1542 PRODUCTIVITY DIFFERENCE BETWEEN Bt AND NON Bt COTTON FARMS IN KARNATAKA STATE, INDIA-AN ECONOMETRIC EVIDENCE

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There has been an on-going debate since the introduction of Bt cotton during 2002 in India on the superiority and/ or inferiority of Bt cotton over conventional cotton. Therefore, a study was carried out to assess the effect of Bt cotton technology on output and efficiency of inputs used in cotton cultivation in Karnataka state of South India during 2005-06. The modified Cobb-Douglas production and decomposition analysis techniques were used to estimate the influence of factors and Bt technology on output change. The production estimates revealed that output elasticities of inorganic fertilizers and organic manure had significant influence on yield of both Bt and non Bt cotton farms. However, plant protection chemicals had significant positive influence in Bt cotton production while it was negative and non-significant in non- Bt cotton farms. With ratios of MVP to MFC equal to almost one, indicated an optimum use of plant protection measures by Bt cotton farmers. The decomposition analysis showed that per acre output of cotton in Bt farms was higher by 16% over non Bt farms, of which 32 % was contributed by Bt technology. Hence, Bt cotton needs to be expanded among all cotton growers in the state to harvest the benefits in terms of higher yield and income.

Key Words : Bt technology, resource use efficiency, decomposition of output change,

production function, bt cotton, non Bt cotton.

INTRODUCTION

Cotton, 'The white gold' or the 'King of fibres', as it is often referred to, still holds its position high. Its use world over has been on the upswing. India has the largest cotton area in the world with about 90 lakh hectares accounting for one-fourth of the global cotton area. Cotton contributes 29.90 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. In Karnataka, cotton is grown on an area of 3.34 lakh hectares with the production of 4.00 lakh bales and productivity of 204 kg per hectare(Khadi, 2006).

In recent years, pest menace in cotton is severe resulting in escalation of cost of production, increase in crop losses and reduction in productivity and income to farmers. Pest problems in cotton have caused socio-economic calamity. To address these concerns biotechnology tools came handy in transferring pest resistance to cotton. Bt cotton as a ray of hope for all these maladies was released for commercial cultivation in 2002 in India. However, several apprehensions were raised against this technology by farmers' organizations, environmentalists, NGOs and other stakeholders (Abdul Qayuam and Kiran Sakkhari 2003). Clearly there has been a fair amount of confusion in drawing inferences on benefits and or losses from Bt cotton (Hugar and Patil,2007).

Therefore, an attempt is made in the present paper to assess the effect of Bt cotton technology on cotton output empirically. More specifically, the objectives of the study are: (i) to find out the resource use efficiency in Bt cotton vis-a-vis non-Bt cotton cultivation, (ii) to estimate the productivity difference between Bt and non-Bt cotton farms and (iii) to decompose the difference in output into the contributing factors namely (a) Bt technology and (b) differences in input use.

MATERIAL AND METHODS

The present study was carried out in Karnataka State of Southern India during 2005-06. The input-output coefficients were generated from personal surveys from 89 Bt and 90 non-Bt sample farmers selected from three major cotton growing districts of Karnataka state.

Production Function Analysis

The resource use efficiency in cotton cultivation under Bt and non-Bt cottons was studied by fitting following Cobb-Douglas type of production function per acre.

$$Y = a\, x_1^{b1} .\ X_2^{b2} .\ X_3^{b3} .\ X_4^{b4} .\ X_5^{b5} .\ X_6^{b6} .\ e^{0} \text{ ------ } (1)$$

Where,

Y = Yield in quintals (100kg)

X_1 = Seeds in kg

X_2 = Human labor (person days)

X_3 = Animal power (pair days)

X_4 = Organic manure (t)

X_5 = Inorganic fertilizer (kg)

X_6 = Plant protection chemicals (Rs.)

e = Error / disturbance term

b_1 to b_6 = Production elasticity with respect to the particular factor indicated above.

The equation (1) was converted into log-linear form and the parameters (coefficients) were estimated by using Ordinary Least Squares (OLS) method.

Estimation of Marginal Product and Marginal Value Product

The marginal products were calculated at the geometric mean levels of the variables by using the following formula.

$$\text{Marginal product of input} = b_i \frac{\bar{y}}{\bar{X}_i}$$

Where,

$\bar{y}$ = Geometric mean of output

$\bar{X}_i$ = Geometric mean of i^{th} independent variables

b_i = The regression coefficient of i^{th} independent variables

The marginal value product of each resource was calculated by multiplying the marginal product of the resource by the price of the product.

$$\text{MVP of } X_i = b_i \times \frac{\text{Geometric mean of } Y}{\text{Geometric mean of } X_i} \times Py$$

Where,

b_i = Elasticity of production of i^{th} input

Py = Price of that product

Structural Break in Production Relation

The following log linear estimable forms of equations were used for examining the structural break in production relation.

$\ln y_1 = \ln A_1 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 +$

$b_6 \ln X_6 + Ui$ …………… (2)

$\ln y_2 = \ln A_2 + b'_1 \ln X_1 + b'_2 \ln X_2 + b'_3 \ln X_3 + b'_4 \ln X_4 + b'_5 \ln X_5 + b'_6 \ln X_6 + Ui$ … (3)

$\ln y_3 = \ln A_3 + b''_1 \ln X_1 + b''_2 \ln X_2 + b''_3 \text{Ln } X_3 + b''_4 \text{Ln } X_4 + b''_5 \ln X_5 +$

$b''_6 \ln X_6 + e_3 d + U_i$ …….. (4)

Where,

Equations 2, 3 and 4 represent Bt, non Bt and pooled regression functions with Bt as dummy variable, respectively.

b_1, b_2, b_3, b_4, b_5, b_6, b'_1, b'_2, b'_3, b'_4, b'_5, b'_6, b''_1, b''_2, b''_3 b''_4, b''_5, b''_6

represent individual output elasticities of respective input variables in equation (2), (3) and (4). 'd' in equation (4) represent dummy variable. If the regression coefficient of dummy variable is significant, then there is structural break in production relations with the adoption of Bt technology.

Output Decomposition Model

The output decomposition model developed by Bisaliah (1977) is used in the study, which is depicted below.

ln Y Bt - ln Y non Bt = [Intercept Bt - Intercept non BT] +

[(b'_1 - b_1) x ln X_1 non Bt + ... + (b'_6 - b_6) x ln X_6 non Bt] +

[(b'_1 (ln X_1 Bt – ln X_1 non Bt) +… (b'_6 (ln X_6 Bt - ln X_6 non Bt)]

.... (5)

The decomposition equation (5) is approximately a measure of percentage change in output with the adoption of Bt in the production process. The first bracketed expression on the right hand side is a measure of percentage change in output due to shift in scale parameters (A) of the production function. The second bracketed expression is the difference between output elasticities each weighted by the natural logarithms of the volume of that input used under non Bt category, a measure of change in output due to shift in slope parameter (output elasticities) of the production function. The third bracketed expression is the sum of the natural logarithms of the ratio of each input of Bt cotton farms to non Bt cotton farms, each weighted by the output elasticity of that input. This expression is a measure of change in output due to change in the per acre quantities of seeds, animal power, human labor, inorganic fertilizers, organic manures and plant protection chemicals.

RESULTS AND DISCUSSION

Resource Use Efficiency in Bt and Non Bt Cottons

The production function estimates (Table 1) have clearly indicated that the chosen factors of production have significantly influenced the production of cotton both in Bt cotton and non Bt cotton farms by 64 and 70 per cents, respectively. However, there were considerable differences in the extent of influence of different factors of production of cotton. Inorganic fertilizers and organic manure were found to influence the production significantly in both the type of farms. Animal power and human labor were also found to influence the yield in non Bt cotton farmers.

It is worth noting that the plant protection measures significantly influenced the yield on cotton in Bt cotton farmers, while it was negative and non-significant in the case of non Bt cotton farmers. Further, the ratio of MVP to MFC being 0.98 clearly indicated that the plant protection chemicals and other inputs were optimally utilized by Bt cotton farmers. This was mainly due to the adoption of Bt cotton as well as practice of recommended package of cultivation by the farmers who had undergone demonstrations. In the case of non Bt cotton farmers, not only the regression coefficient of plant protection chemicals was negative (-0.15) but also the ratio of MVP to MFC (Table 2) was negative (-0.47) and less than one. This clearly indicated that plant protection chemicals were used excessively by non Bt cotton farmers, resulting in lower returns. Therefore, the farmers cultivating non Bt cotton with conventional practices of plant protection measure needs to be educated about the ill-effects of excessive and indiscriminate use of chemical pesticides both on production and income.

The sum of output elasticities in the case of Bt cotton production (1.03) was more than one, indicating an increasing returns to scale which was mainly due to significant influence of plant protection chemicals, organic manure and inorganic fertilizers. The increasing returns to scale clearly revealed that there is scope to increase the Bt cotton production by increasing the above inputs. In case of non Bt cotton farms, the sum of output elasticities (0.52) was less than one, indicating a decreasing return to scale. Hence, there is no scope to increase cotton production by increasing other inputs. Therefore, the Bt cotton technology needs to be extended to those farmers who have not adopted so far, through extension activities and other measures. This would, on one hand, cut down the plant protection costs of non Bt cotton farmers and on the other, increase their cotton yields through improved protection and efficient use of other resources. Therefore, concentrated efforts needs to be made to encourage the farmers to adopt the Bt cotton to get real benefits.

Structural Break and Decomposition of Output Change

For identifying the structural break in production with the introduction of Bt cotton technology in cotton production, the Cobb-Douglas type of production function was used. Production function with Bt technology dummy as variable was fitted for identifying structural break in production relations between the Bt and non Bt cotton farms. Production function with 'one' for the Bt cotton and 'zero' for non Bt cotton farms was estimated.

The regression co-efficient (0.24*) for dummy variable was significant. 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 of output with the adoption of Bt cotton technology. This result is in conformity with those of Bisaliah (1977) for Punjab wheat economy, Kunnal (1978) for sorghum economy in Hubli taluka of Dharwad district in Karnataka and Hugar *et. al* (2000) in IPM technology in cotton.

With the identification of structural break, the growth in output was decomposed into constituent forces i.e., efficiency of Bt cotton technology and change in level of inputs use.

The decomposition analysis showed that per acre production of cotton in Bt farmers was 16.64 per cent higher than that of non Bt farmers. The Bt cotton technology has alone contributed to the tune of 32.73 per cent to the total change in output while the contribution of all other inputs was found to be negative (-16.14%). The effectiveness of the Bt cotton technology in timely control of bollworm insect pests has lead to the increase in the cotton output. This implied that the adoption of Bt cotton technology has to be encouraged by extension activities to harvest its full benefits.

Conclusions

The present study revealed that the productivity difference between Bt and non Bt cotton farmers was largely attributable to Bt technology. The plant protection had significant positive influence on output in Bt cotton farmers while it was negative and non-significant in non-Bt farmers. Further, the plant protection chemicals and other inputs were used optimally by Bt cotton farmers as against excessive use by non-Bt cotton farmers. Therefore, it is necessary to motivate the farmers for cultivation of Bt cotton with appropriate extension strategies and policy measures.

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Table 1. Production function estimates in cotton cultivation under Bt and non Bt cotton farms.

Sl. No.	Variable	Bt cotton	Non Bt cotton	Pooled
1.	Intercept	0.45	3.16	0.29
2.	Seeds (kg)	0.31 (0.20)	-0.01 (0.03)	-0.18 (0.53)
3.	Animal power (pair days)	0.11 (0.12)	0.09** (0.05)	-0.03 (0.07)
4.	Human labor (person days)	0.12 (0.18)	0.29** (0.14)	0.14 (0.13)
5.	Inorganic fertilizers (kg)	0.28* (0.06)	0.18** (0.07)	0.27* (0.05)
6.	Organic manure (t)	0.05* (0.02)	0.12* (0.04)	0.05* (0.01)
7.	Plant protection Chemicals (Rs.)	0.16* (0.04)	-0.15 (0.09)	0.06 (0.03)
8.	Dummy (Bt)	-	-	0.24* (0.04)
9.	R^2	0.64	0.79	0.74

Note: ** Significant at 1 per cent level.

* Significant at 5 per cent level.

Figures in parenthesis indicate standard errors of coefficients.

Table 2. Ratios of MVP to MFC in Bt and non Bt cotton farms

Sl. No.	Items	Bt cotton	Non Bt cotton
1.	Seeds	9.08	-0.40
2.	Animal power	5.06	3.81
3.	Human labor	0.92	1.98
4.	Inorganic fertilizers	5.61	2.99
5.	Organic manure	3.63	7.53
6.	Plant protection chemicals	0.98	-0.47

Table 3. Estimates of decomposition of output change between Bt technology and inputs in cotton production.
(Percentages)

Sl. No.	Particulars	Estimates
1.	Total change in output	16.64
2.	Source of change	
A.	Bt cotton technology	32.73
B.	Change due to all inputs	-16.14
a.	Seeds	-8.37
b.	Animal power	0.33
c.	Human labor	1.42
d.	Inorganic fertilizers	-1.27
e.	Organic manure	0.075
f.	Plant protection chemicals	-8.33