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Resource use efficiency in *Bt* cotton- An economic analysis

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ABSTRACT : This study was attempted to assess the resource use efficiency in *Bt* cotton and non *Bt* cotton cultivation in Haveri district of Karnataka. The results showed that the regression coefficients of seeds, human labour and fertilizers in *Bt* cotton cultivation, seeds and human labour in non *Bt* cotton cultivation are significant indicating that increase of these resources over and above the present level lead to significant increase in gross returns. The regression coefficients of plant protection chemicals in *Bt* and non *Bt* cotton cultivation was negative and statistically non significant implying no economic meaning. Therefore, to connote the importance of *Bt* cotton against non *Bt* cotton regarding use of plant protection chemical, modified regression model encompassing gross returns/rupee of pesticide use was regressed on dummy and FYM. The results revealed that *Bt* cotton growers gross returns are likely to increase by Rs. 6.81 as compared to Rs 1.29 in case of non *Bt* growers for every rupee expenditure on pesticide. The allocative efficiency was greater than one for seeds, organic manure, human labour, machine bullock labour for both *Bt* cotton and non *Bt* cotton.

Key words : Allocative efficiency, *Bt* cotton, resource use efficiency

Cotton (*Gossypium* spp) the queen of fibres is multipurpose crop grown under various agro climate conditions. It is cultivated mainly for its lint which is the most sought textile fibre due to its inherent eco friendly and comfort characters. Cotton is major supplier of raw material to textile industry. Cotton plays an important role in generation of employment and foreign exchange. The varieties grown include DCH 32, Binny, Kanaka, BG1, BG2 and Suvin. In the recent past, *Bt* cotton has emerged as a leading variety in the region. Cultivation of cotton requires several resources such as FYM, fertilizers, plant protection chemicals, seeds, labourers etc. It is essential to know the contribution of each one of these to total output. Hence, the present study was undertaken with an objective to empirically analyze the resource use efficiency in cotton in general and *Bt* cotton in particular.

The study was carried out in Haveri District of Karnataka during 2010-2011 as it has larger area under cotton cultivation in the state. It falls under northern transitional zone (Zone 8) of Karnataka. A multistage random sampling was adopted for the selection of sample *taluks*, villages and farmers. In the first stage, Hirekerur *taluk*, having maximum area under cotton was selected and in the second stage 5 villages inter alia Rattihalli, Kod, Battikoppa, Bogavi and Suttagtti were selected. From each village, 10 *Bt* and 10 non *Bt* cotton growing farmers were selected. Primary data pertinent to resource use pattern and output obtained were elicited from the sample farmers using well structured schedule. Cobb-Douglas production function was employed to assess the resource use efficiency in *Bt* cotton *v/s* non *Bt* cotton. The estimated regression coefficients represent the output elasticity of respective input used. The form of Cobb-Douglas production function used in the present study was as follows

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} e^{u_i}$$

The logarithmic form of equation is as below,

$$\text{Ln } Y = \text{Ln } a + b_1 \text{Ln } X_1 + b_2 \text{Ln } X_2 + b_3 \text{Ln } X_3 + b_4 \text{Ln } X_4 + b_5 \text{Ln } X_5 + b_6 \text{Ln } X_6 + u_i$$

Where,

X_1 = value of seeds (Rs/ac)
X_2 = value of FYM (Rs/ac)
X_3 = value of human labour(Rs/ac)
X_4 = value of bullock labour(Rs/ac)
X_5 = value of fertilizers(Rs/ac)
X_6 = value of plant protection chemicals (Rs/ac)

MVP of i^{th} resource = $b\frac{\overline{Y}}{\overline{X_i}}$

Where,

$\overline{Y}$ = Geometric mean of the output

$\overline{X_i}$ = Geometric mean of ith independent variable

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

In order to estimate the efficiency in the allocation of resources, the value of the marginal product (MVP) obtained by multiplying the marginal product (MPP = $b_i * \frac{\overline{Y}}{\overline{X_i}}$) with the price of the product (P_y), was compared with the Marginal factor or input cost (MFC or MIC), which is nothing but price of input (P_x). A ratio of MVP to MIC more than unity implied that the resources were efficiently used. A ratio of less than one indicate that the resource under consideration was over utilized.

The CD type of production function was fitted to analyze factor product relationship in both *Bt* and non *Bt* cotton. The gross income (Rs.) realized from *Bt* and non *Bt* cotton was used as an endogenous variable and regressed upon the exogenous variables inter alia expenditure made on seeds (Rs), fertilizers, FYM (Rs), human labour (Rs) machine/bullock labour (Rs) and plant protection chemicals (Rs.). The estimates of the production functions are presented in Table 1.

The intercept reflects the contribution of those factors, not included in the model. It was slightly higher in case of non *Bt* cotton (1.50) compared to *Bt* cotton (0.32). The coefficient of multiple determination (R^2) for *Bt* and non *Bt* cotton was 0.86 and 0.67, respectively. This indicates that the variables included in the production function explained about 86 per cent and 67 per cent of the total variation in the gross income realized (dependent) from *Bt* and non *Bt* cotton cultivation respectively. Hungar *et al.*, 2010)

In case of *Bt* cotton, the regression coefficient for seed use (0.58) and human labour (0.4222) was found to be highly significant at one per cent level of significance, while fertilizer use (0.17) was significant at 5 per cent level. The coefficient for FYM use (0.09) was positive but non significant and similarly for plant protection chemicals (-0.02) it was negative but non significant.

In case of non *Bt* cotton, the estimated regression coefficient for seed (0.54) and human labour (0.39) was significant at 1 and 5 per cent level of significance respectively, while fertilizer use (0.06), FYM use (0.12), machine / bullock labour use (0.09) were found positive but non significant. The coefficient of plant protection chemicals (-0.08) was negative and non significant.

The output elasticities of seeds, human labour and fertilizers in case of *Bt* cotton and seeds and human labour in case of non *Bt* cotton are found to be significant at varied level of significance indicating that the increase in the use of these resources over and above the present level (%) results in significant increase in gross returns realized by b_i per cent. The regression coefficient of plant protection chemicals in both *Bt* and non *Bt* cotton cultivation was negative but statistically insignificant implying no economic meaning. The CD function do not attain maximum and there is no scope for getting negative coefficients indicating overuse of the resources.

The comparison of marginal value product with marginal factor cost of the resources facilitates to arrive at optimal level of resource

Table 1. Estimates of Cobb-Douglas production function in *Bt* cotton and non *Bt* cotton cultivation during 2010-2011

Variables	Regression coefficients (elasticities)			
	Bt cotton	t value	non *Bt* cotton	t value
Intercept	0.32	0.88	1.50	1.01
Seeds (Rs)	0.58**	4.69	0.54**	4.96
FYM (Rs)	0.09	1.89	0.12	1.58
Human labour (Rs)	0.42**	4.28	0.39*	3.09
Machine / bullock labour (Rs)	0.05	0.22	0.09	1.24
Fertilizers (Rs)	0.17*	2.70	0.06	1.22
PPC (Rs)	-0.02	-0.72	-0.08	-0.57
Adjusted R^2	0.86		0.67	

Note : ** and * indicate significance at 1 and 5 per cent levels, respectively

Table 2. Allocative efficiency in *Bt* and non *Bt* cotton production during 2010-2011

Inputs	*Bt* cotton			Non *Bt* cotton		
	MVP	MFC	MVP/MFC	MVP	MFC	MVP/MFC
Seeds (Rs)	9.96	1	9.96	9.37	1	9.37
Organic manure (Rs)	4.50	1	4.50	5.69	1	5.69
Human labour (Rs)	3.36	1	3.36	2.27	1	2.27
Bullock labour (Rs)	1.19	1	1.19	1.10	1	1.10
Fertilizers (Rs)	3.41	1	3.41	0.86	1	0.86
PP Chemicals (Rs)	-0.56	1	-0.56	-0.73	1	-0.73

MVP : Marginal value product, MFC : Marginal factor cost

use. Table 2 provides details of allocative efficiency. In case of *Bt* cotton, MVP to MFC ratio for seeds (9.96), organic manure (4.50), human labour (3.36), machine / bullock labour (1.19) and fertilizers (3.41) were more than unity indicating suboptimal use of these resources. There is further scope to use the above resources to become price efficient. Similarly the ratio of MVP/MIC was greater than one for seeds, organic manure, human labour and machine / bullock labour in case of non *Bt* cotton indicating their suboptimal use in the production process. Farmers are suggested to increase the level of use of these resources (Donie *et al.*, 2010)

The regression coefficient for the plant protection chemicals in case of both *Bt* and non *Bt* cotton was negative and statistically non significant, hence its MVP/MIC ratio will also be negative indicating the over use of plant protection chemicals in the production process. This result is not in line with the theoretical reality of the CD production function (CD function do not attain maximum). Further, this result also fails to signify the importance of *Bt* cotton as against non *Bt* cotton, for which more than 90 per cent of the area under cotton is brought under *Bt* by the farmers as it saves the cost on plant protection chemicals, which forms the major chunk in the total cost of cultivation. Therefore to emphasize the importance of *Bt* cotton as against non *Bt* cotton, a modified regression model was built considering gross returns/rupee of pesticide use as a dependent variable. It was regressed upon a dummy variable (0 for non *Bt* and 1 for *Bt* cotton), and all other inputs commonly used in the production of both the crops. But the result of such a regression model yielded negative intercept which is incorrect from both economic and statistical sense. Further to overcome this problem, the backward elimination method of regression was employed which resulted in a model where Gross returns/rupee of pesticide use was the function of dummy and FYM. The results of the regression model are presented in Table 3. The result revealed that the cultivation of *Bt* cotton increased their returns by Rs. 6.81 for every one rupee of expenditure on plant protection chemicals. Whereas the gross returns realized by the non *Bt* growers was only Rs. 1.29 for every rupee expended on pesticide use. This clearly reflected that *Bt* cotton is efficient to provide better returns to investment on plant protection than non *Bt* cotton. These results are in a ccordance with the findings of Manjunath *et al.*, 2011.

Table 3. Results of regression of analysis with dummy variables during 2010-2011

Variables	Coefficients	t value
Intercept	1.29	1.47
Dummy (1 for *Bt* 0 for non *Bt* cotton)	6.81**	12.46
FYM	0.009**	6.13
Adjusted R^2		0.76

** indicate significance at 1 per cent level

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