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An Analysis of Socio-economic Impact of *Bt* Cotton Cultivation in India

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ABSTRACT

The performance of *Bt* cotton and its socio-economic impact was assessed with the help of data collected from farmers of north zone (Punjab, Haryana and Rajasthan states) and Central zone (Maharastra,Madhya Pradesh and Gujarat states). North zone farmers received average of 10.61 q/ac from the *Bt* cotton and 8.03 q/ac from the cultivation of non-*Bt* cotton in their field. Thus, the North zone farmers could realize an additional income from cotton yield of 2.58 q/ac (24.31 %) over non-*Bt* cotton growers. Additional yield of *Bt* cotton over non *Bt* cotton of the central zone was 2.89 q/ac with tune of 26.15 per cent. The net returns from the *Bt* cotton cultivation (₹ 19,738/ac) was higher when compared to non *Bt* cotton cultivation (₹ 9,850/ac) by the north zone respondents. A similar result was observed among the Central zone farmers as well. The benefit cost ratio also inferred that the cultivation of *Bt* cotton (1:1.98) is profitable when compared to the non-*Bt* cotton cultivation (1:1.52). The production function analysis revealed that machine labour (hrs.), plant protection chemicals(₹/ac), irrigation (No), picking cost (₹/ac)were showed positive and significant relationship with yield of *Bt* cotton, whereas chemical fertilizers (₹/ac) and seeds(gms/ac) showed negative relationship with yield level of *Bt* cotton.

Key words : Socio-economic impact, assessment, cultivation

INTRODUCTION

India has the largest area under cotton in the world with about 90 lakh hectares accounting for one-fourth of the global cotton area.Cotton contributes 29.9 per cent of the Indian agricultural gross domestic product and provides livelihood to nearly 6 crore people with half of this population employed directly by the textile industry. With the Indian government approving the cultivation of *Bt* cotton in 2002, cotton cultivation in India reached yet another milestone.Commercialization of *Bt* cotton increased 212 fold in the year 2011 at 10.6 million hectares from 50,000 hectares in 2002 (ISAAA, 2012). *Bt* cotton has contributed to increase in the yield of cotton and a reduction in the overall quantity of insecticide substantially in few areas (from 40% to 60% less than the intensity on the corresponding non-transgenic varieties), while giving a mixed response in most regions.

There also exists controversy regarding its low yield potential in some of the regions; increase in the attack of sucking pest in case of unsprayed fields, rise in the cases of wilt; failure of the crop in rain-fed areas; *etc.* Taking into account the lack of empirical research, the present study proposes to undertake a broader analysis on the socio-economic impact of *Bt* cotton in India.

METHODOLOGY

Multi-stage sampling was employed for conducting this study. In the first stage, the district with highest area under *Bt* cotton crop was purposively selected. Secondly, tehsil (Taluka)/block were purposively selected for the study as the cultivation of *Bt* cotton was mostly concentrated in those selected areas. At the third stage, four villages from the predominantly *Bt* cotton growing villages in each of these tehsil/blocks were randomly selected. Finally, samples of 40 farmers were randomly chosen (10 farmers from each village).Thus, 240 farmers were selected from the six states namely Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Maharashtra. Each of the respondent was personally contacted and interviewed with the help of interview schedule.

To study resource productivity and allocative efficiency in *Bt* and non-*Bt* cotton production, Cobb-Douglas type of production function was fitted. The general form of the function is y = axi bi where, 'xi' is the variable resource measure, 'y' is the output, 'a' is a constant and 'bi' estimates the extent of relationship between xi and y and when xi is at different magnitudes. The 'b' coefficient also represents the elasticity of production in Cobb-Douglas production function analysis. This type of function allows for either constant or increasing or

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decreasing returns to scale. It does not allow for total product curve embracing all the three phases simultaneously. Test was conducted to see if the sum of regression coefficients was significantly different from unity. Functions of the form of equation (1) were fitted for both *Bt* and non-*Bt* farmers.

ln Y = ln b0 + b1 ln X1 + b2 lnX2 + b3 lnX3 + b4 lnX4 +b5 lnX5 + b6 lnX6 + b7 lnX7 + b8 In X8 + b9 D1+b10 D2+Error term …(1)where,
Y= Cotton yield (Kg/ac)
X1 = Seed rate (gms/ac)
X2 = Human labour (Human days/ac)
X3= Machine labour (Hrs/ac)
X4 = Bullock labour (pair days/ac)
X5 = Chemical fertilizers (Qty/ac)
X6 = Plant protection chemicals (₹/ac)
X7= Number of irrigations per acre
X8=Picking cost (₹/ac)

D1= Dummy for *Bt* cotton which taken value 1,if the cotton hybrid is *Bt*,0 otherwise ,and

D2=Dummy; North zone = 0 and for central zone =1 bj = Regression coefficients (j=0,1,2…,k) (k=8), and.

RESULTS AND DISCUSSION

Cost-benefit ratio of *Bt* cotton Vs non-*Bt* cotton

The costs and returns of *Bt* and non-*Bt* cotton cultivation have been provided in Table 1. The average expenditure for *Bt* cotton cultivation is ₹ 20,049/acre and ₹ 22,102/acre for the North and Central zone, respectively.

Similar trend was observed in non-*Bt* cotton cultivation also. Inputs usage especially farm yard manure (FYM) and bullock pair utilization is the practices of Central zone cotton cultivation when compared to North zone, hence Central zone leads to more expenditure when compared to North zone.

There was a significant difference in expenditure of plant protection chemicals between *Bt* (₹ 2,301/acre) and non-*Bt* (₹ 3,934/acre) by the respondents. The number of sprays required for control of sucking pests was the same in *Bt* and non-*Bt* cotton crop, but the number of sprays required for bollworm control was lower for *Bt* cotton, and it leads to reduction in the expenditure by 72 per cent. Similarly, Qaim and Zilberman (2003) reported that 70 per cent of the plant protection expenditure was reduced while cultivating *Bt* cotton.

Table 1: Comparison of cost-benefit ratio of *Bt* cotton and non-*Bt* cotton (₹ /acre)

n=240

Items	North Zone (n=120)		CentralZone (n=120)		Total (n=240)	
	Bt cotton	Non-*Bt* cotton	*Bt* cotton	Non-*Bt* cotton	*Bt* cotton	Non-*Bt* cotton
Seeds	1732	448	1088	516	1410	482
Human labour	4038	4055	2523	2412	3280	3233
Machine labour	1075	1075	1276	1276	1175	1175
Bullock labour	NA	NA	1457	1309	1457	1309
Farm Yard Manuare	905	582	2309	2137	1607	1359
Chemical Fertilizers	3112	3037	3559	3270	3335	3153
Plant protection chemicals	2334	4052	2268	3816	2301	3934
Irrigation	947	987	1399	1275	1173	1131
Picking	5376	4822	5671	4097	5523	4459
Marketing cost	530	401	552	408	541	404
Total Cost	20049	19459	22102	20516	21075	19987
Yield (q/acre)	10.61	8.03	11.05	8.16	10.83	8.09
Gross return	39787	29309	44200	31824	41993	30516
Net return(C-A)	19738	9850	22090	11308	20914	10579
Cost Benefit ratio	1:1.98	1:1.50	1:1.99	1:1.55	1:1.98	1:1.52

1. For North zone: Value of output (*i.e* yield of *kapas*) taken as ₹ 3,750 per quintal for the *Bt* cotton and ₹ 3,650 for the non-*Bt* cotton *kapas* and for Central zone: Value of output (*i.e* yield of *kapas)* taken as ₹ 4,000 per quintal for the *Bt* cotton and ₹ 3900 for the non-*Bt* cotton kapas.

2. Picking cost was taken as ₹ 5 per Kg of *kapas*

3. Marketing cost was taken as ₹ 50 per quintal of *kapas*

North zone famers received average of 10.61 q/acre from the *Bt* cotton and they received only 8.03 q/acre from the cultivation of non-*Bt* cotton in their field. Thus, the North zone farmers could realize an additional yield of 2.58 q/acre (24.31 per cent) over non-*Bt* cotton growers. Additional yield over non-*Bt* cotton of central zone was 2.89 q/acre with tune of 26.15 per cent. Naik (2005) reported 34 per cent increase in yield in Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu in 2002-03, whereas Narayanamoorthy and Kalamkar (2006) have reported a yield increase of 52 per cent in Maharashtra in 2003-04. The net returns from the *Bt* cotton cultivation (₹ 19,738/acre) was high when compared to non *Bt* cotton cultivation (₹ 9,850/acre) by the North zone respondents. Similar results were observed in the Central zone farmers as well. The benefit cost ratio also inferred that the cultivation of *Bt cotton* (1:1.98) is profitable when compared to the non-*Bt* (1:1.52) cotton cultivation. Padaria *et. al.* 2009 found cultivation of Bt. Cotton reduced the frequency of spray by 62% and health hazards

by 89%; while increased the yield by 67% and income by 142%. According to Kiresur and Manjunath *et al.,* (2011) the net returns over non-*Bt* cotton were much higher from the *Bt* cotton production (₹ 30,618/ha) than from non-*Bt* cotton (₹ 12,189/ha), accounting for an increase of 151 per cent. Across farm-size categories, the net returns per ha varied from ₹ 30,014 to ₹ 31,035 for *Bt* cotton and ₹ 11,797 to ₹ 12,912 for non-*Bt* cotton. The higher profitability of *Bt* cotton was reflected in terms of cost benefit ratio (1.83 in *Bt* cotton versus 1.31 in non-*Bt* cotton).Similarly, Dev and Rao (2007) have also reported that net income, farm business income, family labour income and farm investment income per acre were higher in *Bt* cotton by ₹ 1,806 (83%), ₹ 3,067 (146%), ₹ 2,088 (158 %) and ₹ 2,785 (222 %), respectively over non-*Bt* cotton. Thus, the additional return to *Bt* cotton over non-*Bt* was estimated at ₹ 15,791/ha. Therefore, *Bt* practices bring not only additional profits, but also help in bringing stability in the ecosystem by reducing the use of chemicals. Hence, *Bt* technology is considered as eco-friendly, economical and socially acceptable, particularly in cotton cultivation.

Production fuction analysis

The production function with intercept dummy for *Bt* cotton technology was a "good fit" with all the explanatory variables included in the model collectively explaining 93 per cent of the variation in the production (Table 2).

Table : 2 Results of production function analysis for *Bt cotton* cultivation by the growers

n=240

Variables	Estimated co-efficient	Standard Error	t-values
Constant	0.660	0.270	2.430
Seeds(g)	-0.140***	0.010	-13.960
Human labour(Human days)	-0.010 NS	0.030	-0.380
Machine labour(Hrs)	0.080***	0.020	3.380
Bullock labour(bullock pair days)	0.030 NS	0.020	1.300
Chemical fertilizer(Kgs)	-0.110 ***	0.040	-2.510
Plant protection chemicals (₹)	0.050***	0.020	3.090
Irrigation(No.)	0.060***	0.020	4.030
Pickking cost (₹)	0.840***	0.020	46.250
Dummy for *Bt* cotton	0.070***	0.010	4.820
Dummy for the zone	0.110***	0.030	3.330
R^2	0.9291		
Adjusted R^2	0.9276		
F-Value	615.231		
N	480		

Note: ** and *** denote significance at 5 per cent and 1 per cent levels, respectively. NS-Non Significant.

Most of the co-efficients have positive value except seed rate and chemical fertilizers. All the north zone farmers have been following machine sowing while the central zone farmers followed hand sowing (Dibbling method). Genrally more seeds are required in machine sowing when compared to hand (Dibbling) sowing.Thus, inspite of more seed rate in north zone, the yield level is low when copmared to central zone. Chemical fertilizer had a negative effect on yield probably because farmers used excessive quantities of nitrogenous fertilizers than the recommended dose resulting in reduction of yield. The use of fertilizers, which was 2.4 million tones in 2010-2011 has increased to 2.7 million in 2011-12. Unbalanced use of fertilizers is reducing the soil fertility and damaging physical conditions of the soil. The variable namely machine labour, bullock labour, plant protection chemicals, irrigation had significant influence on the production. The implication of the result is the increasing use of machine labour, plant protection chemicals, irrigation and picking by 10 per cent will increase the cotton production each 0.8 per cent, 0.5 per cent,0.6 per cent and 8.4 per cent. The human labour and the bullock labour showed negative influence on the production. The regression co-efficient for the intercept dummy variable was positive and significant (0.070***).This implied that the parameters governing the input-output relations in the case of *Bt* cotton farms were different from those of non-*Bt* cotton farms. Thus, the results provided the necessary proof for decomposing the total change in per acre output with the adoption of *Bt* cotton technology. This result is in conformity with those of Hugar *et.al* (2000), wherein the regression coefficient (0.24*) for intercept dummy variable was significant. These findings are in line with the study of Kiresur and Manjunath *et al.,* (2011) and Loganathan *et al.,* (2009) revealing that seed, plant protection chemicals and mechanical labour was the significant factor for influencing the production level of *Bt* and non-*Bt* cotton.

CONCLUSION

The cost benefit ratio of this study clearly indicated that farmers can get 2.74 q/ac additional yield with tune of ₹ 10,335/ac as an additional income while adopting *Bt* cotton cultivation. Farmers spent ₹ 3,934/ac, ₹ 2,301/ac for plant protection measures for non-*Bt cotton* and *Bt* cotton, respectively. Thus, farmers can save ₹ 1,633/ac while adopting *Bt* cotton by way of saving the plant protection cost. Hence, it is concluded that *Bt* cotton cultivation will give more yield and increased net income compared to non-*Bt* cotton cultivation. The cost of cotton cultivation and profit from the *Bt* cotton crop showed negative growth when compared to other major crops like maize, paddy and wheat in the study area. Hence,

recommendations of low cost and eco-friendly technologies are essential for reducing the cost of *Bt* cotton cultivation and increasing the profit of growers.

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