs.2320.51/qtl). The net returns per hectare obtained by large size farms were high (Rs.41348.80) as followed by medium and small size farms (Rs.36474.25 and Rs.29963.75), respectively with sample average of 33640.68 per hectare. Benefit and cost ratio was highest in large size farms (1 : 1.80) as followed by medium size farms (1: 1.70) and lowest in small size farms group (1: 1.55). Hence, we can seethat there is a decrease in cost of production and increase in net returns along the farm size groups from small, medium to the large group. Major constraint identified in production of Bt cotton was labour scarcity followed by inadequate credit supply by financial institution and high labour cost.

Suggestions for policy implications :

– Majority of Bt cotton cultivating farmers were no aware of adverse impact of pesticides and fertilizers consumption. Hence, awareness programmes are to be organized.

– Farmers may be educated to reduce the use of plant protection chemicals in cotton since any further increase in the use of the above resource would lead to financial loss and environmental damage.

– Many of the respondents have expressed concern about spurious / low quality Bt cotton seeds sold in the market. There is a need for strict control regulations and enforced on the supply of Bt cotton seeds.

Table 6: Constraints in production of Bt cotton in different size of farms group S M L= 57+ 25+ 18 =100

Sr. No.	Particulars	Bt cotton farm house hold				Rank
		Small	Medium	Large	Total in percentage	
1.	Labour scarcity	42	20	16	78 (78.00)	I
2.	Inadequate credit supply by financial institution	32	18	15	65 (65.00)	II
3.	High labour cost	21	18	15	54 (54.00)	III
4.	High incidence pest and diseases	26	15	12	53 (53.00)	IV
5.	Low quality seed	25	15	12	52 (52.00)	V
6.	Input supply centre is far away	21	16	12	49 (49.00)	VI
7.	Low productivity	21	10	11	42 (42.00)	VII
8.	High cost of growth regulators	19	12	9	40 (40.00)	VIII
9.	Low yield	22	11	6	39 (39.00)	IX
10.	Scarcity of farm yard manure	15	13	10	38 (38.00)	X
11.	Non-availability of recommended pesticides	19	11	6	36 (36.00)	XI
12.	Shortage of fertilizers	15	10	8	33 (33.00)	XII

Note: Figure in the parenthesis indicates percentage to the total

– The study results have indicated that cultivation of Bt cotton has the slight advantage of higher yields and lower cost of pesticides and hence, the technology needs to be popularized through intensive extension efforts.

– The cost of cultivation was high while, net returns was low in Bt cotton cultivation as compared to the other crops grown in the study area this leads to negative economic impact on farmers. Hence, awareness programmes are to be organized to divert the farmers from cotton to other crops which will give good economic growth.

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LITERATURE CITED :

Bairwa, K.C., Sharma, R. and Kumar, T. (2012). Economics of growth and instability: fruit cropsof India, *Raj. J. Extn. Edu.,* **20** : 128-132.

Balakrishna, A. (2012). Economics of Bt cotton in India, *African J. Econ.,* **1** (2) : 43-47.

Bennett, R., Buthelezi, T.J., Ismael, Y. and Morse, S. (2003). Bt cotton, pesticides labour and health: A case study of smallholder farmers in the Makhathini Flats, Republic of South Africa. *Outlook on Agric.*, **32**(2) : 123-128.

Bennett, R.M., Ismael, Y., Kambhampati, U. and Morse, S. (2004). Economic impact of genetically modified cotton in India. *AgBioForum,* 7(3) : 96-100.

Cotton Advisory Board (2016) - Ministry of Agriculture, Government of India.

Gandhi, V. P. and Namboodri, N.V. (2006). *The adoption and economics of Bt cotton in India*: Preliminary results from a study, Indian Institute of Management Ahmedabad-380 015, India

Jagmail, S. and Kaushik, S.K. (2007). Bt cotton in India. Present scenario and future prospects, *Indian Farm.*, **56** (11) : 26 - 28.

James, C. (2002). Global review of commercialised transgenic crops featuring Bt cotton (ISAAA Brief No. 26). Ithaca, NY: International Service for the Acquisition of Agri-Biotech Applications.

Naik, G. (2001). *An analysis of socio-economic impact of Bt technology on indian cotton farmers.* Ahmedabad, India: Indian Institute of Management, Centre for Management in Agriculture.

Narala, Anuradha and Reddy, A.R. (2010). *Analysis of growth and instability of cotton production in india*, World Cotton Research Conference on Technologies for Prosperity.

Panchali, Meena S., Prabakaran, K. and Hemavathi, M. (2017). Cotton crop status in Tamil Nadu. *Statistical Approach on Multidisciplinary Research* 23-30, ISSN: 2349 – 4891.

Pray, C., Rozelle, S., Huang, J. and Wang, Q. (2002). Plant biotechnology in China. *Science,* **295** : 674-677.

Qaim, M. and De Janvry, A. (2002). Bt cotton in Argentina: Analysing adoption and farmers' willingness topay. Paper presented at the American Agricultural Economics Association, Long Beach, CA.

Qaim, M. and Zilberman, D. (2003). Yield effects of genetically modified crops in developing countries. *Science,* **299** : 900-902.

Reddy, M.C., Tirapamma, K. and Reddy, K.G. (2011). Socio-economic impact of bt cotton in andhra pradesh, india: acomparative study, *Internat. J. Plant Anim. & Environ. Sci.,* **1** (1) : 126-130.

Sabesh, M., Rajesh, M., Prakash, H. and Bhaskaran, G. (2014). Is there any shift in cropping patternin Maharashtra after the introduction of Bt cotton, *Cotton Res. J.,* **6**(1): 63-70.

Sundaram, V., Basu, A.K., Krishna Iyer, K.R., Narayanan, S.S. and Rajendran, T. P. (1999). *Handbook of cotton in India.* Mumbai, India: Indian Society for Cotton Improvement.

Traxler, G., Godoy-Avilla, S., Falck-Zepeda, J. and Espinoza-Arellano, J.J. (2001). *Transgenic cotton in Mexico: Economic and environmental impacts.* Paper presented at the 5th International Conference on Biotechnology, Science and Modern Agriculture: A new industry at the dawn of the century, Ravello, Italy.

Visawadia, H.R., Fadadu, A.M. and Tarpara V.D. (2006). A comparative analysis of production and marketing of Bt cotton and hybrid cotton in Saurashtra region of Gujarat state, *Agric. Econ. Res. Rev.*, **19**: 293-300.

WEBLIOGRAPHY

Kranthi, K.R. (2012). Bt cotton questions and answers, Indian society for cotton improvement, Mumbai, pp.71. (*www.cicr.org.in/pdf/Bt_book_Kranthi.pdf*).

Meena, P., Prabakaran, S, K. and Hemavathi, M. (2017). Cotton crop status in Tamil Nadu -A statistical approach, *Statistical Approaches on Multidisciplinary Research,* retrieved from *http://www.ijrras.com/Book_v1/ Chapter%204.pdf.*

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