

Stakeholders Perception about Bt Cotton and Related Socio-economic Implications and Bio-safety Concerns

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ABSTRACT

Unprecedented rates of diffusion and adoption of Bt cotton have demonstrated its relative advantage as well as acceptance among million of farmers engaged in cotton cultivation. However, the prevailing apprehensions, misconception, ill information based perception and risk concern has led to development to protest group against transgenic crop. Hence the present study was conducted in states of Punjab of Karnataka to examine the perception among different stakeholders about Bt cotton and related issues of socio economic implications and bio-safety. A majority of farmers held positive perception about transgenic cotton (Bt cotton) due to its highly satisfactory performance in terms of higher yield, low requirement of pesticide and labours besides reduced pesticide related pollution and health hazards. The extension worker as well as the scientist engaged in the transgenic research too had positive perception about transgenic technology. Perception about Bt technology and related socio-economic implications differed highly significant ($P < 0.01$) with two sets of farmers i.e. with Bt cotton and without Bt cotton.

Crop biotechnology has emerged as a potential tool for addressing the problems of agricultural production and food security. Successful development and adoption of transgenic crops across the world have drawn the attention of policy makers to provide impetus to biotechnological interventions. Beginning with acreage of 1.7 mha across six countries in 1996, the global acreage under approved biotech crops increased to about 125 countries in ISAAA,2008. However, the related bio safety concern like transgene movement to other varieties and wild relatives leading to possible development of super weeds ,erosion of genetic diversity and ecological disturbances; widespread apprehension about toxicity or allergenicity induced by transgenic product to humans and animals; its adverse effect on non-target organism emergence of more virulent forms of pest and pathogens, concerns related to IPR, ethical and moral issues, etc form the basis of debate towards deployment and adoption of transgenic crops. There are cases of undesirable results of transgenic technology which further strengthen the apprehension about such technology. Hence the present study was conducted top examine the perception among different stakeholders viz. farmers,

extension workers, and scientists about Bt cotton related of biosafety issues.

METHODOLOGY

The present study was conducted in two states of Punjab and Karnataka which were selected purposively to give a representation from north and south regions of the country. A sample of 80 farmers with Bt cotton crop was selected randomly from four villages, two each from district Mansa and Dharwad from the states of Punjab and Karnataka. Similarly extension functionaries, 15 from each state were drawn purposively to access their perception. Also a sample of 30 scientists was purposively selected from research organisations, who were engaged in transgenic research. Thus a total of 180 respondents were taken up for the study, however, the responses of 10 farmers without Bt cotton of Punjab were not included in the analysis and reporting of data because of incompleteness of their interview schedule.

Perception, according to Morgan et al. (1993) refers to the awareness of objects, qualities, or events stimulating the sense organs. It is a person's immediate experience of the world. In the present study, perception was considered

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as the meaning attributed by the respondents to transgenic technology and features of its products. It was measured with the help of respondents' response to Likert -type scale with a battery of statements on 5-point continuum i.e. strongly agree, agree, undecided, disagree and strongly disagree with corresponding weightage of 5,4,3,2 and 1 regarding transgenic technology and product (Bt. crops) as well as related biosafety issues and socio economic and ecological implications. The Cronbach alpha reliability coefficient of the scale for perception of farmers was 0.67, while that for the extension workers and scientist was 0.68. The content validity of the scale was ascertained through a group of judges drawn from the fields of transgenic research and social science. The weighted mean perception scores for each statement were calculated to assess the perception of various stakeholders (Bt. and non-Bt. cotton farmers, extension professionals and Scientists involved In transgenic research).

RESULTS AND DISCUSSION

Perception of farmers about transgenic technology and related biosafety concerns.

A mean perception score of above 4 amply indicate that farmers of both the states of Punjab and Karnataka expressed agreement to the fact that Bt cotton. A mean perception score of above 4 amply revealed that the former held positive perception about Bt indicate that farmers of both the states of Punjab and Karnataka expressed agreement to the fact that Bt cotton was eco-friendly and high yielder. It reflects the favourable perception among farmers (Table 1). A large majority of farmers (90 per cent in Punjab and 85 per cent in Karnataka) felt that the pesticidal pollution had reduced since the introduction of Bt cotton. Regarding the monopoly of private firms over Bt cotton seed sector, a majority of the farmers (40 per cent in Punjab and 47.5 per cent in Karnataka) showed disagreement as they felt that the increased number of emerging companies in the sector would take care of their prices due to competition. From their experience of Bt cotton cultivation they could not find any harmful effect of Bt cotton till now. So they disagreed with the possible ~adverse effect of Bt cotton such as impact on soil microbes, genetic pollution, etc. A vast majority (77 per cent) of Karnataka and almost all farmers of Punjab agreed to the statement that it was advantageous if seed production of Bt cotton would be done by public institutions. They expressed that it might further reduce the seed cost. None of the farmers agreed with the statement that Bt cotton was pro-resource rich farmers, instead they had an opinion that it benefited

resource poor farmers also. Most of them (62 per cent in Punjab and 40 per cent in Karnataka) believed that global debate on transgenic retarded the growth.

The comparison between the states of Punjab and Karnataka regarding perception about Bt cotton among farmers was done by using t test. The mean differences of perception scores were highly significant with respect to statements like Bt. cotton hybrids are eco-friendly and high yielder as compared to hybrids, pesticidal pollution and health hazards had reduced due to Bt hybrids. Bt cotton has not been found effective in management of American cotton bollworm, and seed production and trade of genetically modified crops by public institutions are more advantageous for farmers (Table 1). Though both states were in agreement with respect to almost all the statements, farmers of Punjab were more affirmative and emphatic in agreement as revealed by their mean scores.

Perception about Bt. technology and related socio-economic and ecological implications differed highly significantly ($P < 0.01$) with two sets of farmers i.e. with Bt. Cotton and without Bt. Cotton (Table 2). The higher mean perception scores (4.46 and 3.56, respectively) of Bt cotton farmers in comparison to that of non-Bt farmers (3.8 and 2.56, respectively) on positive dimensions of Bt. Cotton hybrids that they are high yielder and eco-friendly and they reduced pesticidal pollution and health hazards revealed that the former held positive perception about Bt cotton higher than the latter. Similarly with respect to statements which present negative shades of Bt. Cotton and related implications, viz., dependency on seed companies, dangerous to living beings, inducing genetic pollution, destroying soil microorganisms, pro-resource rich failing in benefiting small farmers, ineffectiveness against American Cotton boll worm, increase in labour man days, picking being cumbersome, etc. the farmers using Bt. Cotton expressed disagreement and hence their mean scores were higher than the non-Bt cotton farmers

Perception of extension workers

The mean perception scores of 3.93 and 4.27 respectively for the statement that Bt technology was potential technology for higher productivity and profits reveal positive endorsement by extension workers of both the states. Their positive perception about Bt cotton technology is further revealed by their endorsement with mean scores above 4 for statements that Bt. Cotton was highly effective against American boll worm and was eco friendly requiring very few chemical sprays (Table 4). With mean scores of 4.33 and 4.53 respectively the extension workers of Punjab expressed affirmation to the facts that

adoption of Bt. Cotton had led to reduction in pesticide use and enhancement in productivity and profitability. The respective mean scores to these two stimuli were though relatively lesser in case of Kamataka (3.33 and 3.83), they too expressed agreement. Above 80 per cent of extension workers in Punjab and 66 per cent in Kamataka expressed disagreement with statements like Bt. Cotton was beneficial only for large farmers; Bt. Cotton had failed to benefit the small farmers and cloth of Bt. Cotton caused allergy.

On various aspects of Bt. Cotton and related socio-economic and ecological implications, the extension workers of Punjab and Karnataka differed very significantly as revealed by comparison of means and levels of significance $P < 0.05$ (Table 3).

Comparison of means of both the sets of extension workers (Table 3) revealed significant differences in their degree of agreement and disagreement to the statements that Bt cotton is not safe for animal consumption ($P < 0.05$), Bt technology is beneficial only for large farmers ($P < 0.05$), Bollguard (Bt cotton) has failed to benefit the small farmers ($P < 0.05$), adoption of bollguard (Bt cotton) has led to reduction in pesticide spray ($P < 0.05$), cloths made from Boil guard cotton will cause allergic problem ($P < 0.05$), Bollguard (Bt cotton) has enhanced the productivity and profitability ($P < 0.05$), Bt technology will cause harm to soil as well as soil microbes ($P < 0.05$) and indebtedness among cotton cultivators has increased due to adoption of Bt cotton ($P < 0.05$).

The reasons for better perception among the extension workers of Punjab in comparison to their counterparts of Karnataka could be the success of Bt cotton cultivation in adjoining state of Gujarat as well as successful cultivation of Bt cotton by the farmers of Punjab through trade of illegal Bt hybrids prior to approval in 2005. Comparatively a lesser degree of perception among the extension workers in case of Karnataka could

be due to mixed responses to the performance of Bt cotton in the initial years due to several factors like use of Bt hybrids inappropriate to conditions and predominance of rainfed situation and also the pace of adoption of Bt cotton in Karnataka was comparatively slower than Punjab.

Perception among scientists about transgenic technology

A set of 15 statements including both favourable and unfavourable statements about Bt. Technology (Bt. Cotton) and related implications was administered to 30 scientists engaged in transgenic research. Their responses reveal that the scientists showed agreement with favourable statements and disagreement with unfavourable statements amply reflect positive perception held by scientists about Bt. Technology. A mean score of above 4 shows that a majority of them perceived that Bt. Cotton technology was a potential technology of high yield and profit; it was effective against bollworm and was ecofriendly, it enhanced the productivity and profitability and reduced pesticide spray (Table-4). More than 53 per cent showed disagreement and about 37 per cent showed strong disagreement with the statements that Bt. Cotton plants were not safe for animal consumption and that cloth made from Bt. Cotton would cause allergic problem. Scientists were divided about genetic flow and its impact in agreement, disagreement and undecided category equally. More than two third of them disagreed that Bt technology was beneficial only for large farmers and that it failed to benefit the small farmers. More than two- third expressed disagreements with the statements that it would cause harm to soil and soil microbes. Scientists' categorical agreement and disagreement respectively to the statements favourable and unfavourable to Bt. technology clearly indicate their positive perception about Bt. technology.

STAKEHOLDERS PERCEPTION ABOUT Bt COTTON

Table-1. Perception of farmers about transgenic technology in Punjab and Karnataka

(n1= 40 and n2 = 40)

S\. No.	Statement	State	SA	A	UD	DA	SD	MPS	t-value
			(f)	(t)	(t)	(t)	(t)		
I.	Bt.cotton hybrids are eco-friendly and high yielder as compared to other hybrids	Punjab	28 (70)	12 (3,0)	0 (0)	0	0	4.7	3.247*
		Kar	15 (37.5)	22 (55)	0 (0)	3 (7.5)	0 (0)	4.2	

2.	Before the use of Bt. cotton, the environment in crop field remained polluted due to rampant use of pesticide	Punjab	18 (45)	2 (5)	2 (5)	0 (0)	4.3	1.051	
		Kar	18 (45)	16 (40)	1 (2.5)	0 (0)	5 (12.5)	4.1	
3.	Pesticidal pollution and health hazards have reduced due to Bt. hybrids	Punjab	13 (32.5)	20 (50)	4 (10)	3 (1.5)	0 (0)	4.1	3.995**
		Kar	8 (20)	8 (20)	8 (20)	10 (25)	6 (15)	3.1	
4.	Bt cotton hybrids demand dependency on seed companies which is indicative of farmers' losing their autonomy	Punjab	2 (5)	15 (37.5)	1 (2.5)	16 (40)	6 (15)	2.8	0291
		Kar	1 (2.5)	11 (27.5)	6 (15)	19 (47.5)	3 (7.5)	27	
5.	Bt. cotton hybrids may be dangerous to living beings	Punjab	1 (2.5)	5 (12.5)	3 (7.5)	23 (57.5)	8 (20)	2.3	1.459
		Kar	1 (2.5)	0 (0)	6 (15)	20 (50)	13 (32.5)	1.9	
6.	Bt. cotton hybrids may induce genetic pollution of crops in the area	Punjab	0 (0)	0 (0)	5 (12.5)	19 (47.5)	16 (40)	1.7	-1208
		Kar	0 (0)	2 (5)	5 (12.5)	21 (52.5)	12 (30)	1.9	
7.	They may destroy soil micro-organism	Punjab	0 (0)	2 (5)	10 (25)	18 (45)	10 (25)	2.1	0.656
		Kar	0 (0)	3 (7.5)	11 (27.5)	18 (45)	8 (20)	22	
8.	Organic cultivation can mitigate pest problem more effectively than Bt.	Punjab	4 (10)	10 (25)	6 (15)	14 (35)	6 (15)	2.8	-287
		Kar	3 (7.5)	9 (22.5)	10 (25)	16 (40)	2 (5)	29	
9.	Bt. technology is pro-resource rich farmers and will usher inequality in society.	Punjab	0 (0)	0 (0)	0 (0)	12 (30)	28 (70)	1.3	-1.8
		Kar	0 (0)	1 (2.5)	0 (0)	18 (45)	21 (52.5)	1.5	
10.	Global debate upon rationality of Bt. is blockade in farmers' progress	Punjab	7 (22.5)	13 (40)	9 (7.5)	8 (20)	3 (10)	33	0.648
		Kar	6 (15)	10 (25)	12 (30)	8 (20)	4 (10)	32	
11.	Bollguard (Bt cotton) has failed to benefit the small farmers	Punjab	0 (0)	3 (7.5)	4 (10)	17 (42.5)	16 (40)	1.9	-1.553
		Kar	0 (0)	4 (10)	5 (12.5)	5 (60)	24 (17.5)	7	22
12.	Farmers have been benefited immensely by Bt cotton cultivation	Punjab	20 (50)	11 (27.5)	0 (0)	8 (20)	1 (2.5)	4.0	-1.753
		Kar	6 (15)	21 (52.5)	3 (7.5)	10 (25)	0 (0)	3.6	

13.	Use of Bt hybrid has not reduced the cost of cultivation	Punjab	3 (7.5)	0 (0)	0 (0)	16 (40)	21 (52.5)	1.7	0.732
		.Kar	0 (0)	2 (5)	2 (5)	24 (60)	12 (30)	1.9	
14.	Bt cotton has not been found effective in management of American cotton bollworm	Punjab	1 (2.5)	0 (0)	0 (0)	18 (45)	21 (52.5)	1.6	2.115*
		Kar	0 (0)	4 (10)	4 (10)	18 (45)	14 (35)	2.0	
15.	Seed production and trade of genetically modified crops by public institutions are more advantageous for farmers	Punjab	26 (65)	14 (35)	0 (0)	0 (0)	0 (0)	4.7	-2.449*
		Kar	24 (60)	7 (17.5)	0 (0)	7 (17.5)	2 (5)	4.1	
16.	Labour man days have increased due to use of Bt cotton	Punjab	0 (0)	4 (10)	1 (2.5)	18 (45)	17 (42.5)	1.8	0.768
		Kar	1 (2.5)	1 (2.5)	0 (0)	19 (47.5)	19 (47.5)	1.7	
17	Lint quality of Bt cotton is not good	Punjab	4 (10)	4 (10)	0 (0)	22 (55)	10 (25)	2.3	1.133
		Kar	2 (5)	4 (10)	0 (0)	0 (45)	18 (45)	16	
18.	Picking of cotton is more cumbersome in Bt cotton hybrids than in other hybrids or varieties	Punjab	0 (0)	3 (7.5)	0 (0)	7 (17.5)	30 (75)	1.4	1.710
		Kar	1 (2.5)	0 (0)	0 (0)	24 (60)	15 (37.5)	1.7	

• SA: Strongly Agree, A: Agree, UD: Undecided, DA: Disagree, SO: Strongly Disagree

• Kar: Karnataka; MPS: mean perception score

• Level of significance - * P<.05 and ** P<.01; Figures in parentheses are percentage

Table 2. Comparative analysis between farmers with Bt and non-Bt cotton

S.No.	Statement	MPS		I-value	Level of significance
		Bt	Non Bt		
		(n = 80)	(n =30)		
1.	Bt. cotton hybrids are eco-friendly, high yielder as compared to hybrids	4.46	3.8	3.424	.00)**
2.	Before the use of Bt. cotton, the environment in crop field remained polluted due to rampant use of pesticide	4.17	3.40	3.068	.004)**
3.	Pesticidal pollution and health hazards have reduced due to Bt. hybrids	3.56	2.56	3.7)0	.000)**
4.	Bt. cotton hybrids demands dependency on seed companies which is indicative of farmers' losing their autonomy	2.48	3.33	-3.445	.00)**

5.	Bt. cotton hybrids may be dangerous to living beings	3.97	3.06	3.673	.000**
6.	Bt. cotton hybrids may induce genetic pollution of crops in the area	4.17	3.07	3.844	.000**
7.	They may destroy soil micro-organism	3.83	3.07	3.000	.000**
8.	Organic cultivation can mitigate pest problem more effectively than Bt.	3.28	3.03	0.955	.344
9.	Bt. technology is pro-resource rich farmers and will usher inequality in society	4.58	3.13	7370	.000**
10.	Global debate upon rationality of Bt. is blockade in farmers progress	2.93	3.13	-939	.351
11.	Bollguard (Bt cotton) has failed to benefit the small farmers	4.00	3.03	4.717	.000**
12.	Farmers have been benefited immensely by Bt cotton cultivation	3.8	3.86	-278	.782
13.	Use of Bt hybrid has not reduced the cost of cultivation	4.23	3.23	4.292	.000**
14.	Bt cotton has not been found effective in management of American cotton boll worm	4.35	3.37	4.990	.000**
15.	Seed production and trade of genetically modified crops by public institutions are more advantageous for farmers	4.37	4.30	.039	.751
16.	Labour man days have increased due to use of Bt cotton	1.73	3.03	-5.739	.000**
17.	Lint quality of Bt cotton is not good	3.93	3.1	3.266	.00 **
18.	Picking of cotton is more cumbersome in Bt cotton hybrids than in other hybrids or varieties	4.48	3.36	5.838	.000**

*(P<0.05) & ** (P<.01).

Table-3. Comparative analysis of extension workers perception

1.	Bt technology is potential technology for higher productivity and profits	3.931	427	-.646
2.	It is highly effective against American bollworm insect pest	4.80	433	1.974
3.	It is eco friendly as it requires very few chemical sprays	4.13	4.13	.000
4.	It kills insect by poison contained in the leaves of cotton plant	253	3.00	-1.164
5.	It is not safe for animal consumption, animals will die if they eat boll guard (Bt cotton) plants	153	226	-2.775**
6.	Cloths made from Boll guard cotton will cause allergic problem	1.73	233	-2.483*
7.	Bollguard (Bt cotton) will cause genetic pollution to other valuable germplasm of crops grown in surrounding due to flow of pollen(gene)	2.73	2.86	-.319
8.	Monopoly of private companies in production and trade of Bt technology will erode the seed sovereignty of farmers.	326	3.86	-1.496
9.	Bt technology is beneficial only for large farmers	1.73	2.60	-2.078*
10.	Bollguard (Bt cotton) has failed to benefit the small farmers	1.73	2.66	-2.458*
11.	Adoption of bollguard (Bt cotton) has led to reduction in pesticide spray.	433	333	2.461*
12.	Bollguard (Bt cotton) has increased the cost of cotton cultivation	2.66	2.60	.155
13.	Bollguard (Bt cotton) has enhanced the productivity and profitability	453	3.80	2.646*
14.	Indebtedness among cotton cultivators has increased due to adoption of bollguard (Bt cotton)	1.46	2.53	-4.212**
15.	Bt technology will cause harm to soil as well as soil microbes	120	2.40	-5.499**

*(P<0.05) & ** (P<.01).

Table 4. Perception among scientists about transgenic technology

S.No.	Statement	SA	Agree	ID	OA	SO	MPS
		(t)	(t)	(t)	(t)	(t)	
1.	Bt technology is potential technology for higher productivity and profits	13 (43.3)	14 (46.7)	1 (3.3)	2 (6.7)	0 (0)	427
2.	It is highly effective against American bollworm insect pest	6 (20)	23 (76.7)	1 (3.3)	0 (0)	0 (0)	4.16
3.	It is ecofriendly as it requires very few chemical sprays	10 (33.3)	18 (60)	1 (3.3)	1 (3.3)	0 (0)	423
4.	It kills insect by poison contained in the leaves of cotton plant	8 (26.7)	16 (53.3)	0 (0)	3 (10)	3 (10)	3.76
5.	It is not safe for animal consumption.	0 (0)	0 (0)	3 (10)	16 (53.3)	11 (36.7)	1.73
6.	Cloths made from Boil guard cotton will cause allergic problem	0 (0)	0 (0)	3 (10)	16 (53.3)	11 (36.7)	1.73
7.	Plantation of Bollguard (Bt cotton) will cause genetic pollution to other valuable gennplasm of crops grown in surrounding due to flow of pollen(gene)	0 (0)	9 (30)	10 (33.3)	9 (30)	2 (6.7)	2.86
8.	Monopoly of private companies in production and trade of Bt technology will erode the seed sovereignty of farmers.	4 (13.3)	12 (40)	3 (10)	10 (33.3)	1 (3.3)	326
9.	Bt technology is beneficial only for large farmers	1 (3.3)	6 (20)	3 (10)	19 (63.3)	1 (3.3)	2.56
10.	Bollguard (Bt cotton) has failed to benefit the small farmers	1 (3.3)	5 (16.7)	4 (13.3)	16 (53.3)	4 (13.3)	2.43
11.	Adoption of bollguard (Bt.cotton) has led to reduction in pesticide spray.	5 (16.7)	21 (70)	2 (6.7)	2 (6.7)	0 (0)	3.96
12.	Bollguard (Bt cotton) has increased the cost of cotton cultivation	2 (6.7)	6 (20)	5 (16.7)	13 (43.3)	4 (13.3)	2.63
13.	Bollguard (Bt cotton) has enhanced the productivity and profitability	7 (23.3)	21 (70)	2 (6.7)	0 (0)	0 (0)	4.16
14.	Indebtedness among cotton cultivators has increased due to adoption of Bt cotton	1 (3.3)	1 (3.3)	8 (26.7)	18 (60)	2 (6.7)	2.36
15.	Bt cotton will cause harm to soil as well as soil microbes	0 (0)	3 (10)	7 (23.3)	15 (50)	5 (16.7)	226

SA: Strongly Agree, A: Agree, UD: Undecided, DA: Disagree, SD: Strongly Disagree

MPS: Mean perception score, Figure in parentheses is percentage

CONCLUSION

The study revealed that a majority of farmers of both the states (Punjab and Karnataka) held positive perception about transgenic cotton (Bt. Cotton) due to its highly satisfactory performance in terms of higher yield and low requirement of pesticide and labour, besides reduced pesticide related pollution and health hazards. The extension workers as well as the scientists engaged in transgenic research too had positive perception about transgenic technology. Perception about Bt. technology and related socio-economic and ecological implications differed highly significantly with the two sets of farmers i.e. with Bt. Cotton and without Bt. Cotton. However, the prevailing apprehensions, misconception, ill information based perception and risk concerns have to be dealt with

sincere educational drive to promote transgenic technology. Awareness programme through mass media should be initiated to educate the farmers and other stakeholders about the transgenic technology and to clarify doubts and the concerns with scientific explanation and evidences. Trainings on transgenic technology and biosafety practices should be intensively conducted for farmers and extension workers

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