Research Study No.134

RETURNS TO Bt. COTTON VIS-À-VIS TRADITIONAL COTTON VARIETIES IN GUJARAT STATE

V.D.SHAH

AGRO-ECONOMIC RESEARCH CENTRE
SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR-388 120
GUJARAT

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FOREWORD

Cotton is a major cash crop of India which is being grown under both rainfed and irrigated conditions. The country has the distinction of having largest hectarage under the crop in the world, but its productivity is one of the lowest. The crop suffers from serious insects-pests infestation. Bollworm is the most important pest which severely affects the quantity and quality of the cotton produce. As a result, among all the crops, largest quantity of chemical pesticides are applied in cotton crop. Due to high cost of pesticides and low yields, the cultivation of cotton has become uneconomic in many regions of the country.

Recent advances in genetically modified (GM) crops particularly in cotton (popularly known as Bt.cotton) has given a new hope for cotton producers. Bt.cotton (cotton genetically engineered to contain the insecticide Bacillus thuringiensis with in its tissues) was first introduced in USA and Australia in 1996. In India, the commercial cultivation of the varieties of Bt.cotton has received the formal approval in 2002 only. However, it was discovered that prior to year 2002, an unauthorized variety had been marketed and planted during two growing seasons on about 10,000 ha. in Gujarat and elsewhere without being detected. Rapid adoption of Bt. varieties indicates a high level of demand for GM cotton among cotton producers. This shows the benefits of GM technology to farmers, majority of whom are small and marginal size cultivators. However, it may be noted that the benefits from the technology accrue provided the economic conditions are right and supportive infrastructure is in place. At the same time environmentalists and activists have their concerns which are genuine. Their concerns about the protection of environment, rights of local communities, farmers, breeders, consumer groups have also drawn wide attention of the policy-makers. Keeping the controversies and concerns in view, the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India assigned to the Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat to undertake the research study on the economic aspects of Bt.cotton vis-à-vis non-Bt.cotton in Gujarat State.

In Gujarat State, two districts namely, **Rajkot** and **Vadodara** were selected for the study. From each selected district, 90 sample farmers comprising of 45 Bt. cotton (irrigated) growers and 45 non-Bt. cotton (irrigated) growers were selected. The field data were collected for the year 2004-05 to examine the economics of Bt.cotton and non-Bt cotton with special focus on the use of pesticides, crop productivity, cost of cultivation and returns.

Some important findings emerging from the study are as follow:

1. Bt. cotton yielded better results only under assured irrigation.

2. Seed price of approved Bt. cotton variety was exceedingly high and non-affordable by small and poor farmers.

3. Bt. cotton was effective in preventing bollworm attack only. It was not much effective in preventing the infestation by other insects/pests. Therefore, the savings from pesticides was much less than expected.

4. The yield of approved Bt cotton (G) was 36.34 Qtl./Ha. which was 45 per cent higher than non-Bt.cotton varieties.

5. The total cost of cultivation of approved Bt. variety (G) was 18 per cent higher than that of non-Bt. cotton, but per unit cost of production was lower for the former.

6. The Bt. cotton (G) cultivation realized the net returns of Rs.40675/ha. against Rs.21880/ha. for non-Bt. cotton.

7. It was observed that the cultivation of Bt.cotton in the area did not bring any adverse impact on adjoining crops, human/animal health and environment.

The study confirmed sizeable economic benefit and superiority of Bt.cotton over non-Bt. cotton in Gujarat State.

Shri V D Shah, Research Officer has put in lots of efforts for preparing this excellent research report. **Dr. Mahesh Pathak**, Hon. Advisor of the Centre provided overall guidance and encouragement at various stages. **Prof. Vasant Gandhi** and **Prof. N. Namboodri**, CMA, IIM, Ahmedabad have developed the initial framework for the study and provided the guidance at different stages. The author has also benefited from the interaction with the personnel of the Directorate of Agriculture, GoG. The Directorate also provided required secondary data. Sample farmers showed enthusiasm and co-operated with the survey team. **Shri V. D. Shah** and **Shri G. S. Machhi** toured extensively for the collection of primary and secondary data. **Shri G. S. Machhi**, **Shri R. I. Patel**, **Shri S. R. Bhaiya** and **Shri J. S. Raj** efficiently carried out the field works. **Shri G. S. Machhi** and **Shri Manish C. Makwana** carried out computerized tabulation/data processing with utmost accuracy**. Shri J.B.Kahar** helped in data entry work. **Shri N. M. Parmar** has competently and efficiently handled the computerized entry of the draft of this report.

The major findings and recommendations contained in this study deserve to be carefully examined by all concerned for framing an appropriate policy on **GM** crops. It is hoped that this study will be found useful by the academicians, extension workers, researchers, farmers and policy-makers.

Vallabh Vidyanagar
May 21, 2007

Dr. P. K. Singh
Hon. Director

CHAPTER - 1
INTRODUCTION

1.1 Setting:

Agriculture is the foundation of national prosperity and strategy of economic development in India is not likely to succeed if it does not focus on rapid growth of agricultural sector. Rapid agricultural growth, requires a strategy for raising crop productivity. Cotton is one of the most important commercial crops of India and it plays a dominant role in the industrial and agricultural economy of the country. It is popularly known as the “white gold” and “fiber king”.

Since time immemorial, India has been a producer of cotton and finest cotton fabrics. India also enjoys the distinction of being the earliest country in the world to domesticate cotton and utilize cotton fiber for manufacture of fabrics. The contribution of cotton to Indian economy is of high significance as it sustains the Indian cotton textile and allied sectors, which constitutes the single largest segment of organized industries in the country. As per estimate of report of the working group on textile industry for the Tenth Five Year Plan, cotton provides livelihood to more than 81 million in India by way of support in cotton cultivation, ginning/pressing, trade, cotton textiles and manufacturing of textile machinery. Looking to the high economic significance of cotton in India, Mahatma Gandhi based his freedom movement on cotton economics.

After Independence, India witnessed both, qualitative and quantitative transformation in cotton production. At the time of Independence, long and extra long cottons were not produced in India. Till 1978-79, long staple cottons were imported to meet the domestic requirements. Now, India produces wide range of medium, long and extra long staple cotton capable of spinning upto 120s counts. In recent five years or so, India not only became self-sufficient in cotton requirements

but also became a net exporter. The cotton fiber accounts for almost 73 per cent of the total raw material mix of the textile industry which shows its importance in textile sector. Several factors such as improvement in plant protection and pest control technologies. introduction of transgenic cotton (Bt.cotton) and its fast adoption by farmers, setting up of technology mission for cotton, price support measures, increasing use of quality seeds, continuous improvement in cotton technology and their dissemination were mainly responsible for bringing distinct changes in Indian cotton scenario to its present state.

1.2 India vis-à-vis World:

With a view to see where India stands vis-à-vis world, comparative data about area, production and yield of cotton in India and world have been given in Table 1.1. India has the largest area under cotton in the world ranging between 8.5 to 9.0 million hectares, which is almost 26 per cent of the world cotton area. However, India produces only 12 per cent of the world's cotton and occupies third place in cotton production next to China and U.S.A. This is mainly attributed to low cotton productivity in India. As against the world average cotton yield of about 627 kg. lint/hect. average yield of cotton in India is hardly 315 kg. lint/hect. Australia (1493 kg./hect.), Brazil (1176 kg./hect.) and China (939 kg./hect.) are leading countries in respect of cotton productivity, whereas India's position is nearly last. Dismally low productivity has been the bane of Indian cotton, which forces farmers to demand higher unit prices.

1.3 Indian Cotton Profile:

Cotton is an important crop for diversification of agricultural production and offers a good source of cash income to Indian farmers. However, still India suffers from relatively low productivity. This low productivity can be primarily attributed to the fact that nearly 65 per cent cotton area is under rainfed condition, where there is no control over distribution of water and outcome. Hence, production and productivity are subject to vagaries of weather/monsoon rain.

Table 1.1
Cotton Statistics of world vis-à-vis India

(As per International Cotton Advisory Committee)

Sr.No.	Particulars	Years				
		2000 - 01	2001 - 02	2002 - 03	2003 - 04	2004 – 05
1	Area (Million Hect.)					
	World	31.93	33.54	31.22	32.68	35.91
	India	8.58	8.73	8.00	8.5	9.50
	Share of India as % of world	26.87	26.03	25.62	26.00	21.00
	Rank of India	1	1	1	1	1
2	Production (Million MT)					
	World	19.44	21.48	19.32	20.49	25.96
	India	2.38	2.69	2.50	2.68	3.94
	Share of India as % of world	12.24	12.52	12.94	13.08	13.00
	Rank of India	3	3	3	3	3
3	Yield (Kg./Hect.)					
	World	609	640	619	627	649
	India	278	308	312	315	347
	% of world Average	45.65	48.12	50.40	50.23	53.47
4	Export (Million MT.)					
	World	5.81	6.41	6.39	6.43	-
	India	0.024	0.017	0.026	0.009	-
	Share of India as % of world	0.41	0.27	0.41	0.14	-

Source: Cotton Corporation of India Ltd., Navi Mumbai.

India perhaps is the only country in the world which has the distinction of cultivating all the four cotton species viz., G. arboreum, G. Harbaceum, G. hirsutum and G. barbadense on a commercial scale. In India, about 45 per cent area is covered by hybrids, 31 per cent by upland varieties and 24 per cent by diploid cultivators (ICAC, 1997). G. herbaceum is confined to Gujarat and Karnataka, whereas remaining two species are cultivated in all the nine cotton growing States.

The data of area, production and productivity of cotton in India since 1950-51 to 2004-05 have been presented in Table 1.2. It indicates that area under cotton has increased by only 17 per cent from 76.78 lakh hectares in 1960-61 to 89.60 lakh hectares in 2004-05. As against this, production of cotton increased by 311 per cent from 56.41 lakh bales of lint in 1960-61 to an all time high of 232 lakh bales in

2004-05. During the period 2001-02 to 2004-05, cotton production of India has risen by about 53 per cent. The productivity also rose nearly four fold from 124 kg. of lint to 440 kg. of lint per hectare. These significant gains in production and productivity were possible mainly due to adoption and increase in proportion of area under high yielding varieties and Bt.cotton. Prior to adoption of Bt.cotton, the productivity of cotton in India was 278 kg. of lint in 2000-01. Despite recording good increase in productivity in recent years, India still suffers from substantially low productivity as compared to other nations.

Table 1.2

Area, Production, Productivity and Irrigation of Cotton in India

Sr.No.	Year	Area (Lakh Hect.)	Production (Lakh Bales)	Yield (Kg./Hect.)	% Coverage under Irrigation
1	1950-51	56.48	30.62	92	8.2
2	1960-61	76.78	56.41	124	12.7
3	1970-71	76.05	47.63	106	17.3
4	1980-81	78.24	78.60	170	27.3
5	1990-91	74.39	117.00	267	32.9
6	1991-92	76.93	119.00	263	33.3
7	1992-93	75.41	138.00	311	34.6
8	1993-94	74.40	121.50	278	34.7
9	1994-95	78.61	138.50	300	34.2
10	1995-96	90.63	170.20	319	35.0
11	1996-97	91.66	177.90	330	35.8
12	1997-98	89.04	158.00	302	36.8
13	1998-99	92.87	165.00	302	34.9
14	1999-2000	87.31	156.00	304	35.2
15	2000-2001	85.76	140.00	278	34.3
16	2001-02	87.30	158.00	308	33.9
17	20002-03	73.90	140.00	322	32.6 (P)
18	2003-04	76.30	177.00	394	34.6 (P)
19	2004-05	89.60	232.00	440	35.0 (P)

(P) : Provisional
Source : Cotton Advisory Board (From 1990-91 onwards)
*Each bales of 170 Kg.

The annual growth rates of area, production and yield of cotton in India are given in Table 1.3. It shows that production and yield of cotton fluctuates a lot. However, during the period of 1991-2001, production growth rate shows deceleration to –0.381 per cent and yield growth rate to –2.341 per cent. This

suggests a problem with the cotton technology applicable during this period. However, significant rise in growth rate of cotton production (15.66%) and yield (14.27%) during the period 2001-2005 can be mainly attributed to good rise in area under Bt.cotton and it clearly indicates that Bt. crop is highly favoured by the farmers.

Table 1.3
Annual Growth Rates of Area, Production and Yield of Cotton in India

(in % per annum)

Sr.No.	Period	Growth rates (in %)		
		Area	Production	Yield
1	1981-2001	1.092	2.704	1.599
2	1991-2001	2.020	-0.381	-2.341
3	2001-2005	1.161	15.660	14.270

Source: (1) Study proposal prepared by Prof. V.P. Gandhi and N.V. Namboodiri, CMA, IIM, Ahmedabad.

(2) Economic Times, 17th July, 2006.

1.4 State-wise Area, Production and Yield:

Although cotton is cultivated in almost all the States of the country, 9 States of Punjab, Haryana, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Rajasthan, Madhya Pradesh and Karnataka account for nearly 99 per cent of area and output (Table 1.4). It may be seen from the data that in terms of area under cotton, Maharashtra, Gujarat and Andhra Pradesh are occupying first three ranks covering almost 69 per cent area of India's total cotton area. In Maharashtra (97.6%) and Karnataka (97.5%) cotton is grown mainly as unirrigated, whereas in Punjab (99.6%), Haryana (99.6%) and Rajasthan (98.0%), it is grown as irrigated. In Gujarat, the irrigated cotton was about 40 per cent. In terms of production, Gujarat occupied first rank and in total cotton production of India, share of Gujarat was almost 25 per cent. The other leading cotton producer States are Maharashtra, A.P. and M.P. The yield figures of cotton show that Gujarat, A.P., M.P. and Tamil Nadu recorded much higher yield than the all-India average of 342 kg.lint/hect. In Maharashtra, which has the highest area under cotton among all the States, yield was lowest among all States. This is mainly attributed to cultivation of unirrigated cotton.

1.5 Staple Group-wise Cotton Production in India:

In India, the cotton varieties recommended by the Cotton Advisory Board (CAB) are of four different staple groups : short staple, medium and medium long staple, long staple and extra long staple. The staple group-wise data on cotton varieties recommended by CAB and its production has been presented in Table 1.5. From the table, it is evident that nearly 90 per cent of total cotton production belong to medium and long staple groups.

1.6 Issues of Cotton in India:

The ushering in of hybrid cotton era brought about substantial increase in cotton production upto early 90's. Development of hybrids such as HB-4, HB-6, JKY-7, DCH-32, LRA-5166, MCU-5 brought a white revolution and qualitative changes in Indian cotton. All these cotton varieties are highly plagued by lepidopteron (Bollworm) pests. The pest problem in cotton is one of the worst among all crops. Cotton cultivation in India accounts for about 5 per cent of the total land under cultivation but uses about 54 per cent of India's total pesticides consumption (Shetty, P.K., 2004). As per estimate (Shetty, 2004), the loss due to main pest bollworm is around 40 to 50 per cent of cotton yield. Furthermore, the bollworm and other pests/insects attack in cotton is not only adversely affecting the cotton yield and quality but is also escalating the cost of production. It is also harming the soil structure and natural fertility of the soil. It is also endangering the health of both the farmers and workers. In the initial years of introduction of hybrid cotton, pest attack was at minimum level and was controlled by minimum spraying of pesticides. Over a period of time, pests developed resistance to pesticides resulting in high pest control costs, yield and quality loss and high cost of production.

After being plagued by continuous declining productivity and rising pesticides and cost of cultivation, farmers had gone off cotton in a big way in the 90's. But after 2002, introduction of Bt.cotton brought farmers back to cotton cultivation.

At present, cultivation of non-Bt.cotton has been plagued by rising cost of cultivation, ineffective pesticides, adulterated seeds and other inputs, low irrigation coverage, wide fluctuation in market price etc. The Bt.cotton cultivation is also facing problems of high seed cost, high labour cost, higher water requirement and large scale use of unauthorized non-approved Bt.cotton seeds.

1.7 What is Bt.cotton ?

In recent years, bio-technology made it possible to identify genes, isolate them, know their functions and transfer them from one organism to another. Bt.cotton is a genetically modified (GM) engineered cotton. Bacillus thuringiensis (Bt.) is a common soil bacterium. Through genetic engineering, the Bt.gene can be inserted into cotton seeds. This gene produces protein which is toxic to lepidopteran (Bollworm) insects, if ingested in adequate quantities. The toxin produced exists in nature within the micro organism Bacillus thuringiensis (Bt), Genetic manipulation of cotton has been carried out by inserting gene – CRY-IAC – obtained from the bacterium. The natural gene – CRY-IAC - when ingested by the larva of the targeted moth like bollworms, attacks on the inner lining of its alkaline digestive system and worms become lethargic and are gradually eliminated. In other words, Bt.cotton and non-Bt.cotton are nearly equivalent in every respect except Bt.cotton has an additional property of producing its own bio pesticide to protect itself from its target insect pests. Bt.cotton was introduced to provide a solution of making cotton plants free from bollworm effects and thereby to reduce pesticides cost, improve cotton yield, quality and net return. However, Bt.cotton is not so effective in controlling other pests of cotton such as soil pests, sucking pests and leaf roller pests.

1.8 Bt.cotton in World:

Bt.cotton was allowed first for commercial cultivation in the U.S.A., Australia and Mexico in 1996. Subsequently, it was introduced in many countries including China, Argentina, South Africa and Indonesia. Monsanto Inc., U.S.A. Company

developed and modified Bt.cotton. The varieties of Bt.cotton containing this improved gene have been branded “Bollgard” by the Company. There has been substantial increase in area under Bt.cotton and it is spreading at a very fast pace. By 2002, as much as 50 per cent of the cotton area world wide was covered by Bt.cotton. The area under biotech cotton has increased from 0.8 million hectares in 1996 to almost 6.3 million hectares in 2004. There is a great demand for it from farmers of cotton growing nations since it reduces the cost of pesticide and exposure to pesticide to a great extent. Though performance of Bt.cotton has been reported satisfactory in main cotton growing nations, some agencies particularly NGOs and environmentalists voiced discontent with regard to effectiveness, bio-safety and health implications of this variety.

1.9 Bt.cotton in India:

Bt.cotton is the first GM crop of India and hence no tested implications of Bt. variety on bio-safety, environment, health, soil etc. were available. Mahyco had, therefore, to take permission from the government to produce and sell the seeds to farmers. Therefore, the Genetic Engineering Approval Committee (GEAC) comprising of experts of all related fields was formed by the Government of India. Before the approval, GEAC conducted field trials and detailed tests to study implications of Bt. technology on environment, health, soil etc. and results of trials and tests proved various doubts and fears as unfounded. On the other hand, the benefits for the farmers were found to be substantial. The GEAC gave a conditional approval in early 2002 to Mahyco for commercial seed production in India for three genetically modified Bt.cotton hybrids namely, Bt.MECH-162, Bt.MECH-184 and Bt.MECH-12 for a period of only three years from April 2002 to March 2005 and as a precaution reserved the right to withdraw it at any time. Even before approval of cultivation of Bt.cotton, it was illegally cultivated by Gujarat farmers using seeds developed by a local company. The approval of cultivation of Bt.cotton was granted for six States of India namely, Andhra Pradesh, Gujarat, Maharashtra, Karnataka, Tamil Nadu and Madhya Pradesh. In subsequent years, encouraged by positive results of Bt.cotton, GEAC approved RCH-2 and RCH-144 Bt. developed by Rasi seeds for commercial cultivation in central and south zone of India. In 2004-05, the

GEAC approved six more varieties of Bt.cotton and for the first time released them in north zone States. Unfortunately, without approval of GEAC, a number of unauthorized, non-confirmed Bt.cotton varieties were released for cultivation in Gujarat and other States too. In Gujarat, area under non-confirmed Bt.cotton is reported to be quite large and substantially higher than approved Bollgard cotton. As of now, production of non-approved Bt. cotton seed has become a cottage industry in Gujarat and there is a flourishing black market for non-approved Bt.cotton seeds. As per official estimates, the area under authorized Bt.cotton in India was around 38,038 hectares in the first year 2002-03. In 2004-05, the net increase in area under approved Bt.cotton over previous year was about 4.91 lakh hectares. In 2005-06, it touched to 10.14 lakh hectares (see table given below).

Net increase in area under approved Bt.cotton over previous year

(Area in '000 ha.)

Year	2003-04	2004-05	2005-06
Gujarat	41.68 (2.53)	125.92 (6.61)	149.25 (7.19)
India	93.08 (1.22)	491.02 (5.50)	1014.40 (11.51)

Source : Indiastat.com

Note : Figures in brackets denote percentage to total area of cotton.

The performance of Bt.cotton during 2002-03 and 2003-04 was reported as by and large satisfactory in majority parts of cotton growing areas and showed excellent results in terms of increase in yield and reduction in use of pesticides. However, some organizations from different parts of India, raised voice of discontent about the effectiveness of Bt.cotton. Some indicated that variety is susceptible to bollworm and the yield is sometimes below par. Some said that new pests and diseases emerged and Bt.cotton failed in total prevention of the bollworm attack. Even Gujarat government reported large scale wilt in Bt.cotton in year 2004. Thus, a mix bag of opinions were reported for Bt.cotton in India.

1.10 Review of Literature on Bt.cotton:

The performance of Bt.cotton has been considered as satisfactory by government, farmers associations and a majority of Bt.cotton growers. After introduction of Bt.cotton in 2002 in India, a few studies were taken up by NGOs, independent researchers, anti-GM activists etc. which looked into the impact of Bt.cotton crop on different parameters. Of these, some studies found Bt.cotton providing substantial positive benefits, whereas some studies reported concerns over impact on environment, bio-safely and health implications.

1.11 Voices in Favour and Against:

A. Voices in Favour of Bt.. cotton:

The Indian field trials data demonstrated that Bt. technology can significantly reduce pesticide use and increase effective yields (Qaim 2003, ICAR 2002, Naik 2001).

The impact assessment study conducted by IMRB international used data of 3199 farmers spread over six States of India, reported that average per acre saving on pesticides worked out to Rs.1137 for Bt.cotton. It also asserted that yield of Bt.cotton was 8.02 qtl./acre as against 5.07 qtl./acre for non-Bt.cotton. Average profit per acre was Rs.9610 for Bt.cotton as against only Rs.3660 for non-Bt.cotton.

A. Narayanmoorthy and S.S. Kalmakar (2003) of Gokhale Institute, Pune carried out a study on Bt.cotton in Maharashtra and came out with observation that irrigated Bt.cotton have better yield, higher net return, low pesticide cost. Bt.cotton growers realized Rs.31880/hect. as against Rs.17790/hect. by non-Bt.cotton growers. Bt.cotton seeds cost is very high and unaffordable to small farmers.

FAO released a report on GM crops in 2004 which painted a very rosy picture of Bt.cotton. It said that Bt.cotton gives higher yield, improves quality, reduces pesticides cost and health risks from chemical pesticides exposure.

K. B. Patel (2005), an official of all Gujarat Cotton Producers' Association, said that Bt.cotton is more profitable to farmers and farmers of Saurashtra region are switching from cultivation of groundnut to Bt.cotton.

A survey conducted by A.C. Nielson ORG Marg (2004) found that Bt.cotton yield was 30 per cent higher than conventional cotton. Number of pesticide sprays were less in bollgard than non-Bt.cotton. Bt.cotton increased farmers' net profit per acre by Rs.3126. Bt.cotton lint fetched higher prices. About 90 per cent Bt-cotton growers intended to repeat it in next season. Reduction in use of pesticides led to reduction in harmful effect on environment, soil, water and human life.

An impact assessment field study conducted (Gopal Naik, Qaim, A. Subramanian and D. Zilforman, 2003) in 4 States of India confirmed that Bt. technology generates positive agronomic as well as economic advantages. As compared to conventional cotton, spraying of pesticides was 2.6 times less in Bt.cotton. The average per acre gross margins for Bt.cotton was Rs.2161 higher than that for non-Bt.cotton, a relative income gain of 69 per cent.

Assessing the impact of Bt.cotton in China, Pray et al. (2001) observed that the Bt. cultivators could substantially reduce or eliminate the use of pesticides to control bollworm.

Edge et al. (2002) observed that Bt.cotton reduces the number of pesticides sprays for caterpillar and lepidopteron pests. These additional benefits include reduced risk to growers health, improved environment for beneficial insects and farmland wild life.

Vipin Patel (2005), President of Khedut Sangh, Gujarat, said that Bt.cotton is not only increasing productivity and profitability, but it also provides results within 90-100 days as compared to 120-130 days by non-Bt.cotton.

Shantharam of Swaminathan Foundation in Chennai observed that Bt.cotton is a huge hit. As per All-India co-ordinated cotton improvement project (2001-02), Bt.cotton is more effective in controlling bollworm than their counterpart non-Bt. hybrid cotton. Boll damage was also very low in Bt.cotton. The pesticides cost reduction was significant in Bt.cotton.

B. Voices Against Bt.cotton :

A study conducted surveying 450 farmers of Warangal district, A.P. and prepared by Abdul Qayum and K. Sakkari (2003) indicated that reduction in pesticides use in Bt.cotton was insignificant, cost of cultivation was 10 per cent more and yield of Bt.cotton was 35 per cent less than non-Bt.cotton. About 71 per cent Bt. growers reported losses and 82 per cent non-Bt. growers reaped profit. The fibre quality of Bt. was inferior and fetched lower market prices.

Recently, a 20 member group of NGO conducted survey in several Bt.cotton regions of India and found that Bt. seed failed to germinate in many places of Tamil Nadu. Further, wilt started in Bt. cotton fields in M.P. was found to be spreading. Bt.cotton was found non-resistant to bollworm in a few cases.

As per report by A.P. Coalition, increase in yield for Bt.cotton was insignificant and Bt.cotton growers received 9 per cent lower profit due to high cost of cultivation.

Gene compaign's study on Bt.cotton in A.P. and Maharashtra had shown that 60 per cent of the selected Bt.cotton growers in the selected regions suffered losses and they could not recover their investment.

As per paper published by Suman Sahai and S. Rahman (2003), Bt.cotton reported premature dropping of bolls, number of bolls per plant was less in Bt.cotton and fibre length was also shorter for Bt.cotton. Yield of Bt.cotton was lower.

Many NGOs and environmental organizations raised their voice against Bt.cotton citing environmental hazards.

The Central Institute of Cotton Research (CICR), Nagpur published paper which showed that India's Bt.cotton technology is faulty and inadequate to protect crop from bollworm. Bt.cotton seeds produced as hybrids which force farmers to buy seeds for every new planting. Bt.cotton cultivation is taking place without mandated insect refuge management strategy.

Many researchers found that Bt.cotton requires more water and greater application of fertilizers and labour inputs.

A study conducted by K. Venkateshwarlu (2002) in Warangal district, A.P. indicates that non-Bt. cotton produced 30 per cent more than Bt.cotton. Bt.cotton farmers paid Rs.1150 more for seed per acre and price of Bt.cotton was 10 per cent less in local market. The study indicated that claims made by Bt.cotton seed companies were far from reality.

In some cases, new pests and diseases emerged and Bt.cotton failed to prevent the bollworm attack. Many cases of Bt.cotton afflicted with the "leaf curl virus" were found in northern States. In some cases, new pest and disease problems emerged.

The studies done by Greenpeace, Deccan Society and other researchers reported more or less poor performance of Bollgard.

1.12 Need of the Study:

The conflicting assertions made by the pro and anti-Bt. cotton groups indicated that a clear picture has yet to emerge. Keeping in view this controversy and debate on impact of Bt.cotton, emerging issues concerning Bt.cotton in India and government decision for progressive application of commercial cultivation of Bt.cotton, was necessary to undertake a comprehensive, systematic assessment and analysis of agronomics, economics and other aspects of Bt.cotton using field data of ongoing cultivation of Bt. cotton across different States. Keeping this in view, the Ministry of Agriculture, Government of India, asked Agro-Economic Research Centre, Vallabh Vidyanagar to undertake this study for studying the impact of Bt.cotton on different parameters using field data collected from farmers of Gujarat State. This common study, to be conducted in four States, namely, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu is to be co-ordinated by CMA, IIM, Ahmedabad.

1.13 Objectives of the Study:

Following are the objectives of the study:

1. To examine the advantages and disadvantages of Bt.cotton as a pest resistant variety in rainfed and irrigated conditions.

2. To make an assessment of the cost of cultivation and net return of Bt.cotton.

3. To examine difference between cost of cultivation and net returns from Bt.cotton vis-à-vis non-Bt.cotton and reasons for the same.

4. To examine other possible factors for the differential performance such as the germplasm, agro climatic differences, quality of seeds, other inputs, farmer behaviour and support systems.

5. To find out about any other impacts perceived by the farmers such as on pest population/incidence, other crops or the environment.

6. To comment on the usefulness of the technology and ways, if any, to improve its performance.

1.14 Frame Work and Scope of Study:

CMA, IIM, Ahmedabad provided survey instruments, technical inputs and guidance for the study. Moreover, after submission of survey reports by respective AERCs, CMA will prepare the consolidated report.

The present study make an attempt to identify the impact of Bt.cotton vis-à-vis non-Bt.cotton on various parameters using field survey data collected from selected cotton growers of Gujarat State. The present study will be helpful to judge the claims and counter claims made by researchers, NGOs and manufacturers about the impact of Bt.cotton.

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CHAPTER - 2

SAMPLING DESIGN AND METHODOLOGY

The sampling design used for the study in selection of sample districts, sample tehsils and sample farmers as well as methodology used for the collection and analysis of data have been discussed in this chapter.

2.1 Sampling Design:

The study is based on both primary as well as secondary data. For primary data collection, the selection of sample districts, tehsils, villages and sample farmers was made in the following manner :

i) Selection of districts : For the selection of sample districts, major cotton growing districts of the State were classified into two categories considering criteria given below :

Category I : Districts having sufficiently large area under Bt.cotton and also characterized with higher irrigation facilities.

Category II : Districts having sufficiently large cultivation of Bt.cotton but having relatively lower irrigation facilities.

From the above two categories, **Vadodara** district from category I and **Rajkot** district from category II were selected purposively. While selecting two districts care was exercised to select districts from two different agro climatic zones.

ii) Selection of sample tehsils : From each of selected district, one tehsil having cotton as a major crop and having significantly large area under Bt.cotton was selected purposively. Accordingly, **Karajan** tehsil from **Vadodara** district and **Gondal** tehsil from **Rajkot** district were selected (see Table 2.1).

iii) Selection of sample villages : Three sample villages from each of selected tehsil were selected purposively considering criteria shown below :

a) Selected village must have adequate number of Bt.cotton growers as well as non-Bt. HB cotton growers.

b) One village near to town place as well as cotton market yard.

c) Second village at least 15 kms. away from town place and has road linkage.

d) Third village in which agriculture is relatively progressive.

The list of selected villages and selected tehsils is given in Table 2.1.

iv) Selection of sample farmers : It was decided to select 15 Bt.cotton growers and 15 non-Bt. HB cotton growers sample households from each selected village in the following manner :

Firstly, all the cotton cultivating households of the selected village were classified into 2 categories as Bt.cotton growers and non-Bt. HB cotton growers. The farmers growing non-confirmed Bt.cotton (Navbharat-151 or local Bt.cotton) were considered on par with Bt.cotton growers. The farmers growing both, Bt.cotton as well as non-Bt.cotton, were selected as Bt.cotton grower when his area under Bt.cotton was higher than area under non-Bt. cotton and vice-versa. Again on the basis of their landholding, Bt.cotton growers and non-Bt. HB cotton growers were classified into 3 categories, namely, small farmers (below 2.00 hects.), medium farmers (2.00 to 4.00 hects.) and large farmers (above 4.00 hects.). From each sample village, 15 Bt.cotton growers comprising 7 small farmers, 5 medium farmers and 3 large farmers were selected at random. Following a similar selection procedure, 15 non-Bt. HB cotton growers were also selected from each sample villages. Thus, overall, from each selected villages, total 30 sample farmers

(15 Bt.cotton growers and 15 non-Bt.cotton growers) were selected. For the study, altogether, a sample of 180 (30 x 3 = 90 from each district) sample households were selected for collecting primary data for the study (see Table 2.1). The circumstances listed below compelled us to deviate slightly from the prescribed selection procedure :

i) Bt.cotton is a hybrid variety and hence in Gujarat including selected study areas it is mostly grown as irrigated crop. Therefore, it was not possible for us to find unirrigated Bt.cotton growers in selected villages. Hence, in view of non-availability of unirrigated Bt.cotton growers, we selected all sample farmers having irrigated Bt.cotton (HB). In order to make meaningful comparison of data, as a counterpart, only irrigated non-Bt.cotton (hybrid) growers were selected. In short, all the selected sample farmers were of irrigated hybrid cotton.

ii) When adequate number of non-Bt.cotton/Bt.cotton growers belonging to a particular size class in one selected village were not available, we selected the shortfall number of farmers of same size class from the another selected village and kept the total sample size unchanged.

2.2 Method of Primary Data Collection:

The primary survey instruments was prepared and finalized by CMA, IIM, Ahmedabad after consultation with associated AERCs. The season-wise primary data were collected by recall method from the selected sample households by interviewing the decision makers of the households. Quantitative/qualitative information was collected in the schedule on various study related aspects such as educational background, landholding, irrigation, season-wise crop pattern, variety-wise area under Bt.cotton and non-Bt. cotton in last 5 years, seed rate, sources of cottonseeds, variety-wise cost of cultivation of Bt.cotton and non-Bt.cotton, intensity of pest attack in cotton, insecticides/pesticides used, qualitative impact of Bt.cotton as compared to non-Bt.cotton etc. Also opinions of farmers on various aspects such as germ plasm, quality of seeds, other inputs, support system, environmental effect etc. were collected.

In addition to the field survey, important information was also obtained through personal discussion and contacts with concerned officers of State government, CCI and progressive farmers growing Bt.cotton.

2.3 Secondary Data Collection:

The secondary data required for the study were collected from the State government offices including Directorate of Agriculture, Gujarat, regional office of CCI, websites of CCI and cotton Advisory Board and Central/State government publications. The time series data on area, yield, production of cotton (variety-wise) for selected districts and State, annual average prices of kapas and lints for different years, staple length of important cotton varieties etc. were collected from above mentioned sources.

2.4 Analytical Framework:

The main objective of the study is to examine the advantages and disadvantages of Bt.cotton as compared to non-Bt.cotton. Therefore, average cost of cultivation, yield per unit, cost of insecticides/pesticides, input use pattern, net return etc. were worked out size group-wise for genuine Bt.cotton, NC Bt.cotton and non-Bt.cotton separately and by comparing these results conclusions are drawn about difference between Bt.cotton and non-Bt.cotton. Also using this analysis, an attempt is made to identify reasons for difference in cost of cultivation and net return. The general views collected from farmers were analysed to study the impacts perceived by the farmers such as pest incidence, quality of seeds, impact on other crops and environment, availability of seeds, suitability of Bt.cotton, usefulness of technology, continuation of sowing of Bt.cotton in years to come etc. There are a few cases where selected genuine Bt.cotton growers had grown non-confirmed Bt. or non-Bt.cotton and selected non-Bt.cotton growers had grown Bt.cotton. In such situation for the analysis of genuine Bt.cotton growers, only genuine Bt.cotton plots are considered and other cotton plots are ignored. Similarly for analysis of non-Bt.cotton growers, only non-Bt.cotton plots are considered and other cotton plots ignored.

2.5 Reference Year:

It was decided to select agricultural year 2004-05 as reference year. As final harvesting of cotton crop ended around February, it was decided to conduct field survey during March to June 2005.

2.6 Organisation of Report:

The present study report is divided into six chapters including first introductory chapter. The sampling design and methodology used for study has been presented in chapter two. Chapter three presents an overview of cotton scenario in Gujarat and selected districts. The fourth chapter presents socio-economic characteristics of sample households and spread of Bt.cotton. The Chapter Five presents economics of cotton cultivation based on field data and general views of farmers on Bt.cotton. Chapter Six provides summary, conclusions and policy recommendations.

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CHAPTER - 3

AGRICULTURAL AND COTTON PROFILE OF THE SELECTED REGIONS - An Overview

After Independence, Gujarat achieved remarkable success in boosting agricultural sector mainly in terms of crop production and productivity of food and commercial cash crops including cotton. It is obvious that growth of agricultural sector is directly linked with profitability of cultivation of crops. And, realization of profit from cultivation in a particular region is a function of many agricultural characteristics and practices of that region. Therefore, to assess more precisely the overall impact and profitability of Bt.cotton in selected regions, broad picture of cotton crop related agricultural characteristics of the selected regions will be helpful. With this in view, brief information about climatic conditions, rainfall, crop pattern, irrigation, trend in area, production and productivity in cotton etc. for State and selected districts has been provided in this chapter.

3.1 Climate and Soil Type:

Gujarat has tropical climate. The climate of the State as well as of selected districts is extreme and subject to significant variations in temperature. The range of minimum and maximum temperature of the State was 2.3^{o} Celsius to 47^{o} Celsius. The temperature in Vadodara district normally varies between 8^{0} c in winter to 43^{o} c in summer. In Rajkot district, it normally varies between 7^{o} c and 44.2^{o} c. During the reference year 2004-05, the climatic conditions remained more or less most favourable to cotton crop in the selected areas of the study.

The soils of southern part of Vadodara district including selected Karjan taluka is moderately deep black cotton soils and it is suitable for cotton crop. The soils of western part of Vadodara district is alluvial sandy loam locally known as ‘goradu’. These soils are loamy and well suited for irrigated farming including hybrid cotton. The soils of Rajkot district are shallow medium black and calcareous. Nearly 74 per cent area of the district falls into semi-arid zone.

3.2 Rainfall:

In Gujarat State, nearly 64 per cent cotton cultivation is rainfed. Therefore, cotton output of the State and farmers' net return from cotton cultivation in a particular year is directly associated with suitability of the rainfall pattern to the crop. The district-wise rainfall recorded for the years 2001 to 2004 and average rainfall of last ten years ending 2003 has been displayed in Table 3.1.

Table 3.1
District-wise Average Rainfall

(In millimeters)

Sr. No.	District	Average rainfall (1994-03)	Years			
			2001	2002	2003	2004
1	Ahmedabad	771	658	397	883	814
2	Amreli	509	509	573	667	413
3	Anand	743	525	547	1063	821
4	Banaskantha	638	694	251	807	426
5	Bharuch	845	885	1023	889	1085
6	Bhavnagar	593	622	831	537	549
7	Dahod	705	530	750	1015	1127
8	Dangs	2703	2200	2442	2129	2642
9	Gandhinagar	610	421	373	1031	806
10	Jamnagar	612	583	433	1429	869
11	Junagadh	839	896	589	1178	890
12	Kheda	718	715	479	1091	759
13	Kuchchh	316	243	78	712	223
14	Mehsana	733	930	437	720	636
15	Narmada	1147	822	802	1275	1255
16	Navsari	1631	2014	1396	2933	2492
17	Panchmahal	946	677	735	1353	929
18	Patan	626	540	282	720	603
19	Porbandar	586	623	271	666	477
20	Rajkot	562	429	373	989	719
21	Sabarkantha	723	593	431	957	499
22	Surat	1185	1126	1130	1730	1962
23	Surendranagar	484	671	636	525	550
24	Vadodara	873	826	835	1014	1154
25	Valsad	1851	2104	1624	2100	2246
26	Gujarat State	853	817	636	1078	959

Source: Directorate of Agriculture, Gujarat State

Gujarat State normally receives rainfall through south-west monsoon which mostly commences between mid of June to end of June and withdraw by the end of September. The rainfall in the State is erratic and scanty. Therefore, several parts of State experience frequent drought or drought like situations which have led to poor harvests and incomes. For State as a whole, the average rainfall of last ten years ending 2003 was 853 mm and across districts it varied from 2703 mm for Dangs to 316 mm for Kutchh. This wide variation in annual rainfall across different years and across districts causes significant fluctuations in crops productivity.

During the reference year 2003-04, average annual rainfall of the State was 959 mm, whereas it was 1154 mm for Vadodara district and 719 mm for Rajkot district. During the period from last week of July, 2004 to second week of August, heavy rain affected the cotton crop in some parts of Vadodara district. It also caused problem of pest and disease namely spodoptera in selected Rajkot district. However, during the reference year other pest diseases problems remained below threshold level.

3.3 Irrigation and Sources of Irrigation:

Irrigation is a basic need and one of the most crucial factor affecting the productivity of cotton and other crops. The groundwater, surface water and irrigation scenario of Gujarat State is not so encouraging as compared to national level. Of the total, 80 per cent of the surface water is available only in south and central Gujarat. The data on irrigation and sources of irrigation in selected districts is exhibited in Table 3.2. These data show that average gross irrigated area of the State was about 33 per cent of State GCA and year-wise, it ranged between 31 to 35 per cent. It was around 41 per cent for Vadodara district and only 24 per cent for Rajkot district.

Table 3.2
Irrigation and Sources of Irrigation in Selected Districts

Sr. No.	Particulars	Districts/State		
		Vadodara	Rajkot	Gujarat State
A	**Irrigation :** (Area in 00' hect.)			
	1 Net Irrigated Area (NIA)	1924	1512	29573
	2 Gross Irrigated Area (GIA)	2284	1860	36031
	3 % of NIA to Net Sown Area	36.62	20.79	30.65
	4 % of GIA to Gross Crop. Area (GCA)	40.66	23.89	32.85
	5 Irrigation Intensity	118.71	123.01	121.84
B	**Source-wise Net Irrigation (%)**			
	1 Govt. Canals	2.01	20.63	16.26
	2 Well-Tubewells	95.83	77.46	82.51
	3 Other Sources	2.16	1.91	1.23

Note: Figures are triennial average ending year 2001.
Source: Directorate of Agriculture, Gujarat State.

In Gujarat including selected districts, wells and tubewells are the principal sources of irrigation (see Table 3.2). In total net irrigation, the share of well and tubewell irrigation was 82.5 per cent for State, 82.51 per cent for Rajkot district and 95.83 per cent for Vadodara district (see Table 3.2). The public sector canal was the second most important source of irrigation claiming 16.26 per cent of State total irrigated area.

3.4 Cropping Pattern:

Agricultural output of the State as well as of the selected districts is highly dependent on rainfall. Therefore, cropping pattern of selected districts is directly affected by rainfall behaviour and availability of irrigation. Hence, general practice is to grow single crop during the year on areas where scope of irrigation is negligible and rabi crops are grown on limited areas where irrigation sources are available.

The cropping pattern data shown in Table 3.3 exhibit that groundnut, cotton, bajra, rice, wheat and maize were the main crops of the State. The area under cotton alone in the State was to the extent of 16.45 per cent of GCA. In the State cropping pattern, groundnut, cotton and bajra crops together accounted for more than 44 per cent of GCA.

In Vadodara district, cotton, tur, rice and maize were the main kharif crops. Generally, hybrid and Bt.cotton are grown as irrigated crops. Vadodara district is a leading medium and long staple cotton producer. In the district, cotton and tur crops are most important and cotton accounted for nearly 30 per cent and tur 15.45 per cent of the district GCA.

In Rajkot district, groundnut, cotton, wheat and bajra were important crops. Majority area under groundnut is rainfed. The hybrid cotton and Bt.cotton (confirmed and non-confirmed) is mostly grown in areas where assured irrigation is available and non-HB cotton is grown as rainfed as well as irrigated crop. The district is a leading producer of groundnut and cotton. Groundnut alone occupied 46.79 per cent of district GCA. Cotton is the second most important crop claiming 21.94 per cent of district GCA. Nearly 70 per cent area of district GCA was thus occupied by groundnut and cotton.

In both selected districts, area under Bt.cotton was very high during the reference year 2004-05. In total Bt.cotton area, share of non-approved Bt.cotton was also reported as significant.

3.5 Hybrid/HYV and Non-hybrid Varieties of Cotton in Gujarat:

Alongwith irrigation, coverage of areas under hybrid/HYVs varieties is a crucial factor influencing the yield of cotton crop. With this in view, year-wise data of area under prominent hybrid and non-hybrid varieties of cotton in the State have been presented in Table 3.4.

Table 3.4
Prominent Varieties of Cotton Grown in Gujarat State

(Area in Hect.)

Cotton Variety	Years						
	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Non-Hybrids							
Digvijay	84818	59984	20232	17926	51195	10292	37918
G-Cot.-10	65535	12760	9517	5821	4300	3150	3200
G-Cot.-12	36822	32200	21250	7928	0	16000	16100
G-Cot.-13	313114	259044	314248	232437	294282	228452	187850
V-797	311934	221076	262365	202879	217810	229855	276090
Deviraj	8409	18936	22210	53557	26944	47410	39530
Other varieties	134496	51941	155808	98379	182183	184933	200560
Total Non-Hybrid (Hect.)	955128	655941	805630	618927	776714	719822	761248
% to total Cotton	57.60	42.36	50.86	35.00	46.39	43.70	38.16
Hybrids							
H-4 (S-4)	16951	14090	32850	32369	1440	1990	900
H-6, H-8, H-10 (S-6, 8,10)	595669	695386	579055	902410	655227	507199	610590
Bt. (Approved)	-	-	-	-	16900 (p)	80000 (p)	208502 (p)
Others Hybrid (Inclusive non-app. Bt.)	90426	182949	166337	214749	224006	338068	413763
Total Hybrid Area	703046	892425	778236	1149528	897573	927257	1233755
% to HB. to Grand Total	42.40	57.64	49.14	65.00	53.61	56.30	61.84
Grand Total (Non-HB + HB) Area	1658174	1548366	1583866	1768455	1674287	1647079	1995000
%	100.00	100.00	100.00	100.00	100.00	100.00	100.00

P = Provisional
Source : Directorate of Agriculture, Gujarat State, Gandhinagar

Data presented in Table 3.4 show that Gujarat cotton-13 and V-797 are the two main non-hybrid cotton varieties of the State, whereas H-6, S-8, S-10, Bt.approved and other hybrid varieties (mainly non-approved Bt. including Navbharat-151 and others) are the main hybrid cotton varieties in the State. The data clearly show that after the approval of Bt.cotton cultivation in the State in 2002, the area under cotton H-4 declined significantly and touched negligible level in 2004-05. The area under other hybrid (mainly non-confirmed Bt.cotton varieties) varieties shows continuous upward trend since 1999-2000. It moved up from 90426 hects. in 1998-99 to 413763 hects. in 2004-05 showing net increase of 357 per cent.

At present, of the total cotton area of the State, nearly 62 per cent area is under hybrid varieties and only 38 per cent under non-hybrid varieties. In the total cotton area of the State, the share of non-hybrid varieties declined from 57.60 per cent in 1998-99 to 38.16 per cent in 2004-05. This clearly suggests that cotton farmers are shifting from non-hybrid to hybrid cotton and particularly to Bt.cotton at a very fast pace.

3.6 Profile of Cotton Varieties Grown in Gujarat:

As stated earlier, many varieties of hybrids, HYVs and non-hybrid cotton are grown in different tracts of the State. Based on attributes, these varieties may be classified into two main groups. Cotton varieties S-6, H-8 and H-10 may be put into one group and varieties V-797, Guj.Cot-13, Guj-Cot-21 (Wagad cotton), GS-23 (Bharuch) may be categorized into another group. The salient features and profile of each group of varieties are given in Table 3.5. Also map of Gujarat State showing variety-wise districts/tracts where it is grown is given.

From the Table 3.5, it is evident that non-HB varieties like V-797, G-Cot-13 etc. are not grown at all in selected Vadodara district. However, it is grown in some parts of selected Rajkot district.

Generally, Bt.cotton and others hybrid varieties of cotton are sown in the State during the period 15th June to 15th July. But the farmers who have adequate irrigation facilities and hoping to take rabi crop are opting for sowing of Bt.cotton in the month of May.

Table 3.5
Cotton Profile of Gujarat

Variety/Hybrid	S-6,H-8,H-10,MECH 12, MECH 184,MECH-162,RCH-2	V-797,G Cot-13,G Cot-21(Wagad Cotton) GS23(Bharuch)
Sowing period	June-July MECH-12,184,RCH-2 in May-June Under assured Irrigated cond.	July-August
Harvesting period	Oct.-March	Feb.-March
District/Tracts	All districts of Gujarat except Valsad and Dang	Ahmedabad,Mehsana, Rajkot,Jamnagar,Kutchh, Junagadh,Banaskantha, Surendranagar, Panchmahal
Potential Lint Yield (Kg. per hectare)	500-600	600-700
Staple Length (2.5 % S.L.mm)	28-30	22-23
Micronaire Value	3.5-4.5	5-5.5
Tenacity (g/tex.) At 3.2 mm gl	22-24	20-21

Source : (i) Directorate of Agriculture, Gujarat State, Gandhinagar.
(ii) Indian Cotton – A Profile 2003-04, CCI, Navi Mumbai.

3.7 Cotton Scenario in Gujarat:

The total area under cotton in Gujarat in 2005-06 was about 20.8 lakh hectares which was nearly 23 per cent of the cotton area of the country. After the introduction of Bt.cotton, area under cotton in Gujarat is increasing every year at a fast pace. It moved up from 16.4 lakh hectares in 2002-03 to around 20.8 lakh hectares in 2005-06 (see table 3.6.1 and graphs). Today, Gujarat State contributes about 30 per cent to the national cotton production. The main cotton cultivating districts are Surendranagar (23%), Bhavnagar (12%), Rajkot, Ahmedabad and Vadodara (about 10% each). As regards annual output of cotton in the State, it

ranged from 13.23 lakh bales (each of 170 kgs.) in 1990-91 to 40.27 lakh bales in 2003-04 and as per revised estimate, it is likely to hit target of 89 lakh bales in 2005-06 (see Table 3.6.1). The annual compound growth rate worked for the cotton yield during 1990-91 to 2001-02 showed negative growth of –3.2 per cent. However, it showed positive growth of 2.4 per cent for extended period 1990-91 to 2005-06 (see Table 3.6.1). The annual compound growth rates worked out for area, yield and production for the period 2000-01 to 2005-06 showed a very rapid growth rate of 40, 4 and 44 per cent respectively.

Table 3.6.1
Area and yield of cotton in Gujarat – 1990-91 to 2005-06

Year	Area (lakh hect.)	Yield (kg./hect.)	Production (lakh bales)
1990-91	9.2	274.8	13.2
1991-92	11.4	223.6	14.9
1992-93	11.5	329.3	22.3
1993-94	11.3	208.3	19.8
1994-95	12.1	375.1	26.6
1995-96	14.1	388.0	32.2
1996-97	14.9	392.0	34.3
1997-98	15.2	470.0	42.0
1998-99	16.1	497.0	47.0
1999-2000	15.4	230.0	20.8
2000-01	16.2	112.0	11.6
2001-02	17.5	165.0	16.9
2002-03	16.4	175.0	16.9
2003-04	16.5	417.0	40.3
2004-05@	19.1	651.0	73.0
2005-06@	20.8	728.0	89.0
Annual Compound Growth Rate (Per cent)			
1990-91 to 2001-02	5.31	-3.20	1.55
1990-91 to 2005-06	4.47	2.39	6.51
2000-01 to 2005-06	4.33	40.0	44.1

@ = Revised estimates

Source : Cotton Revolution in Gujarat – The Impact of Bt. Technology - by Vasant Gandhi & N.V. Namboodri, CMA, IIM, Ahmedabad.

3.8 District-wise Cotton Area in Gujarat:

The district-wise cotton area is given in Table 3.6.2 for the years 1990-91 to 2004-05. Though, cotton crop is being grown in all the districts of the State except Valsad and Dangs, the prominent cotton growing districts are Surendranagar, Rajkot, Bhavnagar, Ahmedabad, Vadodara, Bharuch, Mehsana (including Patan) and Amreli. The table reveals that in the early two thousands, the cotton area in the State as well as in almost all districts has shown an upward trend as compared to period of early 90s. After the government approval of commercial cultivation of Bt.cotton, in each district and State as a whole, the cotton area increased sharply as Bt. cotton made inroad into area under groundnut and other crops cultivation in the State. The increase in cotton area of the State in 2004-05 was around 21.5 per cent as compared to previous year 2003-04. The fast momentum of adoption of Bt.cotton was mainly responsible for such a sharp increase in cotton area.

Data presented in Table 3.6.2 shows that the distribution of cotton area is highly varying across districts. Surendranagar is an important cotton producing district with cotton area around 400 thousand hects. The district grew mainly Vagad deshi (short staple) cotton under dry farming conditions due to very poor irrigation facilities. Ahmedabad is also famous for deshi cotton (V-797 and Vagad) producing district and cotton area of the district during 1990-2005 ranged between 121 thousand to 197 thousand hects. In Vadodara district, mainly medium staple Digvijay, long staple American cotton and Bt.cotton are grown and area under cotton increased from 120 thousand hects. in 1990-91 to 178 thousand hects. in 2004-05. In terms of cotton area, Rajkot occupied 2nd rank in the State. The cotton area in the Rajkot district increased at a very fast pace and it touched 244 thousand hects. in 2004-05 as against only 96 thousand hects. in 1990-91. The most favourable economics of Bt.cotton cultivation was the main reason for such significant increase in cotton area. Bhavnagar, Bharuch, Amreli and Sabarkantha are other traditionally cotton belt districts. Out of 25 districts of the State, seven districts (Ahmedabad, Vadodara, Bharuch, Rajkot, Surendranagar, Mehsana and Bhavnagar) together accounted for as much as 78 per cent of State total cotton area in 2004-05.

3.9 District-wise Cotton Production in Gujarat:

The district-wise data on cotton production are presented in Table 3.7. In post-introduction period of Bt. cotton, State witnessed sharp rise in cotton production. This is mainly due to higher area under Bt.cotton, higher irrigation coverage and favourable climatic and rainfall conditions.

District-wise data on cotton production show that districts like Surendranagar and Ahmedabad accounted for relatively lower share of production as compared to their share in area. This is mainly due to lower productivity as cotton grown here has been rainfed and low yielding non-hybrid. In Surendranagar, which has the highest area under cotton among all districts, production has been fluctuating from year to year and no definite trend is noticeable. Similar trends prevailed for Rajkot and Ahmedabad districts too. However, districts like Rajkot, Vadodara, Bhavnagar, Bharuch and Sabarkantha generally recorded higher production as compared to their share in area. This is mainly because of higher yield achieved by these districts. The data clearly reveals that cotton production in Vadodara, Bharuch, Gandhinagar, Rajkot, Bhavnagar, Sabarkantha, Jamnagar and Amreli districts, jumped significantly after 2001-02 which are coincides with post-introduction period of Bt.cotton.

It is seen from the data presented in Table 3.7 that cotton production in almost all the districts of the State has been showing fluctuations across the years. However, in case of Surendranagar, Rajkot and Ahmedabad districts, fluctuations in cotton production were very wide and significant. It varied in Surendranagar district between 181300 bales to 661000 bales, in Ahmedabad it varied between 92800 bales to 42940 bales and for Rajkot between 70000 bales and 1011800 bales.

In districts like Vadodara, Gandhinagar etc. which are well endowed with irrigation, the fluctuations in cotton production were found to be in relatively narrow range.

3.10 District-wise Lint Cotton Yield in Gujarat:

The district-wise lint cotton yield figures per hectare are presented in Table 3.8. The year-wise cotton yield in lint form for the State during considered time periods varied from as low as only 122 kgs. in 2000-01 to 454 kgs. in 2003-04. Likewise in Rajkot district, it varied from 66 kgs. in 2000-01 to 1023 kgs. in 2003-04. In Vadodara district, year-wise fluctuations in cotton yield were there, but varied in a relatively narrow range of 151 kgs. in 2001-02 to 396 kgs. in 2004-05.

Table 3.8
District-wise Yield of Cotton in Gujarat State

No.	District	Yield of Cotton (Kg.lint/Hectare)							
		1990-91	1995-96	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05 (p)
1	Ahmedabad	291	175	206	94	97	117	249	370
2	Vadodara	219	257	276	187	151	262	340	396
3	Bharuch@	178	196	318	160	182	225	257	454
4	Gandhinagar	457	503	582	233	268	567	478	429
5	Mehsana	185	279	213	163	221	204	234	363
6	Sabarkantha	251	505	252	193	250	159	632	519
7	Amreli	245	391	226	137	167	269	554	287
8	Bhavnagar	261	371	187	78	111	261	368	380
9	Jamnagar	319	401	227	119	232	141	998	414
10	Kuchchh	208	269	438	269	279	256	423	207
11	Rajkot	289	442	262	66	177	70	1023	540
12	Surendranagar	218	166	184	82	159	103	271	290
13	Gujarat State	244	265	230	122	165	175	454	388

@Bharuch Includes Newly formed Narmada District and Mehsana includes Patan district

(p) = Provisional Figure

Source: Directorate of Agriculture, Govt. of Gujarat, Gandhinagar.

For the same time period, wide fluctuations in lint cotton yield were observed across the districts. In 2003-04, it ranged from a low of 234 kgs. per hectare in Mehsana district to 1023 kgs. per hectare in Rajkot district.

It is seen from the table that Vadodara, Bharuch, Gandhinagar, Sabarkantha, Jamnagar and Rajkot districts recorded lint cotton yield higher than the State average yield of 388 kgs. during 2004-05. Inspite of highest area under cotton in the State, Surendranagar district recorded much lower yield in almost all the years mainly owing to negligible coverage of irrigation to cotton crop. Similar situation was observed in Ahmedabad district too.

It was observed that districts which had higher coverage of irrigation to cotton crop recorded relatively higher cotton yield. This suggests that coverage of irrigation is a key variable for increasing the productivity of Bt. cotton and non-Bt. cotton crop.

3.11 District-wise Cotton Yield in Irrigated and Unirrigated Area and Coverage of Irrigation:

It is an established fact that irrigation and variety of cotton grown are two most crucial factors impacting the cotton yield in a big way. With this in view, district-wise data on yield of irrigated cotton, unirrigated cotton and irrigation coverage have been furnished in Table 3.9.

In the State, irrigation coverage to cotton was to the extent of 40 per cent. Across districts, irrigation coverage to cotton crop showed significantly wide variations and it ranged from as low as 8.22 per cent for Ahmedabad district to cent per cent for Gandhinagar district. It was more than 50 per cent for Sabarkantha, Rajkot, Junagadh, Amreli, Bhavnagar, Kheda and Vadodara districts. This high variation in irrigation coverage for cotton across districts is causing high variations in cotton productivity.

Table 3.9
District-wise Yield* of Irrigated and Unirrigated Cotton in Gujarat

Yield in Lint Kg./Hect.
Area in 00' Hect.
Prod. in 00, Bales

Sr.No.	District	Irrigated Cotton			Unirrigated Cotton			Total Cotton			% of Irri. coverage to cotton	Ratio of IY and UY
		Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield		
1	Ahmedabad	141	297	358	1576	1250	135	1717	1547	153	8.22	2.65
2	Banaskantha	44	126	487	102	55	92	146	181	211	29.93	5.29
3	Vadodara	884	1544	297	765	852	189	1649	2396	247	53.61	1.57
4	Bharuch	454	1083	406	1159	1027	151	1613	2110	222	28.15	2.69
5	Gandhinagar	83	224	459	0	0	0	83	224	459	100.00	N.A.
6	Kheda	93	225	411	63	99	267	156	324	353	59.62	1.54
7	Mehsana	298	820	468	796	603	129	1044	1423	232	27.41	3.63
8	Panchmahal	33	84	433	41	35	145	74	119	273	44.59	2.99
9	Sabarkantha	323	715	376	24	21	149	347	736	361	93.08	2.52
10	Surat	15	37	419	32	26	138	47	63	228	32.61	3.04
11	Amreli	471	1240	448	453	636	239	924	1876	345	50.97	1.87
12	Bhavnagar	979	2198	382	945	571	103	1924	2769	245	50.88	3.70
13	Jamnagar	220	794	614	110	84	130	330	878	452	66.67	4.72
14	Junagadh	183	618	574	81	64	134	264	682	439	50.29	4.28
15	Kutch	224	717	544	241	139	98	465	856	313	48.17	5.55
16	Rajkot	1435	4036	478	393	285	123	1828	4321	402	78.50	3.82
17	Surendranagar	834	1770	361	3259	2438	127	4093	4208	175	20.38	2.84
18	Gujarat State	6712	16527	419	10040	8186	139	16752	24713	251	40.07	2.95

* Yield figures shown are an average of 2001-02 to 2003-04.
IY= Irrigated Cotton Yield, UY=Unirrigated Cotton Yield.
Source: Directorate of Agriculture, Govt. of Gujarat, Gandhinagar.

In all the districts of the State, the yield of irrigated cotton was significantly higher than that of non-irrigated cotton. The ratio of yield of irrigated cotton and unirrigated cotton for the State worked out to 2.95, whereas among districts it varied from 1.54 for Kheda district to 5.55 for Kutchh district. As compared to non-irrigated cotton, yield of irrigated cotton was observed more than three time in Banaskantha, Mehsana, Surat, Bhavnagar, Junagadh, Rajkot, Jamnagar and Kutch districts. The very high yield of irrigated cotton clearly suggests very strong positive association between irrigation coverage and yield of cotton crop. This further suggests that cotton production can be increased further by bringing more areas of cotton under irrigation.

3.12 District-wise Sales of Approved Bt.cotton Seeds in Gujarat during 2004-05 :

The cultivation of illegal Bt. cotton in Gujarat in 2001-02 raised controversy and forced Government of India to think over whether or not allow cultivation of Bt.cotton in country. Hence, after long consideration on all issues related with Bt. cotton, GEAC approved in 2002 three Bt. hybrids viz., MECH-12, MECH-162 and MECH-184 for cultivation in Gujarat and other States. Later on, two more hybrids from Rasi seeds were approved. The authorized Bt. cotton seeds are sold in a bag and each seed bag contains 450 gm Bt. cotton seeds and 120 gm non-Bt. cotton seeds. The suggested seed rate is one bag for one acre. The approved Bt. cotton seed price was around Rs.1600 per bag in 2004-05 which was two to three times as compared to price of unauthorized non-approved varieties of Bt. cotton seed. Among Bt.cotton growers of the State, many farmers preferred these low priced unauthorized local variants of Bt. seeds (Navbharat-151 and others) as farmers found it almost same in respect of quality, yield and income.

District-wise sales of approved Bt. cotton seeds in 2004-05 is given in Table 3.10. The data reveals that sales of Bt. cotton seeds across districts showed wide variations and it was higher in Bhavnagar, Rajkot, Vadodara and Jamnagar districts. The year-wise examination of approved sales of Bt. cotton seeds shows significant increase in 2004-05 over previous year.

It was observed that farmers in Gujarat are not adopting recommended system of growing refuge crops on boundary of Bt. cotton plots. Moreover, sale of non-approved Bt. cotton seeds was much higher than approved Bt. cotton seeds.

Table 3.10
District-wise Sales of Approved Bt.Cotton Seeds In 2004-05

Sr.No.	District	Nos. of bags (each of 450 gm.Bt.)		
		MECH - 12 MECH-162 MECH-184	Rasi's RCH-2	Total
1	Ahmedabad	2330	-	2330
2	Amreli	22420	10550	32970
3	Bharuch	14000	6010	20010
4	Bhavnagar	92000	13500	105500
5	Vadodara	43800	12810	56610
6	Gandhinagar	3600	-	3600
7	Jamnagar	34000	12850	46850
8	Junagadh	27000	11130	38130
9	Kheda & Anand	5850	4642	10492
10	Kutch	16000	3750	19750
11	Mehsana	14500	-	14500
12	Panchmahal	6000	2110	8110
13	Rajkot	77600	23670	101270
14	Surendranagar	6800	4910	11710
15	Sabarkantha	24600	-	24600
16	Surat	8000	4230	12230
17	North Gujarat	1500	11095	12595
18	Total	400000	121257	521257

Source:(1) Directorate of Agriculture, Gujarat State Gandhinagar.
(2) Data Provided by Rasi Seeds, Salem.

3.13 Minimum Support Prices and Annual Average Market Prices of Kapas:

Before the start of cotton season, every year the Government of India, based on the recommendation of the CACP, announces Minimum Support Prices (MSP) for the two basic varieties of kapas viz., F.414/H-777/J-34 (medium staples) and H-4 (long staple). The prices for other varieties of cotton are subsequently fixed by the Textile Commissioner based on market differentials and discussions with various organizations related with cotton such as CCI, East India Cotton Association, farmers' co-operative organizations etc.

In Table 3.11, support prices of kapas for those varieties of cotton which are mainly grown in Gujarat State have been shown.

Table 3.11
Support Prices for Varieties of Kapas of FAQ - 2000-01 to 2004-05

(As announced by Govt. of India) (Rs./Qtl.)

Sr. No.	Variety	Basic Staple Length (2.5 % span Length) mm	Micro-nnaire Value	2000-01	2001-02	2002-03	2003-04	2004-05
1	V-797	22.00	4.2-4.8	1515	1560	1560	1605	1640
2	G.Cot.12,13,21	23.00	4.2-5.0	1440	1485	1485	1530	1560
3	H-4 /H-6/H-10	30.00	3.6-4.2	1825	1875	1875	1925	1960
4	Sankar -6/10 (Saurashtra)	29.00	3.7-4.3	1840	1840	1860	1910	1960
5	RCH-2 (Bt.)	30.00	3.5-4.5	-	-	-	-	1960
6	MECH-12/162/184 (Bt.)	29.00	3.5-4.5	-	-	1875	1925	1960
7	MCU-5	33.00	3.0-3.5	1875	1950	1950	2000	2035

Note: FAQ = Fair Average Quality

Source : Indian Cotton, A Profile 2003-04, Published by CCI, Mumbai.

Vagad and V-797 varieties are very popular in the rainfed farming areas of Gujarat and particularly in Surendranagar, Ahmedabad, Rajkot, Kutch, Patan and Mehsana districts eventhough, government has not been announcing MSP for Vagad kapas since 1999-2000.

In recent years, the global market prices of cotton have been impacting highly on domestic market prices of cotton. Hence, during the cotton season 2004-05, owing to depressed global prices of raw cotton (kapas) domestic market also witnessed continuous down trend in kapas prices. During the first picking of H-4 cotton, the market price of kapas was around Rs.2250 per quintal which subsequently declined to around Rs. 1900-1950/qtl. during 4^{th} to 7^{th} picking period and stabilized near to MSP level. In some interior rural areas of the State, the prices of kapas ruled even below support prices. The plausible reasons given for such decline in kapas prices were large volume of carried over stock, good harvest of kapas and lower global prices of cotton..

The profit level of cultivation of cotton is highly influenced by the prevailing market prices of kapas. Hence, average annual rate of H-4 and S-6 kapas and lint

candy for the years 2000-01 to 2004-05 is shown in Table 3.12. The average prices of H-4 and S-6 kapas in each year had ruled above the level of MSP. However, in 2001-02 and 2004-05 kapas market prices were quite fluctuating and uneven and reached near to MSP. The average prices of kapas S-6 for the year 2004-05 was lower by 21 per cent compared to previous year 2003-04. The market prices of kapas showed wide fluctuation in different years and hence fluctuated the economy of cotton cultivation.

Table 3.12

Annual Average Prices of Kapas and Lint Candy for Years of 2000-01 to 2004-05

Sr.No.	Year	MSP of Kapas (Rs./qtl.)		Average Market Rate of Kapas (Rs./qtl.)		Market Price as % Over MSP		Annual average Market Price of Lint Candy (Rs./candy)	
		H-4	S-6	H-4	S-6	H-4	S-6	H-4	S-6
1	2000-01	1825	1840	2207	2310	120.93	125.54	19676	20863
2	2001-02	1875	1840	1891	1900	100.85	103.26	15559	16659
3	2002-03	1875	1860	2215	2323	118.13	124.89	19910	20720
4	2003-04	1925	1910	2533	2632	131.58	137.8	22139	21309
5	2004-05*	1960	1960	2025	2076	105.92	105.92	16353	17190

MSP = Minimum Support Price 1 Candy = 355.62 kgs. * Upto January 2005

Note: Kapas Prices of Bt. Cotton normally are very near or slightly higher than Price of H-4/S-6.

3.14 Conclusion:

Overall review of the chapter reveals that Gujarat is a leading cotton producing State of India and in recent years, particularly after introduction of Bt. cotton, productivity of cotton in the State witnessed spectacular rise. However, Bt.cotton in Gujarat State was found ideal only for assured irrigation situations and non-suitable for rainfed areas. In majority areas of the State, Bt. cotton proved cost efficient and generated higher profit and productivity. No striking difference noticed between market price of Bt. cotton and non-Bt. hybrid cotton. The coverage under Bt. cotton in the State is moving up at a fast pace. In total Bt. cotton area of the State, share of non-approved varieties of Bt. cotton was higher as compared to share of approved varieties of Bt. cotton. In Gujarat, farmers are not following recommended practice of planting refuge plants on boundary of Bt. cotton plots. Bt. cotton was found suitable to State soils and climate and hence majority of cotton growers believed that Bt. cotton cultivation would be helpful in raising productivity as well as the net income.

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CHAPTER - 4

SOCIO AND AGRO ECONOMIC PROFILE OF SAMPLE HOUSEHOLDS

4.1 Background:

In this chapter, the socio-agro economic profile of selected 180 sample households is given based on the analysis of farm level survey data collected for cotton season 2004-05. As mentioned earlier in chapter 2, two districts namely, Rajkot and Vadodara were selected and from each selected district, 90 sample households comprising 45 Bt.cotton growers and 45 non-Bt. HB cotton growers covering small, medium and large farmers were selected.

4.2 Educational status :

It is obvious that apart from other factors, education level of decision maker of household also plays an important role in adoption of new agricultural technology and agricultural practices. Formal education helps farmers for better and judicious use of farm resources and in understanding quickly the positive and negative effect of new technology. As Bt. is a recently introduced new technology, it is pertinent to examine the educational status of the head of sample households.

The data presented in Table 4.1 shows that the average education level of head of all Bt. Cotton households (Vadodara and Rajkot together) was slightly higher (2.17, higher than primary level) than that of non-Bt. cotton counterpart (2.01, very close to primary level). The marginal difference in average education level between Bt. cotton and non-Bt. cotton households clearly suggest insignificant role of education level in adoption of Bt. technology.

However, a comparison of average education level of sample households (both, Bt. as well as non-Bt.) of Rajkot district with counterpart of Vadodara district showed wide difference. It was very low, below primary schooling for Rajkot district as against nearly secondary schooling for Vadodara district.

4.3 Family size, age and experience:

Family human labour is a major source of labour required for carrying timely all types of farm activities including cultivation and other allied activities. The availability of family labour also affecting the cost of cultivation. The availability of family human labour mainly depends upon the size and composition of family. In this context, the family size of sample households is being examined here. Table 4.1 shows that the family size of Bt. and non-Bt. growers is almost the same in both the districts. The average number of members per family was 6.

Age of decision maker is one of the important factors for deciding on adoption of new technology. Young farmers on account of relatively higher risk bearing attitude, tend to adopt new technology earlier than old age farmers. The data on average age of head of households given in Table 4.1 show marginal difference between age of Bt. and non-Bt. cotton growers. It was 46 years for Bt. growers as against 47 years for non-Bt. growers. The average farming experience was the same at 16 years (see Table 4.1) for both, Bt. and non-Bt. cotton sample households.

The distance between place of sample households and nearest town/ marketing place is an influential factor in the decision making process for purchase of farm inputs and marketing of crop output. The data given in Table 4.1 show that overall average distance between residing villages and nearest market town is 19 kms for sample households of Rajkot district, whereas it is 13 kms. for sample households of Vadodara district.

4.4 Average size of operational area :

Size of operational holding influence the cost of cultivation of crops, adoption of modern and new agriculture technology and capital investment in agriculture. In this context, size of operational holding is examined in Table 4.2.

Table 4.2 presents the category-wise average operational area of the sample households. The overall average operated area per household worked out to 3.45 hectares for Bt. cotton growers and 3.13 hectares for non-Bt. cotton growers. In Rajkot district, it was 3.26 hectares for Bt. growers and 3.05 hectares for non-Bt. cotton growers. In Vadodara district, it was 3.65 hectares for Bt. growers and 3.20 hectares for non-Bt. cotton growers. For different size groups, the overall (Rajkot and Vadodara together) average operational area per household for Bt. cotton growers worked out to 1.58 hectares for SF, 3.15 hectares for MF (medium) and 8.33 hectares for LF. For non-Bt. cotton growers, it worked out to 1.28 hectares for SF, 3.09 hectares for MF and 7.49 hectares for LF (see Table 4.2).

As majority of the sample households have small to moderate size of operational holding, the adoption of modern agriculture technology and capital investment in agriculture is bound to be at low to medium level.

4.5 Irrigation status :

Irrigation is one of the key factors for deciding type and variety of crops to be grown and use level of other inputs. It is established that in Gujarat, Bt. cotton yielded better and positive results mostly under irrigated situation. In this context, it is worthwhile to examine irrigation status of sample households. The data on irrigation sources and percentage of irrigated area and cropping intensity of sample farmers have been presented in Table 4.3.

The cost of irrigation is varying with the use of different sources of irrigation. Data given in Table 4.3 suggest that in sample villages of both the selected districts, open wells and tubewells are the main sources of irrigation for both type of sample households. In all selected sample villages of both the districts, groundwater irrigation accounts for cent per cent irrigation. Overall, among groundwater sources, wells accounted for over 77 per cent of irrigated area and tubewells accounted for about 23 per cent of irrigated area for both, Bt. growers as well as non Bt. growers (see Table 4.3). In sample villages of Rajkot district, wells were the only source of irrigation and hence it accounted for cent per cent of irrigated area. In Vadodara district, wells and tubewells, both were used for irrigation.

Overall (both districts together), the share of gross irrigated area to gross cropped area was 82.60 per cent for Bt. cotton growers and it was slightly lower at 79.42 per cent for non-Bt. cotton growers. In Rajkot district, the difference in irrigation percentage between Bt.cotton growers and non-Bt. cotton growers was 8.77 per cent as against –2.09 per cent for Vadodara district. This clearly suggest that in Rajkot district, sample households of Bt. cotton growers were placed in a slightly better position in respect of irrigation as compared to counterpart non-Bt. cotton growers. In Vadodara district, both, Bt. cotton growers as well as non-Bt. cotton growers had almost similar position in respect of irrigation.

4.6 Cropping intensity:

Cropping intensity measured in percentage terms is a ratio of GCA and the net operated area. The data regarding cropping intensity of sample households have been displayed in Table 4.3. Overall (both districts together) the cropping intensity of Bt. Cotton households worked out to 118 which was slightly lower than 121 for non-Bt. cotton growing households. For Bt. cotton growing households, cropping intensity in Rajkot district was 134, whereas it was only 104 for Vadodara district. As compared to Vadodara district, cropping intensity of non-Bt. cotton growing households of Rajkot district was significantly higher.

In Rajkot district, some farmers having adequate assured irrigation had sown Bt. cotton in May and completed all harvesting of cotton around October/November. These farmers, due to availability of irrigation facilities, opted for either rabi or summer crops. This helped them to achieve higher crop intensity. The low cropping intensity in Vadodara district was mainly due to nature of cotton crop and situation of late resowing of cotton as excessive rainfall damaged first sowing of cotton crop. Cotton is a long duration crop (130 to 200 days) and if it is sown around or after mid-June, the picking of cotton continues upto December. Hence, farmers with sowing of cotton on or after mid-June are not in a position to grow rabi crops on cotton land. Hence, cropping intensity of such farmers remained at low level.

4.7 Cropping pattern:

Since our main objective is to study the effect of Bt. cotton on crop income, profit level, yield level and climatic and soil suitability, it is pertinent to examine cropping pattern adopted by sample households and particularly proportion of area devoted to different varieties of cotton crop. It is also worthwhile to examine and identify difference in the cropping pattern of Bt. and non-Bt. cotton growers. The cropping pattern of the sample households is presented in Table 4.4. The table exhibits the per farm area under the important crops as a percentage of GCA.

Table 4.4
Cropping pattern of sample households

(Figures are percent to GCA)

Sr. No	Crop	Rajkot (R)		Vadodara (V)		Overall (R+V)	
		Bt.cotton hhs.	Non-Bt.cotton hhs.	Bt.Cotton hhs.	Non-Bt.cotton hhs.	Bt.cotton hhs.	Non-Bt.cotton hhs.
A	**Kharif season**						
	Bt.Cotton (G)	21.55	-	20.27	1.24	20.92	0.57
	Bt.Cotton (NC)	17.43	-	36.72	2.14	26.46	1.89
	Non-Bt.Cotton	4.36	35.09	0.71	50.62	2.62	42.21
	Total cotton	43.34	35.09	57.70	54.00	50.00	44.67
	Groundnut	28.21	36.86	-	-	15.20	19.96
	Tur	-	-	11.02	12.26	5.15	5.62
	Vegetables	0.80	0.22	2.47	3.15	1.22	1.57
B	**Rabi season**						
	Wheat	8.72	5.13	2.10	4.89	5.66	5.02
	Garlic	2.98	8.50			1.54	4.60
	Fodder	5.05	1.10	0.52	0.23	2.95	0.70
	Vegetables	1.15	2.89			0.74	1.57
C	**Summer season**						
	Sugarcane			11.29	12.21	5.39	5.60
	Vegetables	0.08	0.04	0.24		0.15	0.02
	Fodder	2.52	1.20	4.99	2.02	3.68	1.58
D	**Gross cropped area (GCA)** %	100.00	100.00	100.00	100.00	100.00	100.00
	Hect. *	4.36	4.11	3.81	3.48	4.08	3.79

* Average per farm

Overall (both districts together) as well as in both districts, the GCA was higher for Bt. cotton households as compared to non-Bt. cotton households. Further, examination of overall cropping pattern reveals that in both the districts, cotton was the most important crop and sample farmers had allocated major share of total cropped area to it. The Bt. cotton growers have relatively higher share to cotton crop (50.00% of GCA) as compared to the non-Bt. cotton growers (44.67% of GCA). Besides cotton, groundnut, tur, wheat and sugarcane were other important crops of the selected districts. Cotton and these other crops together accounted for more than 80 per cent of GCA for both group (Bt. and non-Bt) of households.

In Rajkot district, cotton, groundnut and garlic crops dominated the cropping pattern and together covered atleast 75 per cent of GCA in both categories (Bt. and non-Bt.) of households. Wheat, garlic and fodder crops were important rabi crops and for Bt. cotton households they claimed about 8.72, 2.98 and 5.05 per cent area of GCA respectively. Garlic accounted for 8.50 per cent area of GCA for non-Bt. cotton households. As compared to non-Bt. cotton households, 8.25 per cent more area was devoted to cotton crop by the Bt. cotton households. The data further reveals that farming economy in Rajkot district is highly relying on output of the crops viz., cotton, groundnut and garlic.

On account of non-availability of adequate water for irrigation in rabi season, majority of cotton farmers of Rajkot district had harvested cotton only upto 5 to 6 pickings and thereafter utilized it either for growing late rabi/summer crops or keeping it idle for next year sowing.

In Vadodara district, cotton, tur and sugarcane were most important crops and data clearly reveal that economy of farmers of this region is heavily relying on the prospect of these three crops. Bt. cotton households devoted as much as 57.70 per cent of GCA to only cotton crop. The corresponding figure for non-Bt. households was 54 per cent. Tur and sugarcane together covered around 22 per cent for Bt. cotton households, whereas it was around 24 per cent for non-Bt. households.

In Vadodara region, on account of adequate availability of water for irrigation throughout the year, the general practice of cotton farmers is to give irrigation to cotton after each picking operation and to take at least 7 to 9 pickings of cotton and hence, the picking operation of cotton last upto end of February. This practice coupled with good area under long duration sugarcane crop reduces the availability of land for growing rabi/summer crops and thereby causing low cropping intensity.

4.8 Type of cotton grown by sample farmers – 2001-02 to 2004-05:

The overall distribution of sample farmers according to type of cotton grown during agricultural year 2001-02 to 2004-05 has been presented in Table 4.5. The following important points are emerging from the table :

1. The commercial cultivation of Bt.cotton was allowed officially in the year 2002-03. In this year, only 30 sample farmers had grown Bt. cotton. Surprisingly, out of these 30 Bt. cotton growers, only 1 sample farmer grew approved variety of Bt.cotton, whereas rest 29 farmers opted for non-approved varieties of Bt.cotton. In the year 2001-02 (prior year of approval of Bt.cotton) not a single farmer had grown Bt.cotton.

2. In year 2001-02, out of 180 sample farmers only 87 farmers (48.33%) had grown conventional non-Bt. cotton varieties.

3. In each year during 2002-03 to 2004-05, number of farmers growing non-approved varieties of Bt.cotton outclassed the number of farmers growing approved varieties of Bt.cotton. This suggests popularity of non-approved Bt.cotton among farmers and easy availability of non-approved Bt. seeds in the market.

4. In each year during 2001-02 to 2004-05, the number of sample farmers growing cotton has shown significant upward trend which suggest that introduction of Bt.cotton caused shift in crop pattern in favour of cotton and brought farmers back again to cotton cultivation.

5. Majority (around 88%) sample farmers had grown cotton varieties which had staple length either super medium (25.50 to 27.50 mm) or long (>28 mm).

4.9 Sources of seeds:

The distribution of sample farmers according to sources of seeds during 2001-02 to 2004-05 has been provided in Table 4.6. The data show that sample farmers bought seeds for cotton crop from multiple sources such as private traders, company depot, company salesman, fellow farmers, local producers etc. Ideally, in case of Bt.cotton and hybrid non-Bt. cotton, seed is required to be replaced every year and hence the number of farmers using own produced seed was negligible.

Few farmers used more than one sources for meeting their seed requirement of cotton crop. The scatter frequencies in Table 4.6 for source-wise purchase of seed of cotton crop suggest that cotton growers patronized different sources and their importance varied with type of seeds. From Table 4.6, it is evident that company depot/agents and private traders emerged as the most powerful sources of seed supply for approved and non-approved Bt.cotton. Fellow farmers/relatives/friends/neighbour farmers were also important source for seed supply of non-approved Bt.cotton. Some fellow farmers supplied F_1 seeds. In case of non-Bt. cotton, company depot/agents, local producers and fellow farmers emerged as the main sources of seed supply for cotton crop. Most of the sample farmers who purchased seeds from local producers, private traders and fellow farmers said that quality of seeds supplied by these sources were not always good. Eventhough, they purchased seed from private traders, local producers and fellow farmers due to higher prices of authorized company seeds and availability of seeds on credit from these sources. Examination of data according to size of holdings suggests that small farmers relied somewhat more on private and local sources to meet their seed requirement as compared to large farmers.

4.10 Brand-wise use of seeds for cotton crop:

The data on seed brands and varieties for Bt.cotton and non-Bt.cotton which are more preferable and used by majority of sample farmers have been furnished in Table 4.7. Large diversity is noticed in types and varieties of cotton grown in the State. Within the sample also use of many varieties have been reported.

The GEAC gave approval of Bt.cotton cultivation in 2002-03 and in this year only 3 branded varieties of genuine Bt.cotton namely MECH-162, MECH-184 and MECH-12 were released by MAHYCO. In 2003-04, genuine branded Bt. variety RCH-2 was released by Rasi seeds, salem. Among 3 varieties of MAHYCO brand, MECH-12 is relatively more popular in Gujarat at present, wherein due to low level performance MECH-162 and MECH-184 varieties are now less preferable by State farmers. Owing to comparatively better performance, the RCH-2 variety is now gaining more favour from the farmers. From the data given in Table 4.7, it is evident that non-approved Bt.cotton brand, mainly Navbharat-151 is most popular among Bt. cotton growers. The branded Bt. cotton seed producing companies providing guarantee of 98% purity of seeds, minimum 65% germination and atleast 90 per cent genetic purity, whereas local non-branded seed producers are not giving such guarantee, yet farmers favour non-branded local Bt. cotton seeds. During the period 2002-03 to 2004-05, in each year number of users of branded genuine Bt.cotton seeds was much lower than that of non-branded Bt.cotton. The main considerations quoted by sample farmers for favouring non-branded Bt.cotton varieties are :

i) Comparatively very low price of seed
ii) No need of advance booking by paying advance payment. Also available in adequate quantity as and when needed
iii) Facility of credit purchase
iv) No significant difference in output and performance with respect to yield and quality, if seed is obtained from reliable source

Table 4.7
Brand-wise use of cotton seeds during 2001-02 to 2004-05

Brand	2001-02		2002-03		2003-04		2004-05	
	Nos. of farmers	%	Nos. of farmers	%	Nos. of farmers	%	Nos. of farmers	%
Genuine Bt. Cotton								
RCH-2	-	-	-	-	4	16.67	19	51.35
MECH-12 & 184	-	-	1	100	20	83.33	18	48.65
TOTAL	-	-	1	100	24	100	37	100
Non-Genuine(Non-confirm) Bt.cotton								
NAVBHARAT-151	-	-	18	62.07	32	60.38	32	60.38
DHANLAXMI	-	-	1	3.45	7	13.21	19	35.85
OTHERS	-	-	10	34.48	14	26.42	2	3.77
TOTAL	-	-	29	100	53	100	53	100
Non-Bt.cotton								
SANKAR(4,6,8,10)	66	75.86	85	68.55	63	61.17	30	33.33
VIKRAM-HB	7	8.05	7	5.65	9.71	9.71	23	25.56
OTHERS-HB	-	-	4	3.22	-	-	3	3.33
NAVBHARAT-DESHI	1	1.15	8	6.45	13	12.62	20	22.22
OTHERS DESHI	13	14.94	20	16.13	17	16.5	14	15.56
TOTAL	87	100.00	124	100.00	103	100.00	90	100.00

v) Suitable to their soil and weather conditions

vi) Non-suitability of approved varieties to their soil chemistry

From the Table 4.7, it is evident that among genuine Bt.cotton seed varieties, RCH-2 and MECH-12 are most prominent brands, whereas among non-approved Bt.cotton seed varieties Navbharat-151 and Dhanlaxmi (local name) are more popular brands.

In 2004-05, out of 37 Bt.cotton (G) growers, 19 opted for RCH-2 brand and 18 for Mahyco (MECH-12 and MECH-184) brand. Among 53 non-genuine Bt.cotton growers, around 60 per cent opted for Navbharat-151 brand seed and remaining opted for local non-branded seed varieties.

Among non-Bt. cotton growers, 33.33 per cent opted for Sankar brand (S-4, S-6, S-10), 25.56 per cent opted for Vikram-HB brand and 22.22 per cent opted for Navbharat brand.

Surprisingly at present in Gujarat, local producers and non-approved Navbharat-151 brand possess good market share in seed market for Bt.cotton crop. Also, there is a strong demand from cotton growing belts of Punjab and Haryana for non-approved, non-branded Bt.cotton seeds produced by farmers of Gujarat.

4.11 Average seed price and seed rate in Bt. and non-Bt. cotton:

Bt. cotton cultivation is cost-intensive and Bt. seed is very costly as compared to seed of non-Bt. conventional hybrid cotton varieties. For achieving optimum crop productivity, timely and adequate use of all related inputs as per recommendation is most essential. Keeping in view high cost of Bt. seeds, an attempt is made here to examine whether or not Bt. cotton growers followed the recommended level of seed rate.

From Table 4.8, it is evident that actual seed rate applied by Bt. cotton growers (G), Bt. cotton growers (NC) and non-Bt. hybrid cotton growers was slightly higher than the recommended seed rate of 1.125 kg./ha. (1 bag of 450 gms/acre), 1.5 kg./ha. and 1.75 kg./ha. respectively. Despite high cost of seeds, marginally higher seed rate applied by sample farmers was mainly attributed to following reasons :

i) Few resowing cases;
ii) Bt. cotton seed is available mostly in a bag of 450 gms. Hence, farmers who require seed quantity less than 450 gms. or multiple of 450 gms. have no alternative but to purchase compulsory higher quantity of seed and use it.

Table 4.8
Average seed price and average seed rate for Bt. and non-Bt. cotton

Cotton type	Particulars	Year			
		2001-02	2002-03	2003-04	2004-05
Bt. cotton (G)	Average seed rate (Kg./Hect.)	-	-	1.077	1.210
	Average price (Rs./Kg.)	-	-	2944	3371
Bt. cotton(NC)	Average seed rate (Kg./Hect.)	-	1.557	1.613	1.660
	Average price (Rs./Kg.)	-	827	1195	1396
Overall Bt. cotton (G+NC)	Average seed rate (Kg./Hect.)	-	1.557	1.432	1.473
	Average price (Rs./Kg.)	-	827	1698	2092
Non-Bt. cotton (HB)	Average seed rate (Kg./Hect.)	1.781	2.232	1.722	1.968
	Average price (Rs./Kg.)	526	564	642	673

The average seed price per kg. paid by farmers of Bt. cotton (G), Bt. cotton (NC) and non-Bt. hybrid cotton was Rs.3371, Rs.1396 and Rs.673 respectively. The slightly higher application of seed rate in Bt. cotton by sample farmers clearly reveals their willingness to invest on new technology eventhough it is cost intensive, and also to use all recommended inputs adequately for enhancing productivity and generating higher income.

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CHAPTER - 5

ECONOMICS OF Bt. COTTON AND PERCEPTION OF SAMPLE FARMERS

In this chapter, an attempt has been made to examine operation-wise/item-wise cost of cultivation of Bt.cotton and non-Bt. hybrid cotton (only for irrigated) using field level data collected from sample farmers. Productivity, output-input ratio, cost efficiency and net and gross return per unit of land for Bt. vs. non-Bt. cotton have also been worked out. The intensity of pests attack and pesticides cost differentials between Bt. and non-Bt. cotton have also been examined.

In order to know farmers' views and their stand on various aspects associated with the cultivation of Bt. vis-à-vis non-Bt., data were collected from 90 Bt.cotton growing sample farmers. Analysis based on these perception data has also been attempted here.

5.1 Type and intensity of pests/insects attack :

The present non-Bt. hybrid cotton varieties are highly suffering from bollworm, sucking pests, leaf curl virus and other pests/insects attack. Among these pests, bollworm is a major danger and devastating. The loss due to bollworm is estimated at around 40 to 50 per cent of cotton yield. To control the bollworm and prevent yield loss, farmers are spraying more doses of pesticides. Therefore, it is not only escalating the pesticides cost and in turn cost of cultivation, but also causing yield and quality loss too. Subsequently, this affects the rate of return from cotton cultivation. Moreover, constant and continuous exposure to pesticides could result in severe health impacts for farmers and farm workers.

A new cotton variety using BT technology was introduced to provide solution of making cotton plants free from bollworm infestation and particularly American bollworm. The introducer of Bt. cotton claimed that it is resistant to pests, particularly bollworm and hence prevents the attack of bollworm. With a view to ascertain this claim, information on type of pests/insects attack and their intensity level was collected from sample farmers and presented in Table 5.1.

Out of total 37 genuine Bt.cotton growers, only 2 farmers reported mild American/pink bollworm attack, whereas 61 per cent of non-Bt. hybrid cotton growers reported moderate to light American/pink bollworm attack. From the total non-confirmed Bt.cotton growers, only 20.75 per cent reported bollworm infestation. This result clearly supports the claim that BT technology in cotton is highly effective in providing strong resistance to American bollworm for virtually Bt.cotton growers. Now, it remains to be seen whether or not this intensity of effectiveness will sustain in the years to come. Some farmers expressed the apprehension that due to non-growing of suggested refugia plants surrounding Bt.cotton, the effectiveness of Bt. cotton in preventing bollworm attack is bound to be weaker in the years to come as bollworm will gradually develop resistance power to Bt.gene.

Both, Bt.cotton and non-Bt. cotton suffered attack of soil pests, sucking pests and foliage feeding pests. However, intensity of attack of these pests was found slightly lower in Bt.cotton as compared to non-Bt.cotton. This clearly suggests that Bt.cotton is substantially effective in protecting cotton plants from only bollworm infestation. It is found not so effective in preventing sucking pests and other pests/insects infestation. However, for other than bollworm pests, Bt. variety appears to have slightly less infestation as compared to non-Bt. varieties. Hence, farmers must be told that Bt.cotton does not control all pests. Consequently, there may be need of spraying insecticides in Bt.cotton too.

5.2 Pesticides use pattern:

Pesticides is one of the important and crucial inputs of cotton cultivation. In total cost of production, share of pesticides is significant. The primary aim of introducing Bt.cotton was to make cotton plants free from bollworm infestation and thereby to effect reduction in pesticides consumption and cost. With a view to ascertain effectiveness of Bt. technology in reducing use and cost of pesticides in cotton, information on average quantity of pesticides used per hectare and cost of pesticides per hectare is presented for Bt. and non-Bt. cotton in Table 5.2.

Table 5.2
Average quantity of pesticides used and number of spray in Bt. and non-Bt.cotton

District	Particulars	Bt. (G)	Bt.(NC)	Bt.(G+NC)	Non-Bt.
Rajkot (R)	Average Number of spray	4.22 (-16.27)	4.19 (-16.87)	4.20 (-16.67)	5.04 (0.00)
	Qty.per sprays (Ml. /Hect.)	364 (-52.60)	725 (-5.60)	549 (-28.52)	768 (0.00)
	Total qty.of pesticides used (Lit. /hect.)	1.53 (-60.47)	3.04 (-21.45)	2.30 (-40.57)	3.87 (0.00)
	Total cost of pesticides (Rs. /Hect.)	2337 (-28.75)	3699 (12.77)	2965 (-9.60)	3280 (0.00)
Vadodara (V)	Average Number of spray	5.72 (-3.05)	5.62 (-4.75)	5.65 (-4.24)	5.90 (0.00)
	Qty.per sprays (Ml. /Hect.)	527 (-21.58)	469 (-30.21)	489 (-27.23)	672 (0.00)
	Total qty.of pesticides used (Lit. /Hect.)	3.02 (-23.93)	2.63 (-33.75)	2.76 (-30.48)	3.97 (0.00)
	Total cost of pesticides (Rs. /Hect.)	3152 (2.30)	2202 (-28.53)	2530 (-17.88)	3081 (0.00)
Overall (R + V)	Average Number of spray	4.83 (-11.21)	5.00 (-8.09)	4.92 (-9.56)	5.44 (0.00)
	Qty.per sprays (Ml. /Hect.)	430 (-40.11)	580 (-19.22)	516 (-28.13)	718 (0.00)
	Total qty.of pesticides used (Lit. /Hect.)	2.13 (-45.38)	2.79 (-28.46)	2.53 (-35.13)	3.90 (0.00)
	Total cost of pesticides (Rs. /Hect.)	2682 (-15.34)	2771 (-12.53)	2732 (-13.76)	3168 (0.00)

Note: Figures in bracket are percentage increase/decrease over non-Bt. cotton
G = Genuine (approved) Bt., NC = Non-confirmed Bt.

In field survey, farmers reported a number of pesticides having different quality brands, form and power. The pesticides used by farmers were either in liquid or powder form. The names of major pesticides used by farmers were BHC, cholorophyriphes, cholorofenac, carboxin, carbosulfan, endosulfan, sevin, fenitrothion, monocrotophos, quinalphos, thiodan, sulphur etc. Owing to difference in quality, power and brand, very wide difference was noticed in prices of pesticides. Hence, comparison of number of sprays or quantity of pesticides used in Bt. and non-Bt. cotton will not explain fully the real impact of Bt. technology on pesticides consumption.

Overall (both districts together) non-Bt. hybrid cotton required as many as 5.44 number of pesticides sprays per hectare, while approved and non-approved Bt. required an average of 4.83 and 5.00 pesticides sprays respectively. This shows that approved Bt. cotton growers have used 11.21 per cent less number of pesticides sprays as compared to hybrid non-Bt. cotton. Similar trend was also noticed in Rajkot and Vadodara districts too (see Table 5.2).

In respect of quantity of pesticides used per spray and total quantity used per hectare, Bt. cotton growers (approved and non-approved together) utilized less quantity of pesticides as compared to non-Bt. cotton growers in both the districts. Owing to lower pesticides usage, expenses incurred on pesticides by Bt. cotton growers was also found lower as compared to that of non-Bt. cotton growers in both the districts. In Rajkot, it was Rs.2337 per hectare for approved Bt.cotton, whereas it was Rs.3280 for non-Bt. cotton. The contrary to expectation, the unapproved Bt (NC) growers in Rajkot district sprayed slightly less quantity of pesticides as compared to non-Bt. cotton, but total cost of pesticides sprayed for Bt. (NC) was found somewhat higher. This has happen mainly due to wide difference in quality, brand and power (concentration) of pesticides used. As Bt.cotton seed is more costly, they used high power costly pesticides, whereas they used less relatively low price, low power pesticides for non-Bt. cotton. In Vadodara, it was Rs.2530 for total Bt. (G+NC), Rs.2202 for non-approved Bt. and Rs.3081 for non-Bt. cotton. Overall, on an average, Bt. cotton growers (G+NC) spent nearly 13.76 per cent less amount on pesticides as compared to non-Bt. cotton farmers.

According to sample farmers, Bt. cotton protects plants from only bollworm attack. It is equally susceptible to other pests/diseases, which are appearing at various stages of cotton crop. Therefore, Bt.cotton also requires the application of good quantity of pesticides/insecticides. The data presented in Table 5.2 clearly suggest that quantum of reduction in pesticides consumption in Bt. cotton was very low and not in line with claim made by Bt. promoters. The major reasons for not achieving expected reduction in pesticides consumption in Bt. cotton are:

1. On account of higher investment on seed and other inputs farmers devoted more care to crop and hence with the notice of any sign of pests/diseases in cotton, as a precautionary measures, farmers sprayed pesticides/insecticides, even though it is not required. When pests' appearance is below threshold level, pesticides spraying is not needed. Even though, due to fear, farmers sprayed pesticides on cotton plants. This faulty practice reduced the savings on pesticides.

2. In reference year, due to more favourable climatic conditions, bollworm pressure was relatively low in all the cotton varieties including non-Bt.cotton. Therefore, cost of pesticides sprayed in non-Bt. cotton was relatively low for the reference year. This brought down the savings on pesticides for Bt. cotton.

3. As Bt.cotton suffered attack from sucking pests, leaf curling virus, foilage feeding pests, soil pests and other diseases compelled farmers to spray pesticides/insecticides in Bt.cotton. This raised the cost of pesticides for Bt.cotton.

4. In a few cases, substandard quality of pesticides pushed up the consumption and subsequently cost of pesticides.

5. Few farmers were not able to distinguish between Bt. and non-Bt. cotton. And, therefore, continued to spray same level of pesticides/insecticides in Bt. and non-Bt. cotton.

Overall, one can conclude that Bt. technology is pesticides savings but the quantum of savings is very low and far from level of expectation.

5.3 Break-up of cost of cultivation of Bt. and non-Bt. cotton:*

The conflicting assertions made by pro and anti Bt. cotton groups on impact of Bt. technology with special reference to various operational costs and gross cost of cultivation indicates that a clear picture is yet to emerge. In this context, it is pertinent to examine impact of Bt. technology in cotton on each operational cost and gross cost of cultivation. Table 5.3.1 examines item-wise cost data of Bt. cotton vs. non-Bt. cotton.

5.3.1 Cost of cultivation per hectare : The data presented in Table 5.3.1 clearly shows that the average gross cost of cultivation for total Bt. cotton (G+NC) was higher than that for non-Bt. hybrid cotton in both the districts. Overall (both districts together), the average cost of cultivation per hectare comes to Rs.31815 for Bt.(G), Rs.28145 for Bt.(NC), Rs.29743 for total Bt. (G+NC) and Rs.26993 for non-Bt. cotton. The overall average cost of cultivation for total Bt.cotton is higher by Rs.2750, an increase of 10.19 per cent compared to that for non-Bt. cotton (see Table 5.3.3). For Vadodara district, the cost of cultivation for Bt.cotton was up by 13.20 per cent, whereas it was 6.17 per cent up for Rajkot district (see Table 5.3.3). The examination of cost of cultivation data according to landholding categories do not reveals any definitive trend. However, cost of cultivation was found lowest for small size farmers for both Bt. as well as non-Bt. cotton.

There were several reasons which pushed up the cost of cultivation of Bt.cotton. Firstly, the seed cost per hectare of Bt.cotton (G) and total Bt.(G+NC) cotton were Rs.4079 and Rs.3079 respectively, whereas it was only Rs.1324 for non-Bt.cotton. Thus, as compared to non-Bt. growers, average expenses incurred per hectare on seed for Bt.(G) and total Bt.(G+NC) was about 208 per cent and 133 per cent higher (see Table 5.3.3) respectively. Secondly, owing to substantially

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* It includes all expenses cash and kind and imputed value of own family labour, own bullock and machines labour.

higher productivity, cost of picking/harvesting operation was about 22.91 per cent higher for total Bt.(G+NC) compared to that for non-Bt.cotton. Thirdly, there was a reduction in pesticides cost for Bt.cotton, but quantum of reduction was much lower than expectations and hence cost saving on pesticides was lower. This saving was not enough to compensate fully for the higher seed cost.

The absolute amount spent on items like FYM, fertilisers, human labour (excluding picking) and irrigation for cultivation of Bt.cotton differs only marginally from non-Bt.cotton. The data given in Table 5.3.1 clearly suggest that Bt. technology is a cost intensive and not cost saving in cotton.

5.3.2 Percentage share of inputs in gross cost of cultivation : The share of each operational cost in the gross cost of cultivation is expected to be influenced by Bt. technology in cotton. Therefore, to study the composition of share of inputs in total cost of cultivation, mainly for seed, harvesting, irrigation and pesticides, the related data have been presented in Table 5.3.2. As expected considerable variation was observed in share of these costs between Bt. and non-Bt. cotton.

The share of seed cost in total cost was 10.35 per cent for total Bt. cotton (G+NC) which was substantially higher than share of 4.91 per cent for non-Bt. cotton. This is so because of the abnormally high seed prices of Bt. varieties as compared to that for non-Bt.cotton varieties. Though, picking operation accounts for the largest share (21.56%) in total cost of Bt. cotton, it was only marginally higher than its share (19.33%) in total cost of non-Bt. cotton. The share of pesticides cost in total cost of cultivation was 9.19 per cent for Bt. cotton which was relatively lower than the share of 11.74 per cent of non-Bt. cotton. As compared to non-confirmed (NC) Bt. cotton, the share of pesticides cost was lower for approved Bt. cotton (G). Surprisingly, the share of irrigation was 12.84 per cent for Bt. cotton, which was lower than it share of 14.34 per cent for non-Bt. cotton. Like irrigation, the share of fertiliser was also observed somewhat lower for Bt. cotton (10.92%) as compared to that for non-Bt. cotton (12.19%). This suggests that Bt. cotton neither requires higher

doses of fertilisers nor more irrigation than counterpart non-Bt. cotton. On the whole, it is emerging from the analysis that the seed and harvesting cost are the major contributors for the increase in the cost of cultivation of Bt.cotton.

5.4 Yield level of Bt. and non-Bt. cotton:

According to pro Bt.cotton group, yield superiority over non-Bt. cotton is one of the most important positive impact of Bt.cotton. For verification of this claim, yield differential between Bt. and non-Bt. cotton is examined here. Tables 5.4.1 and 5.4.2 provide comparative yield performance of Bt. and non-Bt. cotton across districts and farm sizes.

From Table 5.4.1, it is obvious that the overall yield performance of Bt. cotton was far better than that for non-Bt. cotton. For both districts together, an average yield of total Bt. cotton (G+NC) was 32.20 qtls./ha., which was 28.44 per cent higher than that of 25.07 qtls./ha. for non-Bt. cotton. The corresponding figures for approved Bt.cotton (G) was 36.34 qtls./ha. and for non-approved Bt.cotton (NC) was 28.99 qtls./ha. This clearly suggests yield superiority of genuine/approved Bt.cotton varieties over the non-confirmed Bt.cotton and non-Bt. cotton varieties. Almost similar pattern of yield trend was observed in both the selected districts.

Examination of yield across districts clearly reveals inter-district variations. In both the districts, the yield obtained for Bt.cotton was substantially higher than that for non-Bt. cotton. The overall average yield obtained by total Bt.(G+NC) farmers in Rajkot district was 34.14 qtls./ha., which was nearly 12 per cent higher than 30.50 qtls./ha. for Vadodara district. The non-Bt. cotton farmers of Rajkot district obtained about 18 per cent higher yield than that for Vadodara district. This shows that sample households of Rajkot achieved notable increase in the yield of Bt. and non-Bt. cotton as compared to their counterpart in Vadodara district (see Table 5.4.1). Favourable rainfall and climatic condition helped cotton farmers of Rajkot district to achieve higher yield. The damage caused to cotton crop (Bt. and non-Bt.) due to excessive rainfall led to relatively lower cotton yield in Vadodara district.

Table 5.4.1
Average yields, revenue and price realization for Bt. and non-Bt. cotton

District	Particulars	Kapas			
		Bt. (G)	Bt. (NC)	Total Bt. (G+NC)	Non-Bt.
Rajkot (R)	Average area per farm (Ha.)	1.93 (134.03)	1.58 (109.72)	1.75 (121.53)	1.44 (100.00)
	Yield of kapas (Kg. /Ha.)	3593 (131.23)	3206 (117.09)	3414 (124.69)	2738 (100.00)
	Value of kapas (Rs. /Ha.)	72335 (133.79)	63493 (117.44)	68260 (126.25)	54066 (100.00)
	Average price realized per qtl. (Rs.)	2013 (101.95)	1980 (100.29)	1999 (101.25)	1975 (100.00)
Vadodara (V)	Average area per farm (Ha.)	2.09 (112.97)	1.97 (106.49)	2.01 (108.65)	1.85 (100.00)
	Yield of kapas (Kg. /Ha.)	3692 (158.66)	2711 (116.50)	3050 (131.07)	2327 (100.00)
	Value of kapas (Rs. /Ha.)	72984 (163.48)	53166 (119.09)	60102 (134.63)	44643 (100.00)
	Average price realized per qtl. (Rs.)	1977 (103.04)	1961 (102.22)	1971 (102.71)	1918 (100.00)
Overall (R + V)	Average area per farm (Ha.)	1.99 (120.61)	1.8 (109.09)	1.88 (113.94)	1.65 (100.00)
	Yield of kapas (Kg. /Ha.)	3634 (144.95)	2899 (115.64)	3220 (128.44)	2507 (100.00)
	Value of kapas (Rs. /Ha.)	72490 (148.32)	57056 (116.74)	63942 (130.83)	48873 (100.00)
	Average price realized per qtl. (Rs.)	1995 (102.32)	1968 (100.96)	1986 (101.86)	1949 (100.00)

Note: Figures in bracket denote percentage with respect to non-Bt.
G = Genuine, NC = Non-confirmed Bt.

Table 5.4.2
Farm size-wise average yields, revenue and price realization for Bt. and non-Bt.cotton

Farm Size	Particulars	Bt.Cotton (G)	Bt.Cotton (NC)	Total Bt.Cotton (G + NC)	Non-Bt. Cotton
Small	Area in Hect. (Per farm)	0.98	1.05	1.03	0.87
	Yield of kapas (Kg. /Ha.)	3270	2762	2924	2107
	Value of Kapas (Rs. /Hect.)	64993	52778	57952	40699
	Average price realized (Rs. / Qtl.)	1988	1911	1982	1932
Medium	Area in Hect. (Per farm)	2.17	1.93	2.05	1.59
	Yield of kapas (Kg. /Ha.)	3955	2764	3434	2561
	Value of Kapas (Rs. /Hect.)	76545	54748	68138	49949
	Average price realized (Rs. / Qtl.)	1935	1981	1984	1950
Large	Area in Hect. (Per farm)	3.61	3.55	3.57	3.56
	Yield of kapas (Kg. /Ha.)	3394	3096	3213	2695
	Value of Kapas (Rs. /Hect.)	68380	60625	63969	53345
	Average price realized (Rs. / Qtl.)	2015	1958	1991	1979
Overall	Area in Hect. (Per farm)	1.99	1.80	1.88	1.65
	Yield of kapas (Kg. /Ha.)	3634	2899	3220	2507
	Value of Kapas (Rs. /Hect.)	72490	57056	63942	48873
	Average price realized (Rs. / Qtl.)	1995	1968	1986	1949

G = Genuine, NC = Non-confirmed Bt.

Examination of yield data across different farm categories shows that yield level of Bt.cotton for all the three categories of farmers was found to be higher than for corresponding categories of non-Bt. cotton (see Table 5.4.2). The yield level of Bt.cotton (G+NC) was found highest (34.34 qtls./ha.) for medium landholding farmers, wherein it was observed lowest (29.24 qtls./ha.) for small landholding farmers (see Table 5.4.2).

The coefficient of variation (CV) for Bt.cotton was found 28.29 per cent, slightly higher compared to 25.17 per cent for non-Bt.cotton (see Table 5.4.3). Moreover, the yield range of Bt.cotton was 12.80 to 53.54 qtls./ha., whereas for non-Bt.cotton, it was 6.18 to 41.18 qtls./ha. The higher CV and higher range of variability clearly suggests slightly higher inter-farm yield variability for Bt.cotton. This result does not support the claim that Bt.cotton has less inter-farm variations and more stability in yield as compared to non-Bt. cotton.

Table 5.4.3
Yield variations in Bt. and non-Bt.cotton

Cotton type	Range of yield (Qtl. / Hect.)		Mean	Standard Deviation	CV (%)
	Minimum	Maximum			
Total Bt. (G+ NC)	12.80	53.54	32.20	9.11	28.29
Non-Bt.	6.18	41.18	25.07	6.31	25.17

CV = Coefficient of Variation

5.5 Average price realization and revenue differentials:

As per market sources, the quality difference between Bt. and non-Bt. cotton is very marginal. Owing to less spraying of pesticides, Bt. cotton was found relatively cleaner and better in colour and hence in respect of quality, Bt.cotton has slight edge over non-Bt.cotton. On account of good market acceptance of the product, Bt. cotton growers have not faced any problems in selling the product. On the contrary, Bt. cotton growers realized somewhat better price. The data provided in Table 5.4.1 show that overall average price realized per quintal for total Bt. cotton (G+NC) was

Rs.1986 as against Rs.1949 for conventional non-Bt. hybrid cotton. The market price of cotton during the reference year fluctuated widely between Rs.2300/qtl. and Rs.1750/qtl. It was higher in October-November and then due to global and other impact, it depressed gradually and at the peak of the market arrival of the product, it ranged between Rs.1800-1950/qtl. Due to relatively shorter maturity period and early sowing by some Bt. farmers (in May), the picking of kapas for Bt.cotton started around 30 days early. This helped Bt. farmers in fetching relatively higher average price of the kapas. From Table 5.4.1, it is evident that in respect of average price realization for both types of cotton, the Rajkot farmers were found in a marginally better position.

Across farm sizes, no significant difference was witnessed in average price realized for Bt.cotton. However, in respect of non-Bt. cotton, small farmers realized lowest price of Rs.1932/qtls. wherein large farmers realized highest price of Rs.1979/qtl. (see Table 5.4.2).

The main economic benefits of Bt. cotton stems from gains on revenue side as a result of increase in the yields. The average revenue per hectare for total Bt. cotton was Rs.63942, an increase of Rs.15069 (30.83%) over Rs.48873 for non-Bt. hybrid cotton (see Table 5.4.1). The revenue gains for Bt. cotton (G) over non-Bt. cotton was 48.32 per cent, whereas it was only 16.74 per cent for Bt. cotton (NC). This apparently shows superiority of approved Bt.cotton over non-approved Bt.cotton too. For Bt. cotton, the percentage of revenue gains was found higher than its yield gains mainly because of better price realization of the product.

5.6 Picking-wise break-up of productivity and maturity period of Bt. and non-Bt. cotton:

It is said that Bt. cotton has relatively short maturity period and higher number of pickings. For verification of these claims, the data of production obtained in each picking has been collected and presented in Table 5.5.

The data in Table 5.5 show that the average gap between sowing and first harvesting of kapas (maturity period) was 123 days for total Bt. cotton (G+NC), which was shorter by about 10 days as compared to 133 days for non-Bt. cotton varieties. The average gap between two successive pickings was found in the range of 18-20 days and was observed to be almost uniform for both Bt. and non-Bt. cotton. The number of pickings shows absolutely no variation between Bt. and non-Bt. convention hybrid varieties. However, Rajkot farmers completed harvesting of kapas in six pickings, whereas Vadodara farmers continued it upto eight and more pickings. Owing to limited water resources, number of cotton pickings in Rajkot were less. In Rajkot district, about 95 per cent cotton was harvested at the end of fourth picking for both Bt. and non-Bt. cotton. In Vadodara district at the end of fifth pickings, about 84 per cent of Bt. production and about 90 per cent of non-Bt. cotton production was obtained. Further, it can be concluded that number of pickings in Bt. and non-Bt. cotton varied from one region to another depending upon the availability of water and other agro climatic factors.

5.7 Average cost of production of Bt. and non-Bt. cotton:

It is seen from the data presented in Table 5.6 that average cost of production per qtl. of Bt.cotton (G) as well as Bt.cotton (NC) in both the selected districts were found on lower side than that for non-Bt. cotton. Overall, average cost of production of cotton (kapas) per qtl. estimated for Bt. (G), Bt. (NC), total Bt. (G+NC) and non-Bt. cotton were Rs.875, Rs.971, Rs.923 and Rs.1077 respectively. Overall, the cost of production for Bt. cotton (G) and total Bt. cotton were found lower by about 19 and 14 per cent respectively. This shows that cost efficiency of Bt. cotton is higher than counterpart non-Bt. cotton. Across districts, the cost of production per qtl. for both, Bt. and non-Bt. cotton was found slightly higher in Rajkot as compared to Vadodara district. Across size groups, the cost of cultivation per hectare for both, Bt. and non-Bt. cotton was found highest for medium farmers, whereas it was lowest for small farmers (see Table 5.7.1).

Table 5.6
Average cost of production of Bt. and Non-Bt. kapas

(in Rs./Qtl.)

District	Bt.cotton			Non-Bt. cotton
	Genuine (G)	Non-confirm (NC)	Total (G + NC)	
Rajkot (R)	880 (79.78)	1016 (92.11)	939 (85.13)	1103 (100.00)
Vadodara (V)	870 (82.62)	938 (89.03)	910 (86.42)	1053 (100.00)
Overall (R + V)	875 (81.24)	971 (90.16)	923 (85.70)	1077 (100.00)

Despite higher cost of cultivation, the cost of production per qtl. for Bt. cotton was found lower. The higher yield of Bt. cotton outweight the higher cost of cultivation and it ultimately caused notable decline in the cost of production.

5.8 Average net profit per hectare for Bt. and non-Bt. cotton:

Since the introduction of Bt. cotton, the most debated issue has been its economic viability under Indian soil and climatic condition. Therefore, economic viability of Bt. cotton is studied here in terms of net profit per hectare. The average net profit per hectare is calculated by subtracting average cost of cultivation per hectare from the gross value of production per hectare. Table 5.7 presents the data on average net profit for Bt. and non-Bt. cotton in selected districts. Table 5.7.1 presents data on average net profit and output-input value ratio for Bt. (G), Bt. (NC) and non-Bt. cotton.

It is seen from the data presented in Table 5.7 that cultivation of both, Bt. and non-Bt. cotton, was found profitable for the sample households. Further, it clearly shows that average net profit realized from cultivation of approved Bt. as well as non-approved Bt. cotton was significantly higher than the non-Bt. hybrid cotton in both the selected districts.

Table 5.7.1
Farm size-wise net profit and output-input value ratios for Bt. and non-Bt. cotton

Farm size	Particulars	Bt. cotton			Non-Bt. (HB) Cotton
		G	NC	Total	
Small	Gross value of production (Rs./Ha.)	64993	52778	57952	40699
	Gross cost of cultivation (Rs./Ha.)	28267	27844	27978	25122
	Net profit (Rs./Ha.)	36726 (235.77)	24934 (160.06)	29974 (192.42)	15577 (100.00)
	Net profit over non-Bt. (Rs./Ha.)	21149	9357	14397	0
	Out-input value ratio	2.30	1.90	2.07	1.62
Medium	Gross value of production (Rs./Ha.)	76545	54748	68138	49949
	Gross cost of cultivation (Rs./Ha.)	34793	26745	31269	28167
	Net profit (Rs./Ha.)	41752 (191.68)	28003 (128.56)	36869 (169.26)	21782 (100.00)
	Net profit over non-Bt. (Rs./Ha.)	19970	6221	15087	0
	Out-input value ratio	2.20	2.05	2.18	1.77
Large	Gross value of production (Rs./Ha.)	68380	60625	63969	53345
	Gross cost of cultivation (Rs./Ha.)	29686	29347	29475	27188
	Net profit (Rs./Ha.)	38694 (147.93)	31278 (119.58)	34494 (131.87)	26157 (100.00)
	Net profit over non-Bt. (Rs./Ha.)	12537	5121	8337	0
	Out-input value ratio	2.30	2.07	2.17	1.96
Overall	Gross value of production (Rs./Ha.)	72490	57056	63942	48873
	Gross cost of cultivation (Rs./Ha.)	31815	28145	29743	26993
	Net profit (Rs./Ha.)	40675 (185.90)	28911 (132.14)	34199 (156.30)	21880 (100.00)
	Net profit over non-Bt. (Rs./Ha.)	18795	7031	12319	0
	Out-input value ratio	2.28	2.03	2.15	1.81

G = Genuine Bt. , NC = Non-approved Bt.
Note : Figures in bracket denote percentage w.r.t. non-Bt.

The overall average net profit realized per hectare from cultivation of total Bt. cotton (G+NC) was Rs.34199, whereas it was only Rs.21880 for non-Bt. hybrid cotton varieties. The corresponding figures stood at Rs.40675 for approved Bt.cotton (G) and Rs.28911 for non-confirmed Bt. cotton (NC). The net increase in profit margin for total Bt. cotton (G+NC) over non-Bt. cotton was Rs.12319/hect., which shows relative gain of over 56 per cent. The examination of data of increment benefits of Bt. cotton (G) and Bt. cotton (NC) over non-Bt. cotton across different farm sizes (Table 5.7.1) suggest inverse relationship. For Bt. cotton (G), it is decreasing with the increase in farm size.

As compared to non-Bt. cotton, the net profit per hectare for approved Bt. cotton (G) was up by Rs.18795, which is an increase of nearly 86 per cent. In both the districts, cultivation of approved Bt.cotton (G) was more profitable than non-approved Bt. cotton (NC). This clearly shows that Bt. farmers have higher level of income as compared to non-Bt. farmers.

Three factors, sharp increase in yield, better price realization of the product and lower cost of production seem responsible for sharp upsurge in the net profit from Bt.cotton cultivation.

5.9 Regression analysis and output-input value ratio:

5.9.1 Output-input value ratio for Bt. and non-Bt. cotton:

The output-input value ratio is a ratio of gross value of production to gross cost of cultivation. It indicates cost efficiency and rate of return on investment. From Table 5.7, it is evident that overall output-input value ratio for the Bt.cotton (G+NC) is 2.15 which is higher than 1.81 for non-Bt. cotton. In both the selected districts, similar trend is noticed. The examination of output-input value ratio across different farm sizes also showing similar trend (see Table 5.7.1). The higher output-input ratio

for Bt. cotton clearly suggests that it is economically more viable than non-Bt.cotton.

5.9.2 Regression analysis:

By using dummy variable, regression analysis has been attempted to estimate impact of Bt. technology on yield, profit, pesticide cost etc. and to test its statistical significance. The analysis confirms positive and significant impact of Bt. cotton on yield, value of output and net profit (see Appendix I). The impact on yield was statistically highly significant at 35.69 per cent, whereas it was found at 64.65 per cent for net profit. The analysis further indicates that pesticide cost for Bt. cotton is reduced by 16.50 per cent (see Appendix I). The impact on yield, profit and value of output is found highly significant at 1 and 5 per cent level of significance.

5.10 Perception of sample farmers on various aspects of Bt.cotton:

In order to study type and nature of problems faced by farmers and their suggestions for improving the performance of Bt.cotton, opinions and suggestions on various problems associated with Bt. cotton cultivation were collected from all Bt.cotton growing sample households. The following findings are based on perception data collected from these sample farmers.

5.10.1 Farmers' Perception on Advantages or Disadvantages of Bt.cotton vis-à-vis non-Bt. cotton: The responses received on few questions asked on advantages or disadvantages of Bt. cotton vis-à-vis non-Bt.cotton are presented in Table 5.8. The data exhibit that nearly 96 per cent farmers reported abnormally higher seed price of Bt.cotton as a strong disadvantage. Nearly 31 per cent sample farmers considered higher harvesting cost as a modest disadvantage. Majority of sample households found Bt.cotton moderately better in terms of controlling pest incidences and saving of pesticides. As per majority sample farmers, the use level of fertilisers and irrigation in Bt.cotton does not differ significantly from that for non-Bt. cotton. Almost all Bt.cotton growers reported handsome gains in yield and net profit. The yield gains and profit gains are two strong advantages of

Bt.cotton. Not a single Bt. grower faced difficulty in selling the Bt. produce. About 65 per cent farmers found quality of Bt. cotton slightly better than non-Bt. cotton. They found Bt.cotton more cleaner with better colour. Owing to better quality of kapas, Bt. growers fetched somewhat higher price for the product. All sample farmers agreed that Bt.cotton is suitable for early sowing under irrigated situation. As per 98 per cent sample farmers, cultivation of Bt.cotton impacted positively on village economy. It also generated positive impact to some extent on the income level of wage earners/village labourers.

5.10.2 Farmers' Perception on Environmental Impact of Bt.cotton: In response to a few questions on environmental impact of Bt.cotton, all the sample farmers expressed no adverse impact of Bt.cotton on other adjoining crops, insect population, farm animal health, human health and soil health. On the contrary, owing to relatively lower use of pesticides, Bt.cotton is found more health friendly than non-Bt. cotton.

5.10.3 Farmers' Perception on Technical Guidance and Assistance for Bt.cotton: Since Bt.cotton is a relatively new crop, farmers need technical guidance and assistance prior to sowing and at different stages of crop cultivation. According to majority of sample farmers, neither government extension agencies nor representative of seed companies paid visit to Bt.cotton fields. Also, they had not provided any guidance at different stages of the Bt.cotton cultivation. The fellow farmers and to some extent seed dealers provided necessary help and guidance to solve the problems.

Table 5.8
Farmers' Perception on Advantages or Disadvantages of Bt.Cotton vis-à-vis Non-Bt.Cotton

Sr.No	Particulars	% of Bt.cotton growers reporting				
		Advantages		No difference	Disadvantages	
		Strong	Somewhat		Strong	Somewhat
1	Seed availability	16.67	24.44	38.89	20.00	-
2	Seed price	-	-	4.44	40.00	55.56
3	Pest incidence	4.44	86.67	8.89	-	-
4	Pesticide seed/cost	5.56	88.89	5.56	-	-
5	Fertilizer seed/cost	1.11	12.22	80.00	5.56	1.11
6	Irrigation seed/cost	-	4.44	91.12	3.33	1.11
7	Labour cost/need	-	5.56	84.44	10.00	-
8	Harvesting cost	-	-	68.89	-	31.11
9.	Cotton quality & fibre colour	13.33	52.22	34.44	-	-
10	Cotton price	15.56	24.44	58.89	1.11	-
11	Yield	54.44	38.89	6.67	-	-
12	Profit	52.22	42.22	5.56	-	-
13	Suitability for early sowing	21.11	68.89	10.00	-	-
14	Market preferences	17.78	18.89	63.33	-	-
15	Improvement in village economy	8.88	88.89	2.22	-	-

5.10.4 Characteristics of Bt.cotton: Almost all the sample farmers reported that number of bolls per plant were observed to be higher in Bt.cotton. Bt.cotton plants showed vigorous growth. The size of bolls of Bt. and non-Bt. cotton was more or less similar. All the Bt.cotton growers reported early flowering in the range of 15 to 25 days.

The purpose of refuge or non-Bt. cotton cultivation around Bt. plots is that the bollworm resistance of Bt. plant is delayed. In the study, nearly 94 per cent Bt. growers had not planted mandate refuge crop around Bt.cotton field. The small farmers avoided the planting of refugia crop, mainly because of their small landholding. The large farmers deliberately avoided planting refugee crop due to fear of reduction in profit level. Moreover, the unapproved Bt. growers neither received any instruction regarding growing of refuge nor did they cultivate on their own.

Many Bt.cotton growers were not fully aware about the importance of refuge crop. Therefore, there is a need for sincere combine efforts from seed companies and extension agencies for convincing farmers about advantages of planting of refugee crop. The approved Bt.cotton growers find seed germination rate as most satisfactory. However, few non-confirmed Bt.cotton growers were not satisfied in respect of seed germination rate.

The perception of an average farmer on the future of Bt. cotton farming seemed to be positive. Nearly 99 per cent Bt. users were satisfied with Bt. performance and they firmly indicated that in the years to come, they will continue the cultivation of Bt.cotton. Moreover, by effecting changes in their crop pattern, they intend to increase the acreage under Bt.cotton. According to sample farmers, overall Bt.cotton has more advantages as compared to non-Bt. hybrid cotton.

5.11 Policy recommendations:

The study shows that the performance of Bt. cotton is far better compared to non-Bt. cotton. But it does not imply that Bt. cotton is fully free from problems and there is no further scope exist for improvement in the performance. The following policy recommendations emerge from the study for improving the performance level of Bt.cotton.

5.11.1 At present some Bt. growers are found using more pesticides than required. Due to fear of bollworm attack, farmers have a tendency to spray pesticides as a precautionary measure, eventhough it is not required. When pests appearance is below threshold level, pesticides spraying is not needed. Eventhough, partly due to lack of awareness and partly due to fear, farmers are spraying pesticides on cotton plant. This tendency of farmers is not only reducing the saving on pesticides but also increasing the cost of cultivation. This faulty practice of spraying unnecessary pesticides on crop needs to be corrected. Therefore, State

government extension agencies and seed companies must combine and coordinate their efforts to train, advise and educate farmers on pesticide practices to be followed in Bt. cotton. Further, they must explain farmers about when to spray and how much pesticides to spray.

5.11.2 As per sample farmers, the seed price of approved Bt. variants is very high (Rs.1650 per bag of 450 gms) and majority of poor farmers find it non-affordable. Further, like non-approved Bt.cotton, it is not available on credit and as and when needed. Therefore, owing to relatively low prices the production and usage of non-branded illegal Bt. seeds is increasing rapidly. In few cases, farmers were being fooled by traders by providing spurious Bt. seeds which in fact did not contain the Bt. gene. Therefore, to phase out the usage of illegal Bt. seeds, the best possible measure is to effect sizeable reduction in seed prices of approved Bt. cotton. Hence, government must take up this issue of seed prices with the concerned seed companies on a priority basis. Recently, under the MRTP Act, Government of Gujarat undertook necessary steps and succeeded in bringing down the seed prices of approved Bt.cotton at reasonable level in range of Rs.750-900 per bag. The other State governments must act on similar lines for effecting reduction in seed prices of approved Bt. cotton.

5.11.3 In Gujarat, majority of farmers cultivate Bt. cotton without following mandated insect refuge management strategy. Further, they have no knowledge about the importance of planting refugee crop. If farmers continue to avoid planting of refugee surrounding Bt. cotton, it is most likely that bollworm may develop resistance to Bt. gene in near future. Therefore, serious efforts are needed from seed companies and extension agencies to create awareness among farmers about the importance of planting refugee varieties.

5.11.4 In India, Bt. cotton is produced as hybrids, not as true varieties as in China and elsewhere. Therefore, farmers are required to buy seeds every year for new planting. Hence, there is an urgent need to focus more on development of true breeding varieties of Bt.cotton. This will provide much cheaper option to farmers as they can save seeds for the next sowing.

5.11.5 As Bt.cotton is a recently introduced crop, majority farmers were not fully aware about package of practices to be followed for cultivating Bt. cotton. Therefore, adequate arrangement by the seed producing companies is needed for proper dissemination of the package of practices to be followed for cultivation of Bt. cotton. With the help of proper information on practices, farmers will be able to increase the cost efficiency and net return from Bt.cotton.

5.11.6 In Gujarat, the fairly good performance and success of Bt. cotton is restricted to assured irrigation areas. However, Bt. cotton failed to perform well in rainfed areas. Majority of sample farmers reported that rainfed cultivation of Bt. cotton is not only risky but also uneconomical. Therefore, there is immediate need to intensify research for development of drought resistance Bt. variety of cotton which has favourable economic parameters for rainfed cultivation.

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CHAPTER - 6

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Introduction:

Cotton is one of the principle cash crops of India. India has the largest cotton area in the world (26% of world) but it occupies third place in production. Cotton in India is mainly suffering from low productivity which is only 315 kg.lint/hect. against the world average of 627 kg.lint/hect.

Major cotton producing States in India are Maharashtra, Gujarat, A.P., Punjab, Karnataka and M.P. In India, cotton growing farmers are facing various constraints and problems. Besides rainfed cultivation, the insects/pests attack in cotton is one of the worst problem among all crops. The main cotton pest is bollworm and largest quantity of pesticides is applied to prevent yield and quality loss of cotton, sometimes with negligible success. As per estimate, cotton uses about 54 per cent of India's total pesticides consumption. The spraying of pesticides is not only increasing the cost of cultivation, but it is also reducing the rate of return. Because of these reasons, cotton cultivation became increasingly uneconomical in India and farmers went off cotton in a big way in the 90's. But after introduction of Bt. (Bacillus Thuringiensis) cotton in the year 2002, farmers came back to cotton cultivation.

Bt.cotton was first introduced commercially in USA and Australia in 1996 as a solution for making cotton plants free from bollworm effects and thereby to reduce pesticides cost, improve yield and quality. In view of the world wide commercial success of Bt. cotton, field trials of Bt. cotton were also conducted in India. Based on the results of trials, the GEAC of India allowed commercial production and cultivation of genetically modified Bt.cotton in India in April 2002.

The results of available studies suggest uneven performance of Bt. cotton in India. Some studies on Bt. cotton indicate that Bt. cotton is effective in increasing the crop output, improving the quality and reducing the pesticides cost. Hence, it is increasing the profit margin. It is also found eco-friendly . On the other hand, a few studies indicated that Bt. cotton is not effective in controlling bollworm, not reducing pesticides cost, non-profitable and non-eco friendly. With such conflicting assertions, a clear picture about Bt. cotton is yet to emerge. Keeping this controversy in view, the Directorate of Economics and Statistics, MOA, GoI asked the Agro-Economic Research Centre, Vallabh Vidyanagar to undertake this study for Gujarat State. The main objective of this common study undertaken by several Agro Centres has been to assess the economics and other impact of Bt. cotton vs. non-Bt. cotton using field data.

6.2 Objectives of the Study:

The specific objectives of the study are:

1. To examine the advantages and disadvantages of Bt.cotton as a pest resistant variety in rainfed and irrigated conditions.

2. To make an assessment of the cost of cultivation and net return of Bt.cotton.

3. To examine difference between cost of cultivation and net returns from Bt.cotton vis-à-vis non-Bt.cotton and reasons for the same.

4. To examine other possible factors for the differential performance such as the germplasm, agro climatic differences, quality of seeds, other inputs, farmer behaviour and support systems.

5. To find out about any other impacts perceived by the farmers such as on pest population/incidence, other crops or the environment.

6. To comment on the usefulness of the technology and ways, if any, to improve its performance.

6.3. Selection of sample:

Two districts namely, Rajkot and Vadodara having different agro climatic location and having notable acreage under Bt.cotton were selected purposively. From each selected district, one tehsil and from each sample tehsil, 3 villages were selected purposively. From each selected village, 15 Bt. cotton growers (approved and unapproved Bt.). Comprising 7 small farmers, 5 medium farmers and 3 large farmers were selected at random. Bt. cotton is a hybrid variety and hence all selected non-Bt. cotton growers are hybrid cotton growers. Similar procedure was followed for selection of 15 non-Bt. hybrid cotton growers from each selected village. Thus, altogether, 180 sample farmers as per details given in Table 6.1 were selected for the study. On account of non-availability of unirrigated Bt. cotton growers, we selected all the 180 sample farmers having irrigated hybrid cotton. The reference year of the study was agricultural year 2004-05.

Table 6.1
Category-wise details of selected sample hhs.

Selected Districts (Tehsil)	Selected villages	Farm size	No. of sample hhs. Selected			
			Bt.Cotton (HB)			Non- Bt. HB Cotton
			Genuine (G)	Non-confirmed (NC)	Total Bt. (G+NC)	
Rajkot (Gondal) (R)	Charkhadi Devla Patidar	SF	10	11	21	21
		MDF	7	8	15	15
		LF	5	4	9	9
		Total	22	23	45	45
Vadodara (Karjan) (V)	Dhavat Mangrol Simli	SF	4	17	21	21
		MDF	9	6	15	15
		LF	2	7	9	9
		Total	15	30	45	45
Grand Total		Total	37	53	90	90

SF=Below 2.00 Hect. , MDF= 2.00 – 4.00 Hect. , LF = Above 4.00 Hect.
G = Genuine (approved) Bt., NC = Non-confirmed (non-approved) Bt.

6.4 Cotton scenario in Gujarat:

The total area under cotton in Gujarat in 2005-06 was about 20.8 lakh hect. which was 23 per cent of cotton area of the country. After the introduction of Bt. cotton, area under cotton moved up with a faster pace. It jumped from 16.4 lakh

hect. in 2002-03 to 20.8 lakh hect. in 2005-06. The main cotton cultivating districts are Surendranagar (23%), Bhavnagar (12%), Rajkot, Vadodara and Ahmedabad (each 10%). As regards annual output of cotton in the State, it ranged from 13.23 lakh bales (each of 170 kgs. lint) in 1990-91 to 40.27 lakh bales in 2003-04 and as per revised estimate is likely to be around 89 lakh bales in 2005-06. The compound annual growth rates worked for area, yield and production for the period 2000-01 to 2005-06 showed a very strong growth of 40, 4 and 44 per cent respectively. The single most important factor driving this strong growth is high level of adoption and enterprising leadership in Bt. cotton shown by Gujarat.

Prior to the official introduction of Bt. cotton in 2002, the enterprising farmers of Gujarat started cultivation of unauthorized Bt. cotton which was developed by local seed company. Today, the number of unapproved non-confirmed brands of Bt. cotton are easily available in every parts of the State. According to farmers, the yield and quality of non-approved Bt. cotton is near to approved Bt. cotton with lower side bias, if it is purchased from reliable sources. The farmers are opting for unapproved Bt. cotton seeds as it is available at around 40 per cent of the seed prices of approved Bt. cotton. In recent years in Gujarat, acreage put under unapproved Bt. cotton was found much higher than area under approved Bt. cotton. In Gujarat, Bt. cotton is mostly grown under assured irrigation.

6.5 About selected districts:

Vadodara district is a leading medium and long staple cotton producer. Hybrid non-Bt. and Bt. cotton are grown with irrigation. Cotton and tur are two most important crops accounting for 30 and 15 per cent of GCA respectively. Owing to adequate water availability for irrigation, farmers are continuing cotton harvesting upto 8 to 10 pickings.

In Rajkot district, groundnut and cotton are two leading crops and they occupied 47 and 22 per cent of GCA respectively. Here, water is a scare resources and hence generally farmers are continuing cotton harvesting upto 5/6 pickings. Wells and tubewells are the main sources of irrigation.

In both districts, cotton acreage under non-confirmed Bt. was substantially higher than under confirmed Bt.

6.6 Important findings emerging from the study:

The important findings emerging from the study are summarized in Tables 6.2 and 6.3. The main findings of the study are as under :

6.6.1 Overall (both districts together) average operated area per household worked to 3.45 hectares for total Bt. cotton (G+NC) growers and 3.13 hectares for non-Bt. growers. In Rajkot, it was 3.26 hect. for total Bt. growers and 3.05 hect. for non-Bt. growers. In Vadodara, it was 3.65 hect. for Bt. growers against 3.20 hect. for non-Bt. cotton growers. In both the districts, average operated area for Bt. households was found marginally higher than counterpart non-Bt. growers (see Table 6.2).

6.6.2 Overall, the share of gross irrigated area to GCA was 82.60 per cent for total Bt. cotton (G+NC) and 79.42 per cent for non-Bt. cotton (see Table 6.2).

6.6.3 The cropping intensity was low in both the districts. It was slightly lower for Bt. cotton growers as compared to non-Bt. cotton growers (see Table 6.2).

6.6.4 The average cropping pattern of the Bt. cotton growers was marginally different from that for non-Bt. cotton growers in both the districts. Cotton was the main crop accounting for 50 per cent for Bt. cotton growers and 45 per cent for non-Bt. cotton growers. In both the districts, Bt. growers allocated relatively higher acreage to cotton crop as compared to non-Bt. cotton growers (see Table 6.2).

6.6.5 Genuine Bt. cotton growers (G) used 4 varieties, namely, MECH-12, MECH-164, MECH-184 and RCH-2. Among these MECH-12 and RCH-2 were more preferable. Non-genuine (non-approved) Bt. cotton growers used a number of unbranded Bt. variants, but among these Navbharat-151 was largely used. Among non-Bt. hybrid cotton varieties, S-4, S-6, S-10 and Vikram were more popular.

6.6.6 As an integral part of the pest resistance management, planting of refuge crop surrounding Bt.cotton is mandatory. However, owing to limited land resources and not fully aware about importance of it, nearly 94 per cent Bt. growers ignored the planting of refuge crop. Non-approved Bt. growers not received any instruction from seed producers about planting of refuge crop.

6.6.7 Company depots/agents and private traders emerged as the most powerful sources for supply of approved Bt. cotton seeds. In case of non-Bt. cotton and non-approved Bt. cotton, company agents, traders and local farmers emerged as the main sources of seed supply for cotton. In quite a few cases, quality of seeds supplied by these sources was substandard.

6.6.8 Except two, all Bt. cotton growers expressed satisfaction in respect of seed germination rate.

6.6.9 Out of total 37 genuine Bt. cotton growers, only 2 reported mild bollworm infestation, whereas about 61 per cent of non-Bt. cotton growers reported moderate to light bollworm infestation. From non-confirmed Bt. cotton growers, only 20.75 per cent reported bollworm infestation. This clearly bolster the claim that Bt. technology in cotton seems highly effective at present in controlling bollworm infestation. Some farmers expressed an apprehension that due to non-planting of refugia, effectiveness of Bt. cotton in controlling bollworm infestation is bound to be weaker in the years to come as pests may develop resistance to Bt. gene.

6.6.10 Bt. cotton as well as non-Bt. cotton suffered attacks of soil pests, sucking pests, leaf curling virus etc. However, intensity of these pests appeared slightly lower in Bt. cotton. This illustrates that Bt.cotton is not so effective in controlling all the pests.

6.6.11 Bt. cotton growers as well as non-Bt. cotton growers applied slightly higher seed rate than recommended. Despite very high cost of Bt. cotton seeds, higher seed rates applied by farmers clearly reveals farmers willingness to invest in high cost new technology which has higher profitability.

6.6.12 The average seed price per kg. paid by the farmers of Bt. cotton (G), Bt. cotton (NC) and conventional non-Bt. hybrid cotton was Rs.3371, Rs.1396 and Rs.673 respectively. Thus, seed price of approved Bt. cotton (G) was more than 5 times higher than that for non-Bt. hybrid cotton (see Table 6.2).

6.6.13 The number of sprays, pesticides consumption and the expenditure incurred on pesticides by Bt. cotton growers (G+NC) was lower than for non-Bt. cotton growers in both the districts. Overall, on an average, Bt. cotton (G+NC) farmers incurred expenditure of Rs.2732/ha. on pesticides, whereas non-Bt. farmers spent Rs.3168/ha. Thus, Bt. farmers spent about 13.76 per cent less on pesticides. This shows that Bt. technology is pesticides saving but quantum of saving was far below the expectations (see Table 6.2).

6.6.14 The gross cost of cultivation (including imputed values of family labour and own machineries) of Bt. cotton (G+NC) was higher than that of non-Bt. cotton in both the districts. Overall, cost of cultivation of total Bt. cotton (G+NC) was Rs.29743/hect. which was about 10 per cent higher than Rs.26993/hect. for non-Bt. cotton. However, for Bt.cotton (G) it was Rs.31815/hect. which was about 18 per cent higher than Rs.26993/hect. for non-Bt. cotton. For Bt. as well as non-Bt. cotton, it was found much higher in Rajkot district as compared to Vadodara district (see Table 6.2). The above results clearly show that cultivation of Bt. cotton is cost intensive.

6.6.15 In total cost of cultivation, the share of seed cost of Bt.cotton (G+NC) was about 10.35 per cent as against only 4.90 per cent for non-Bt. cotton. The picking operations account for largest share in Bt. cotton (21.55%), but it does not vary much from its share in non-Bt. cotton (19.33%). The share of other inputs did not differ significantly.

6.6.16 As compared to non-Bt., amount spent by Bt. growers on picking operation was 23 per cent higher. It was more or less similar for items like irrigation, fertilisers and FYM.

6.6.17 In both the selected districts, the Bt. yields are higher across different farm sizes. For both districts together, yield of total Bt. (G+NC) was 32.20 qtls./ha.; which was 28.44 per cent higher than 25.07 qtls./ha. for non-Bt. cotton. Overall average yield of Bt.(G) was 36.34 qtls./ha. showing an increase of about 45 per cent over non-Bt. In both the districts, for all farm categories, yield of approved Bt. cotton were found higher than non-approved Bt.cotton (see Table 6.3). This suggests the yield superiority of approved Bt.cotton over non-confirmed Bt.cotton varieties.

6.6.18 Overall, the cost of production per quintal for Bt.(G), Bt.(NC), total Bt.(G+NC) and non-Bt. cotton were Rs.875, Rs.971, Rs.923 and Rs.1077 respectively (see Table 6.3). Thus, cost of production of total Bt.cotton was lower by Rs.154/qtl. (14.24%). This shows that Bt.cotton is more cost effective.

6.6.19 On account of good acceptance of the product, the Bt. farmers have not faced any problems in selling the product. On the contrary, owing to marginal quality edge, Bt. growers realized slightly better price of the product. Overall, average price realized per quintal for Bt. cotton was Rs1986 as against Rs.1949 for non-Bt. cotton (see Table 6.3).

6.20 The cultivation of Bt. and non-Bt. cotton turned out profitable. Overall, the net profit per hectare for Bt. cotton (G), total Bt.cotton (G+NC) and non-Bt. cotton was Rs.40675, Rs.34199 and Rs.21880 respectively (see Table 6.3). Thus, Bt. cotton (G+NC) registered an increase of 56 per cent in net profit over non-Bt. cotton.

6.6.21 The main economic benefit of Bt.cotton stems from gains on revenue side as a result of increase in yields. The revenue gains for total Bt. (G+NC) cotton over non-Bt. cotton. was about 31 per cent (see Table 6.3).

6.6.22 The output-input value ratios were 2.28 for Bt.cotton (G), 2.03 for Bt.cotton (NC), 2.15 for total Bt.cotton and 1.81 for non-Bt. cotton. The high output-input ratio clearly establish superiority of Bt.cotton over non-Bt. cotton in respect of yields, revenues and net profit (see Table 6.3).

6.6.23 Perception of sample farmers :

i) Nearly 96 per cent farmers reported abnormally higher seed price of Bt. cotton as a strong disadvantage.

ii) Majority Bt. growers found Bt. cotton most effective in controlling bollworm infestation and saving of pesticides. However, it is not so effective in controlling soil pests, sucking pests and leaf roller pests. The use level of fertilisers and irrigation for Bt. cotton does not differ significantly from non-Bt. cotton.

iii) Almost all the Bt. cotton growers reported handsome gains in yield and net profit. No one faced any difficulty in selling the Bt. produce. Nearly 65 per cent farmers found quality of Bt. cotton slightly better than non-Bt. cotton.

iv) All the sample farmers expressed no adverse impact of Bt. cotton on soil health and other environmental aspects. Reduction in use of pesticides led to reduction in harmful effect on soil, water and human health/life.

v) Nearly 94 per cent Bt. growers had not planted mandate refuge crop around Bt. plots. Some farmers avoided it deliberately and some farmers were not fully aware about the importance of refuge crop.

6.6.24 The regression analysis also confirms high economic advantage of Bt. cotton (see Appendix I). The analysis showed positive impact of Bt. cotton on yield value of output, and profitability as compared to non-Bt. HB cotton. The impact on yield found at 35.69 per cent and on net profit at 64.65 per cent (see Appendix I). The impact on yield and net profit is found statistically highly significant at 1 and 5 per cent significance level.

6.7 Policy recommendations:

The study shows that the performance of Bt. cotton is far better compared to non-Bt. cotton. But it does not imply that Bt. cotton is fully free from problems and no further scope exist for improvement in its performance. The following are the policy recommendations emerging from the study for raising the performance level of Bt.cotton.

6.7.1 At present some Bt. growers are found using more pesticides than required. Due to fear of bollworm attack, farmers have a tendency to spray pesticides as a precautionary measure, eventhough it is not required. When pests appearance is below threshold level, pesticides spraying is not needed. Eventhough, partly due to lack of awareness and partly due to fear, farmers are spraying pesticides on cotton plant. This tendency of farmers is not only reducing the saving on pesticides but is also increasing the cost of cultivation of Bt.cotton. This faulty practice of spraying unnecessary pesticides on crop needs to be corrected. Therefore, State government extension agencies and seed companies must combine and coordinate their efforts to train, advise and educate farmers on pesticides practice to be followed in Bt. cotton. Further, they must explain farmers about when to spray and how much pesticides to spray.

6.7.2 As per sample farmers, the seed price of approved Bt. variants is very much high (Rs.1650 per bag of 450 gms) and majority of poor farmers find it non-affordable. Further, like non-approved Bt.cotton, it is not available on credit and as and when needed. Therefore, owing to relatively low prices the production and use of non-branded illegal Bt. seeds is increasing rapidly among farmers. In a few cases, farmers were cheated by traders by providing spurious seeds under Bt. label which in fact did not contain the Bt. gene. Therefore, to phase out the use of illegal Bt. seeds, the best possible measure is to effect sizeable reduction in seed prices of approved Bt. cotton. Hence, government must take up this issue of seed prices with the concerned seed companies on a priority basis. Recently, under the MRTP Act, Government of Gujarat undertook necessary steps and succeeded in bringing down the seed prices of approved Bt.cotton at reasonable level of Rs.750 per bag. The other State governments must act on similar lines for effecting reduction in seed prices of approved Bt. cotton.

6.7.3 In Gujarat, majority farmers are cultivating Bt. cotton without following mandated insect refuge management strategy. Further, they are not knowing about the importance of planting refugee crop. If farmers continue to avoid planting of refugee surrounding Bt. cotton, it is most likely that bollworm may develop resistance to Bt. gene in near future. Therefore, serious efforts are needed from seed companies and extension agencies to create awareness among farmers about the importance of planting refugee varieties.

6.7.4 In India, Bt. cotton is produced as hybrids, not as true varieties as in China and elsewhere. Therefore, farmers are required to buy seeds every year for new planting. Hence, there is an urgent need to focus more on development of true breeding varieties of Bt.cotton. This will provide much cheaper option to farmers as they can save seeds for the next sowing.

6.7.5 As Bt.cotton is a recently introduced crop, majority of farmers were not fully aware about package of practices to be followed for cultivating Bt. cotton. Therefore, adequate arrangement by the seed producing companies/pvt. Traders/govt. agencies need to take up information dissemination of the package of practices to be followed for cultivation of Bt. cotton more firmly. The farmers with their own understanding or halt backed information received from the peers and traders could lead to catastrophes. Moreover, with the help of proper information on practices, farmers will be able to increase the cost efficiency and net return from Bt.cotton.

6.7.6 Fairly good performance and success of Bt. cotton in Gujarat is restricted to assured irrigation areas. However, Bt. cotton failed to perform well in rainfed areas. Majority of sample farmers reported that rainfed cultivation of Bt. cotton is not only risky but also uneconomical. Therefore, there is an immediate need to intensify research for development of drought resistance Bt. variety of cotton having favourable economic parameters for rainfed cultivation.

6.7.7 Govt. of India has recommended a state and district level committee comprising administrators and agricultural scientists to monitor the cultivation of Genetically Modified (GM) crops. The issues such as refuge, pest attacks, pesticides practices etc. need to be monitored carefully. At present, these committees are not at work in Gujarat.

6.8 Conclusions:

Recent data on area and production of cotton clearly illustrate that there has been a cotton revolution in Gujarat. The production of cotton in Gujarat jumped from 11.6 lakh bales in 2001-01 to 89.0 lakh bales in 2005-06. The single most important factor driving this production growth is adoption of Bt.cotton on a very large scale. Whatever the experience of Bt. cotton in other States of India, it seems that it has given a new lease of life to cotton farming in Gujarat. Sharp shoot up in cotton area after official introduction of commercial cultivation of Bt.cotton in 2002 clearly shows farmers' satisfaction with Bt. technology in cotton.

The study has illustrated that Bt. cotton is yielding better results only under irrigated farming. The seed price of genuine Bt.cotton (G) is found abnormally high and non-affordable to small and economically poor farmers. Moreover, it is not available on credit. This led to large scale production and use of low cost non-confirmed (NC) seeds of Bt.cotton in the State. In fact, acreage put under non-confirmed Bt.cotton (NC) was found much higher than that for approved Bt.cotton.

The study illustrated that Bt.cotton is capable to provide strong resistance to bollworm. However, it is not found so effective in preventing infestation by sucking pests, soil pests and other pests. As a result, the saving in pesticides cost was around 14 per cent only which was far below the level of expectations. Overall across different farm sizes, Bt. yields were found much higher. On an average, yield of Bt. cotton (G) was 36.34 qtls. /ha. showing an increase of about 45 per cent over non-Bt. cotton. Also, approved Bt.cotton (G) proved its yield superiority over non-approved Bt.cotton (NC). The cost of cultivation of Bt.cotton (G) was found about 18 per cent higher than non-Bt. cotton. The yield gains of Bt.cotton overcompensate the increases in cost of cultivation and as a result, per unit cost of production of Bt.cotton turned lower compared to non-Bt. hybrid cotton. On account of marginal quality edge and good market acceptance of the product, Bt. kapas realized slightly higher price of the output. The yield gains, higher price realization and lower cost of production helped Bt. farmers in boosting their revenues. The revenues for Bt.cotton (G) vs. non-Bt.cotton surged up by about 48 per cent.

The cotton cultivation of both Bt.cotton and non-Bt. cotton has proved profitable. Overall, the net profit per hectare for Bt.cotton (G+NC) was Rs.34199 showing an increase of 56 per cent over Rs.21880 for non-Bt. cotton. This illustrates that Bt.cotton is capable of generating upsurge in profitability. The high output-input

value ratio for Bt.cotton (G+NC) also suggests superiority of Bt.cotton over non-Bt.cotton in respect of generating profitability. Not a single sample farmer noticed any adverse impact of Bt. technology on adjoining crops, environment and human/animal health. On the contrary, they found it health friendly.

The study clearly suggests that Bt.cotton has sizeable economic and agronomic benefits over non-Bt.cotton. This explains the recent robust growth and success of Bt.cotton in Gujarat.

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ANNEXURE - I

Comments offered by Project Co-ordinator Prof. Vasant Gandhi, CMA, IIM, Ahmedabad :

We appreciate the report and the efforts put in by the researchers. The report provides good coverage and insight towards the objectives of the research. We are indicating below a few gaps/deficiencies that can be addressed to improve the report :

1. The most important missing component in the report is the analysis of the qualitative data/information (from the questions on the perceptions of the farmers on Bt Technology). These responses are very important and should be analyzed and provided in the report. We have obtained this from every state covered.

2. In Table 1.3, the growth rates in Area, Production and Yield during 1981-1991 and 1991-2001 may be checked. There appears to be some discrepancies.

3. The area under Bt cotton (approved) reported in Table on page 11 (having no table number) and on Table 3.4 in page 30. This may please be checked.

4. The source of data for Table 3.6 may be given.

5. In Table 4.6, the source of purchase of seeds by Bt cotton farmers from “Fellow Farmers” needs some explanation. Please provide this.

6. In Table 5.2, total cost of pesticides under Bt (NC) in Rajkot is higher than non-Bt by 12.77 per cent while the average number of spray and the quantity of pesticides used under Bt (NC) is lower than the non-Bt cotton. This may be checked/explained.

7. It would be very useful to have Table 5.7.1 by farm size as well. This would explain the scale neutrality of the Bt Technology.

ANNEXURE - II

Action and clarification on comments on study report :

The following are clarifications/actions :

1. The analysis of the perceptions data is already attempted in topic number 5.10 (5.10.1 to 5.10.4 and Table 5.8) of Chapter 5.

2. Table 1.3 checked and corrected.

3. The data given on page 11 shows net increase in area under Bt. cotton (approved) over previous year, whereas data in Table 3.4 show actual area under approved Bt. cotton. Hence, they are not directly comparable. Moreover, both data have different source and data in Table 3.4 are provisional.

4. Source of data for Table 3.6 is already mentioned.

5. Explanation given.

6. Necessary explanation added.

7. As per suggestion, farm size-wise Table 5.7.1 has been added and discussed.

Appendix - I

Regression Analysis - Impact of Bt. cotton

(Total Observations N = 180)

Dependent variable	Description	Independent variable		Impact of Bt. in %
		Constant	Bt.	
Pesticide cost	Coeff.	3042	-502	-16.50
	't' value	14.89	-2.11	
	Significance	51	55	
Seed cost	Coeff.	1339	17.20	128.45
	't' value	13.30	11.79	
	Significance	51	61	
Total cost of cultivation	Coeff.	25982	3493	13.44
	't' value	38.16	3.57	
	Significance	51	51	
Yield	Coeff.	2332	832	35.69
	't' value	28.19	7.10	
	Significance	51	51	
Value production	Coeff.	44867	17189	38.31
	't' value	25.27	7.19	
	Significance	51	51	
Profit	Coeff.	19605	12680	64.65
	't' value	16.33	7.72	
	Significance	51	51	

S_1 = Significant at 1% level.

S_5 = Significant at 5% level.

NS = Non-significant at 1 and 5% level