

## Bt Cotton in Tamil Nadu : An Evaluation of Farmers' Experiences

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### ABSTRACT

*Bt cotton is an attractive alternative technology to protect cotton from bollworms and to make cotton farming more sustainable, economical and eco-friendly. It reduces the use of pesticides resulting in reducing the cost of cultivation. It results in improvement of yield levels and also improves margin of profit to the farmers. It provides opportunities to grow cotton in areas of severe bollworm incidence and promotes eco-friendly cultivation of cotton. Even though the technology crowns the credits of various benefits, it's end users have certain concerns about it's bio-safety, ethical, social, health, economic and environmental implications. These concerns stress the need of regulating the procedures to sustain the technology. The attitude of the people, their awareness about the technology and their adoption behaviour play a major role in sustaining any technology. Keeping this in mind, an empirical study was conducted among 120 randomly selected Bt cotton growers at Coimbatore and Perambalur Districts of Tamil Nadu to evaluate the experiences they had in Bt cotton cultivation. Majority of the growers had favourable attitude towards cultivation of Bt cotton and would like to grow Bt cotton in future too. Their primary sources of information about Bt cotton were the local input dealers. Majority of them had not adopted the refugee technology prescribed by the Government of India to avoid the development of resistance by bollworms to Bt cotton. They perceived that major social, economic, environmental, ethical and bio-safety implications would occur in near future due to intensive cultivation of Bt cotton.*

**Key words:** *Bt cotton; Attitude; Awareness knowledge; Adoption behaviour;*

Biotechnology is currently a hot topic in both academic and political circles for its implications on food security, economic growth and income distribution, human health, the environment, and agricultural trade. Genetic modification techniques are at the center of this focus and have spurred worldwide debate on bio-safety issues (Zhong *et al.*, 2002). Commercial release of nation's first transgenic crop "Bt cotton" in 2002 marks the beginning of transgenic era in India. The technology has numerous benefits accrue to the grower, the global cotton, industry and society on many levels viz., economic, environmental and social (Ismael *et al* (2002), James (2002), Pray *et al* (2002) and Purcell *et al* (2004)). However, based on recent trends, it is expected that there will be resistance against Bt cotton and other biotech crops by farming community and other stakeholders in near future. This resistance is due to the belief on negative implications of the technology

despite it has been proved of its safety through bio-safety experiments beyond doubt. These objections and concerns prophesize that there will be resistance against GE crops in general and Bt cotton in particular in near future. The attitude of the people, their awareness and knowledge level about the technology and their adoption behaviour play a major role in sustaining the technology (Yang *et al.*, 2005). Keeping this in mind, an empirical study was conducted to evaluate the experiences of Bt cotton growers at farm level and the various implications perceived by them about cultivation of Bt cotton.

### METHODOLOGY

For this study, *expost facto* research design was used. A multistage random sampling was followed to select the districts, blocks, villages and farmers under both irrigated and rainfed conditions of cotton. To select the districts, secondary data pertaining to the Bt cotton

cultivated districts both in irrigated and rainfed conditions were perused. Among the 16 Bt cotton growing districts in Tamil Nadu, Coimbatore and Perambalur districts were selected at random for irrigated and rainfed Bt cotton growing conditions. Taking into consideration the need for adequacy of representation of the universe, time availability and data requirement, it was decided to select two blocks at random from the selected districts. Out of the 19 blocks in Coimbatore district, the block having substantial number of irrigated Bt cotton growers namely Annur block of Avinasi taluk was selected randomly. With respect to Perambalur district, out of the ten blocks, the block having substantial number of rainfed Bt cotton growers namely Vepur of Kunnam taluk was selected randomly. In each block, six villages were selected randomly and in each village ten Bt cotton growers were selected randomly. Thus 120 Bt cotton growers from both the conditions were selected as respondents for the study. The data were collected personally by pre-tested schedule. Keeping in view the objectives and hypotheses of the study, for meaningful

interpretation the the statistical methods viz., Per centage analysis, Cumulative frequency, Independent “t” test, Simple correlation analysis and Multiple regression analysis were used based on the nature of data and the relevancy of the tool.

### RESULTS AND DISCUSSION

*Socio-economic background of Bt cotton growers:* Of the farmers interviewed for the study, 50 per cent were irrigated farmers and 50 per cent were rainfed farmers (Table 1). The respondents in both the conditions were old aged, had primary level of education and had farming as their sole occupation. The Bt cotton growers were generally found with 2.51 to 5 acres of land. In their total land, 25.00 to 50.00 per cent was allotted to cultivation of cotton and one to two acres to cultivation of Bt cotton. Almost all of them had more than 10 years of farming experience, 5 – 10 years of experience in cotton cultivation and two to three years of experience in Bt cotton cultivation. The Bt cotton growers in irrigated condition were found with Rs.

**Table 1: Profile characteristics of the Bt cotton growers in Tamil Nadu under irrigated and rainfed conditions (N=120)**

Profile characteristics	Total	Irrigated Condition	Rainfed Condition	Differences+	“t” value
Age	Old	Old	Old	-	-
Educational status	Primary level	Middle	Primary level	1.3833	4.874**
Occupational status	Farming	Farming	Farming	0.0500	-0.334 <sup>NS</sup>
Farm size	2.51-5.0 acres	>10 acres	Up to 2.5 acres	1.5833	11.277**
Area under cultivation of cotton	25.01 – 50.00%	25.01 – 50.00%	25.01 – 50.00%	0.9500	-6.403**
Area under cultivation of Bt cotton	One acre	One acre	One acre	0.3667	1.811 <sup>NS</sup>
Farming experience	>10 years	>10 years	>10 years	0.0500	-1.036 <sup>NS</sup>
Experience in cultivation of cotton	5-10 years	High	Medium	1.3667	1.568 <sup>NS</sup>
Experience in cultivation of Bt cotton	2-3 years	Medium +High*	High	1.0667	9.225**
Annual income	Medium	High	Medium	38.2167	10.838**
Contact with extension agency	High	High	High	3.7167	8.591**
Mass media exposure	High	High	High	6.7500	16.689**
Training undergone	Low	Medium + high*	Low	0.8500	6.427**
Economic motivation	High	High	High	7.8000	8.243**
Risk orientation	High	High	Medium	7.1667	7.936**
Progressiveness	High	High	High	3.8833	26.042**
Pest management behaviour	High	High	Medium	3.4167	7.461**
Credit orientation	High	High	High	0.7333	3.908**
Innovativeness	Moderate	High	Moderate	0.9667	10.780**
Marketing behaviour	Less favourable	Highly favourable	Less favourable	10.9667	14.799**

\*\* Significant at 0.01 level of probability, NS = Non significant

+ Differences Between Mean values of Irrigated Condition and Rainfed Condition

15,000 to 20,000 income per annum and Bt cotton growers in rainfed condition were with Rs.40, 000 to 60,000 income per annum. They had good contact with extension agency and had high economic motivation. They had good exposure to mass media and had only less number of training programmes. They were risk takers, progressive farmers and innovators. They had better pest management behaviour and credit orientation. A comparison between the two categories of respondents revealed that the educational status, farm size, area under cultivation of cotton, annual income, contact with extension agency, mass media exposure,

**Table 2. Distribution of respondents according to their attitude towards cultivation of Bt cotton under irrigated and rain fed conditions (N=120)**

Category	Irrigated Condition (n=60)		Rainfed Condition (n=60)		Total (N=120)	
	No.	%	No.	%	No.	%
Less favourable	12	20.00	20	33.33	32	26.67
Moderately favourable	20	33.33	18	30.00	38	31.67
Highly favourable	28	46.67	22	36.67	50	41.66
Total	60	100.00	60	100.00	120	100.0
Mean	27.2333		22.2833			
Differences between means			4.9500			
't' value			9.790**			

\*\* - Significant at 0.01 level of probability

**Table 3: Distribution of respondents according to awareness knowledge of Bt cotton practices under irrigated and rainfed conditions**

Category	Irrigated Condition (n=60)		Rainfed Condition (n=60)		Total (N=120)	
	No.	%	No.	%	No.	%
Low	16	26.67	17	28.33	33	27.50
Medium	12	20.00	22	36.67	34	28.33
High	32	53.33	21	35.00	53	44.17
Total	60	100.00	60	100.00	120	100.00
Mean	46.4833		34.0667			
Differences between means			12.4167			
't' value			13.86**			

\*\* - Significant at 0.01 level of probability

economic motivation, risk orientation, progressiveness, pest management behaviour, credit orientation, innovativeness and marketing behaviour were significantly higher than rainfed farmers. Further it was found that majority of the respondents in both the categories were found with high and medium levels of economic motivation, risk orientation, progressiveness and innovativeness. These are psychological characteristics which were the main driving factors for them to cultivate the novel technology Bt cotton in their fields.

*Attitude towards cultivation of Bt cotton:* Table 2 reveals that nearly half (41.66%) of the respondents had highly favorable and 31.67 per cent had moderately favourable attitude towards cultivation of Bt cotton. They strongly agreed that cultivation of Bt cotton is a solution for sustainable cotton farming and is compatible with the current farming system. They believed that the Bt toxin in Bt cotton will not affect the soil, underground water and environment in long run. They hoped that Bt cotton increases the opportunities to grow cotton in areas of severe pest infestation and will help the cotton grower, environment and the ultimate consumer in a big way. Their contact with extension agency, exposure to mass media, economic motivation, risk orientation and progressiveness had resulted in their favourable attitude towards cultivation of Bt cotton. This finding is consistent with previous observations in Taiwan and with the study conducted at China by *Zhong et al., 2002* and may pave way to researchers to develop new Bt strains, to the extension personnel to bring out strategies to popularize the Bt cotton hybrids and to the policy makers to develop policy measures for further GE crops.

*Awareness and knowledge about cultivation of Bt cotton :* From the Table 3, it is seen that more than half (53.33%) of the Bt cotton growers under irrigated condition had high level of awareness knowledge about cultivation aspects of Bt cotton, followed by 26.67 per cent with low level and the remaining 20.00 per cent with medium level. With respect to rainfed farmers, more than one third (36.67%) of them were found with medium level of awareness knowledge, followed by 35.00 per cent with high and the rest 28.88 per cent with low levels. In total majority (44.17%) of the respondents had high level of awareness knowledge about the cultivation aspects of Bt cotton. Since, the 't' value was highly significant, it is concluded that with

respect to awareness knowledge of cotton growers about cultivation aspects of Bt cotton, there is significant difference between irrigated and rainfed farmers.

*Farm level adoption behaviour of Bt cotton growers:* Adoption behaviour referred to the extent of adoption of selected improved cultivation practices recommended for Bt cotton, by the Bt cotton growers either as specified or with modifications. A total of 50 items were selected for evaluating the adoption behaviour of Bt cotton growers. For Full or modified adoption of a recommended practice, score one was given and for non-adoption of a recommended practice no score was given. Then, the Adoption Index (AI) was calculated. The distribution of respondents under irrigated and rainfed conditions according to their adoption behaviour of Bt cotton practices is furnished in Table 4. In total, majority (52.50%) of the respondents were found with high level of technology use behaviour. Majority (60.00%) of the irrigated farmers and 70.00 per cent of the rainfed farmers had not adopted the technology of planting refuge crop (five rows (per acre) of non-Bt cotton seeds surrounding the Bt cotton plot) as specified by the Genetic Engineering Advisory Committee (GEAC) to manage pest from developing resistance to Bt toxin. Remaining 40.00 per cent among irrigated farmers and 30.00 per cent among rainfed growers had adopted the technology with modifications of their own. Instead of planting around the Bt cotton plot, they mixed the Bt cotton and non Bt cotton seeds and sown in their fields. Majority of the non-adopters and modified adopters of this technology stated that the troublesome

**Table 4 Distribution of respondents according to adoption behaviour of Bt cotton cultivation practices under irrigated and rainfed conditions**

Category	Irrigated Condition (n=60)		Rainfed Condition (n=60)		Total (N=120)	
	No.	%	No.	%	No.	%
Low	20	33.33	18	30.00	38	31.67
Medium	-	-	19	31.67	19	15.83
High	40	66.67	23	38.33	63	52.50
Total	60	100.00	60	100.00	120	100.00
Mean	39.4333		24.4833			
Differences between means 't' value			14.9500 26.441**			

\*\* - Significant at 0.01 level of probability

work of spraying separately for non-Bt cotton and the fear of spread of pests from non-Bt cotton to Bt cotton were the major reasons for non-adoption of the technology. Added to this, they stated that due to the non-adoption of this technology as specified, they faced shortage of seed per acre but somehow they could manage to get the seeds from input dealers in small quantity too. Further they stated that the dealers used to sell the seeds in small quantity for gap filling and nobody was certain about the nature of seeds i.e., whether it was Bt cotton or not. The Central Institute for Cotton Research, Nagpur had developed a kit to test the presence of Cry 1Ac protein in seeds and leaves of cotton. None of the respondents was aware of this particular technical information in the study area.

*Socio-economic, bio-safety, environmental and ethical implications of adoption of Bt cotton as Perceived by Bt cotton adopters :* From the Table 5, it is evident that, more than half of the irrigated Bt cotton growers perceived that the socio economic implications of Bt cotton in future would be widening the gap between those who can afford the technology and those who cannot (58.00%), development of institutional contact (90.00%), dependence on multinational companies for seeds (86.50%), adverse effect on conventional seed companies (66.0%) and increase of healthy competition between cotton growers (60.00%). With regard to psychological implications, revival of interest towards cultivation of cotton in pest endemic area (85.00%), reduced tension (84.00%), reduction in pesticide poisoning (85.00%), revival of interest towards cultivation of cotton in non traditional area (77.50%) and freed from death wish (suicide) due to indebtedness (80.00%) were the implications opined by them. Less than half of them perceived that the implications viz., possibility of minor pest becoming major, inadequacy of Bt toxin in all parts of the plant, development of resistance to Bt toxin, time frame of Bt toxin and movement of Bt toxin to closely related crops would occur in near future due to intensive cultivation of Bt cotton. With regard to environmental implications, more than 90.00 per cent of Bt cotton growers in both irrigated and rainfed conditions perceived that reduced risks for farm workers, reduced risk for beneficial insects and wild lives, reduced runoff of broad spectrum pesticides, reduced air pollution and water pollution and leaving a better environment for future generation would be the

possible implications of Bt cotton cultivation. As far as ethical implications of cultivation of Bt cotton are concerned, majority of the irrigated farmers perceived that illegal sale of banned/unapproved products/F1/F2 seeds (98.50%), ownership of technologies by few private companies (98.50%), availability of more numbers of Bt cotton hybrids and little information to enable the layperson to make decisions (92.50%), conventional cotton varieties / hybrids will vanish in long run (92.00%) and robbing the rights of farmers to save seeds for future use (92.00%) would be the major ethical

implications due to the introduction of Bt cotton in the subsequent years.

*Relationship of profile characteristics with attitude, awareness, knowledge and adoption behaviour of Bt cotton growers* : The relationship of profile characteristics with attitude, knowledge and adoption behaviour of Bt cotton growers was given in Table 6. With respect to the relationship between the attitude and profile characteristics of the irrigated farmers, the characteristics viz., area under cultivation of Bt cotton, occupational status, progressiveness, pest management

**Table 5: Distribution of respondents according to their perception on socio-economic, bio-safety, environmental and ethical implications of adoption of Bt cotton under irrigated and rainfed conditions**

Perceived Issues	Response	
	Irrigated (n=60) %	Rainfed (n=60) %
<i>Perceived Socio-economic Implications</i>		
Widening the gap between those who can afford the technology and those who cannot	43.00	73.00
Development of institutional contact	100.00	90.00
Dependence on multinational companies for seeds	83.00	90.00
Adverse effects on other seed and pesticides companies	40.00	92.00
Increase of healthy competition between cotton growers	43.00	93.00
<i>Perceived Psychological Implications</i>		
Revival of interest towards cultivation of cotton in non traditional area	63.00	92.00
Revival of interest towards cultivation of cotton in pest endemic area	70.00	100
Freed from death wish (suicide) due to indebtedness	60.00	100
Reduced tension in life regarding pest attack	70.00	98.00
Reduction in pesticide poisoning	70.00	100.00
<i>Perceived Bio-Safety Implications</i>		
Development of resistance to Bt toxin in long run	48.00	48.00
Inadequacy of Bt toxin in all parts of the plant	43.00	45.00
Time frame of Bt toxin	40.00	47.00
Movement of Bt toxin to closely related crops	40.00	45.00
Possibility of minor pest becoming major	47.00	47.00
<i>Perceived Environmental Implications</i>		
Reduced risks for farm workers	93.00	98.00
Reduced risk for beneficial insects and wild lives	97.00	98.00
Reduced runoff of broad spectrum pesticides	100	97.00
Reduced air pollution and water pollution	100	97.00
Leaving a better environment for future generation	100	97.00
<i>Perceived Ethical Implications</i>		
Ownership of technologies by few private companies	100	97.00
Illegal sale of banned / unapproved products/ F1/F2 seeds	10.00	97.00
Availability of more numbers of Bt cotton hybrids and little information to enable the layperson to make decisions	90.00	95.00
Conventional cotton varieties will vanish in long run	87.00	97.00
Robbing the rights of farmers to save seeds for future use	87.00	97.00

behaviour and perception on attributes of Bt cotton had positive and significant association with the dependent variable “Attitude”. In the case of rainfed farmers, the characteristics viz., innovativeness, marketing behaviour, perception on biological performance of Bt cotton and perception on attributes of Bt cotton had positive and significant relationship with attitude. The characteristics of the irrigated farmers viz., the experience in cultivation of cotton, contact with extension agency, progressiveness, area under cultivation of cotton, economic motivation, marketing behaviour, perception on biological performance of Bt cotton and perception on attributes of Bt cotton had positive and significant association with knowledge. Under rainfed condition the characteristics viz., educational status, credit orientation, innovativeness and perception on biological

performance of Bt cotton and perception on attributes of Bt cotton had positive and significant association with knowledge level where as educational status, credit orientation and perception on biological performance of Bt cotton had positive and significant relationship with knowledge. With regard to the relationship between profile and adoption, area under cultivation of cotton, experience in cultivation of cotton, occupational status, contact with extension agency, progressiveness, perception on biological performance of Bt cotton and perception on attributes and marketing behaviour had positive and significant association with adoption behaviour. Under rainfed condition the characteristics, perception on biological performance of Bt cotton and perception on attributes of Bt cotton had positive and significant association with adoption behaviour.

**Table 6. Correlation analysis of profile characteristics with respect to attitude, knowledge and adoption behaviour of Bt cotton growers towards cultivation of Bt cotton under irrigated and rainfed conditions.**

Variables	Attitude		Knowledge		Adoption	
	Irrigated condition 'r' value (n=60)	Rainfed condition 'r' value (n=60)	Irrigated condition 'r' value (n=60)	Rainfed condition 'r' value (n=60)	Irrigated condition 'r' value (n=60)	Rainfed condition 'r' value (n=60)
Age	-0.124 <sup>NS</sup>	0.017 <sup>NS</sup>	0.231 <sup>NS</sup>	-0.268*	0.224 <sup>NS</sup>	-0.145 <sup>NS</sup>
Educational status	0.252 <sup>NS</sup>	0.212 <sup>NS</sup>	0.122 <sup>NS</sup>	0.281*	0.122 <sup>NS</sup>	0.118 <sup>NS</sup>
Occupational status	0.198 <sup>NS</sup>	0.248 <sup>NS</sup>	-0.144 <sup>NS</sup>	-0.149 <sup>NS</sup>	0.284*	-0.077 <sup>NS</sup>
Farm size	0.039 <sup>NS</sup>	-0.354**	0.020 <sup>NS</sup>	-0.023 <sup>NS</sup>	0.068 <sup>NS</sup>	-0.06 <sup>NS</sup>
Area under cultivation of cotton	-0.089 <sup>NS</sup>	-0.011 <sup>NS</sup>	-0.151 <sup>NS</sup>	-0.117 <sup>NS</sup>	-0.003 <sup>NS</sup>	-0.106 <sup>NS</sup>
Area under cultivation of Bt cotton	0.305*	-0.115 <sup>NS</sup>	0.279*	-0.154 <sup>NS</sup>	0.602**	0.045 <sup>NS</sup>
Farming experience	-0.228 <sup>NS</sup>	0.020 <sup>NS</sup>	0.233 <sup>NS</sup>	0.071 <sup>NS</sup>	0.014 <sup>NS</sup>	0.116 <sup>NS</sup>
Experience in cultivation of cotton	0.021 <sup>NS</sup>	0.158 <sup>NS</sup>	0.342**	-0.235 <sup>NS</sup>	0.434**	0.142 <sup>NS</sup>
Experience in cultivation of Bt cotton	0.197 <sup>NS</sup>	0.066 <sup>NS</sup>	0.167 <sup>NS</sup>	0.093 <sup>NS</sup>	0.232 <sup>NS</sup>	0.127 <sup>NS</sup>
Annual income	0.136 <sup>NS</sup>	-0.0147 <sup>NS</sup>	0.159 <sup>NS</sup>	0.213 <sup>NS</sup>	0.177 <sup>NS</sup>	0.252 <sup>NS</sup>
Contact with extension agency	0.211 <sup>NS</sup>	0.202 <sup>NS</sup>	0.396**	-0.140 <sup>NS</sup>	0.346**	-0.172 <sup>NS</sup>
Mass media exposure	0.252 <sup>NS</sup>	-0.068 <sup>NS</sup>	0.217 <sup>NS</sup>	-0.032 <sup>NS</sup>	0.001 <sup>NS</sup>	-0.064 <sup>NS</sup>
Training undergone	0.015 <sup>NS</sup>	-0.051 <sup>NS</sup>	-0.047 <sup>NS</sup>	-0.314*	-0.313*	-0.054 <sup>NS</sup>
Economic motivation	0.124 <sup>NS</sup>	0.048 <sup>NS</sup>	0.260*	0.138 <sup>NS</sup>	0.047 <sup>NS</sup>	-0.315*
Risk orientation	0.088 <sup>NS</sup>	-0.076 <sup>NS</sup>	0.046 <sup>NS</sup>	0.154 <sup>NS</sup>	0.036 <sup>NS</sup>	0.037 <sup>NS</sup>
Progressiveness	0.422**	0.131 <sup>NS</sup>	0.481**	-0.005 <sup>NS</sup>	0.466**	-0.145 <sup>NS</sup>
Pest management behaviour	0.264*	-0.291*	0.037 <sup>NS</sup>	0.053 <sup>NS</sup>	0.312*	-0.109 <sup>NS</sup>
Credit orientation	0.015 <sup>NS</sup>	0.220 <sup>NS</sup>	-0.369**	0.259*	-0.237 <sup>NS</sup>	-0.161 <sup>NS</sup>
Innovativeness	-0.188 <sup>NS</sup>	0.342**	0.160 <sup>NS</sup>	0.388**	0.032 <sup>NS</sup>	-0.012 <sup>NS</sup>
Marketing behaviour	0.108 <sup>NS</sup>	0.255*	0.433**	-0.230 <sup>NS</sup>	0.496**	-0.387**
Perception on performance of Bt cotton	-0.025 <sup>NS</sup>	0.297*	0.594**	0.315*	0.290*	0.476**
Perception on attributes of Bt cotton	0.293*	0.427**	0.396**	0.362**	0.724**	0.384**

\*\* Significant at 1% level, \* Significant at 5% level & NS = Non Significant

## CONCLUSION

Bt cotton is an attractive alternative technology to protect cotton from bollworms and to make cotton farming more sustainable, economical and eco-friendly. The above preliminary survey revealed the attitude of the cotton growers towards Bt cotton, their awareness level about the technology and their adoption behaviour with empirical evidences. Majority of the growers had favourable attitude towards cultivation of Bt cotton and would like to grow Bt cotton in future too. Their primary sources of information about Bt cotton were the local input dealers. Majority of them had not adopted the

refugee technology prescribed by the government of India to avoid the development of resistance by bollworms to Bt cotton. They perceived that major social, economic, environmental, ethical and bio-safety implications would occur in near future due to intensive cultivation of Bt cotton. This information on experiences of Bt cotton growers and their perception would facilitate the researchers, extension personnel and policy makers to draw suitable strategies to the existing Bt cotton as well as forthcoming biotech crops.

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