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RESEARCH ARTICLE :

Resource productivity and resource use efficiency in Bt cotton production in Beed district

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SUMMARY : Investigation was carried out during the year 2013-14. About 96 Bt cotton growers were randomly selected from eight villages of two tehsils of Beed district. Cross sectional data were collected from Bt cotton growers with the help of pretested schedule by personal interview method. Data were related to Bt cotton outputs and inputs like human labour, bullock labour seed, manure, fertilizer and plant protection as resources. Cobb-Douglas production function was fitted to the data. The result revealed that, regression co-efficient of area under cotton was 0.247 followed by that manure (0.142) which were positive at 5 per cent level. Regression co-efficient of nitrogen was 0.093 which were negative at 5 per cent level. Regression co-efficient of human labour was 0.234 which was positive at 1 per cent and bullock labour 0.129 which was negative at 1 per cent. Regression co-efficient of phosphorus, potash and irrigation were positive but non-significant. Co-efficieant of marginal product of area under cotton growers was 6.803 quintals followed by that of seed (1.057q), plant protection (0.332 q) manure (0.209 q) and human labour (0.098 q), phosphorus (54.45 q) and so on. MVP to price ratio with respect to phosphorus was (5.27) followed by manure (3.97), potash (3.13), seed (2.51) and human labour (2.33). Hence, preference might be given to increase human labour on priority basis in cotton production. Optimum use of area under cotton was found to be 1.76 hectares. Co-efficient of multiple determination (R^2) was 0.847 means 84.70 per cent effect of all indipendant variables on main produce.

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BACKGROUND AND OBJECTIVES

Cotton (*Gossypium* spp.) 'king of fibre' belonging to the genus *Gossypium* under *Malvaceae* family which closely linked to the human civilization itself is a large, rich and economically important germ comprising about 40 species of which four are commercially cultivated for cotton lint and seed. Cotton is a basic raw material for textile industry. All the four cultivated species are being grown in India *viz.*, *Gossypium hirsutum*, *Gossypium barbadense*, *Gossypium arborium* and *Gossypium herbacium*. *Gossypium hirsutum* which covers about 50 per cent of the area followed by that of *Gossypium arborium* with 29 per cent and *Gossypium herbacium* with 21 per

cent. Area under *Gossypium barbadense* is negligible and covers only a few thousand hectares.

The 11 million hectares Bt cotton is 95 per cent of the total 11.6 million hectares of Indian cotton, an increase of 2 per cent from the 93 per cent adoption rate in 2012. The major Bt cotton producing states are Punjab, Haryana, Maharashtra, Madhya Pradesh and Andhra Pradesh. The crop is mostly grown in Marathwada region. The Maharashtra state is contributing 22.70 per cent of total production in the country. Area under cotton crop in Maharashtra state 41.46 lakh hectare with production of 79.00 lakh bales and productivity 324 kg per hectare in year 2012 (Source-Cotton Advisory Board–2013). In Beed district total area under cotton in year 2013 total area under cotton is 2097 hectare out of 4192 hectare of total cultivated area (Source–District Agriculture Officer, Beed 2013).

RESOURCES AND METHODS

Multistage sampling design was adopted for selection of district, tehsils, villages, as well as producer farmer of Bt cotton. In the first stage, Beed district was purposively selected on the basis of area under the Bt cotton production. In the second stage, Georai and Beed tehsils was selected on the of basis higher area under Bt Cotton. In third stage, eight villages were selected from the selected tehsils on the basis of highest area under Bt cotton production. The selected villages were namely Jategaon, Kekat Pangri, Golegaon, Thakar-Adgaon in Gevrai tehsil and Kalasambar Balapur, Neknur, Mandavkhel in Beed tehsil. In the fourth stage, from each village, the separate list of Bt cotton grower was prepared. From each of the lists twelve farmers of Bt cotton were randomly selected. Thus, from one village, twelve farmers were selected with equal distribution. Thus total 96 farmers of Bt cotton were selected for present study. The cross sectional data were collected from 96 cotton growers with the help of pre-tested schedule for the year 2013-2014.The data were related to use of resources namely area under cotton, human labour, bullock labour, seed, manures and fertilizer, plant protection. Data were also related to cotton seed production. Cobb- Douglas production function was fitted to the data to estimate resource use efficiency with respect to each of the explanatory variables. The fitted equation was as follows.

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} \ldots\ldots X_n^{bn} e^u$$

In this functional form 'Y' is dependent variable, 'X_i' are independent resource variables, 'a' is the constant representing intercept of the production function and 'bi' are the regression co-efficients of the respective resource variables. The regression co-efficients obtained from this function directly represent the elasticities of production, which remain constant throughout the relevant ranges of inputs. The sum of co-efficients that is 'bi' indicates the nature to returns of scale. This function can easily be transformed into a linear form by making logarithmic transformation. After logarithmic transformation of this function is,

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots\ldots + b_n \log X_n + u \log e$$

The main consequences of multicollinearity are (a) the sampling variances of the estimate co-efficients increases as the degree of collinearity increases between the explanatory variables (b) estimated co-efficients may become very sensitive to small changes in data that is addition or deletion of few observations produce a drastic change in some of the estimates of the co-efficients. This results in non significance of regression co-efficients sometimes it so happens that more of the regression co-efficients are significant but the value of R^2 is very high. The equation fitted was of the following formula.

$$Y = a X_1^{b1} . X_2^{b2} . X_3^{b3} . X_4^{b4} . X_5^{b5} . X_6^{b6} . X_7^{b7} . X_8^{b8} . X_9^{b9}$$

where,

Y = Estimated cotton production in quintals per farm

a = Intercept of production function, bi = Partial regression co-efficient of the respective resource variable (i=1, 2,…,9), X_1 =Area under cotton in hectares per farm, X_2 = Human labour in man days per farm , X_3 = Bullock labour in pair days per farm, X_4 = Seed in kg per farm, X_5 = Manures in quintals per farm, X_6= Nitrogen in kg per farm, X_7= Phosphorus in kg per farm, X_8= Potash in kg per farm and X_9= Irrigation in m^3 per farm.

The marginal value of product of resource indicates the addition of gross value of farm production for a unit increase in the 'i'th resource with all resources fixed at their geometric mean levels. The MVP of various inputs is worked out by the following formula :

$$MVP = \frac{b\bar{Y}}{\bar{X}} Py$$

where,

b = Regression co-efficient of particular independent variable, $\bar{X}$= Geometric mean of particular independent variable, $\bar{Y}$ = Geometric mean of dependent variable, Py

= Price of dependent variable.

OBSERVATIONS AND ANALYSIS

The findings with respect to elasticity of production, marginal production resource use efficiency and optimum resource use were obtained as presented as follows.

Elasticity of Bt cotton production :

Regression co-efficient with respect to various explanatory variables were calculated and are presented in Table 1. It was observed from the table that regression co-efficient of area under cotton was 0.247 which was positive and highly significant at five per cent level. It inferred that when five per cent increased in use of area under cotton over its geometric mean, it would lead to increase production of cotton by 0.247 per cent. Regression co-efficients of manure was also positive and significant. When use of manure was increased by five per cent, it would lead to increase cotton production by 0.142 per cent. Similarly regression co-efficients of human labour was 0.234 per cent significant at five per cent. Regression co-efficients of Bullock labour was negative 0.129, significant at five per cent level and nitrogen was 0.030 at one per cent. Regression co-efficients of phosphorus, potash, seed and plant protection are positive but non-significant. On the contrary, regression co-efficient of potash was negative and non-significant. Co-efficient of multiple determination was 0.847, it means that there was 84.70 per cent effect of all independent variables together on cotton production. Returns to scale was found to be 0.633 which indicated that production of cotton was found in decrease returns to scale.

Marginal productivity of Bt cotton :

Resource productivity with respect to various explanatory variables was estimated and is also presented in Table 1. It was obvious that the marginal productivity with respect to area under cotton was the highest as 6.803 quintals, followed by that of seed (1.057 q), plant protection (0.332 q), manure (0.209 q), human labour (0.098 q), phosphorus (0.046 q) and potash (0.018 q). It inferred that if area under cotton production was increased by one hectare at its geometric mean level, it would lead to increase production of cotton with 6.803 quintals. Similarly, per unit of seed, plant protection, manure, human labour, phosphorus, potash1.057, 0.332, 0.209, 0.098, 0.046 and 0.018 qtl. Could be increased then it would cause to increase production of cotton, respectively.

Resource use efficiency in cotton Bt cotton production :

In regards to resource efficiency, it was also evident from the Table 1 that MVP to price ratio with respect to phosphorus was highest as 5.27 followed by manure (3.97), potash (3.13), seed (2.51) and human labour (2.33). It inferred that in Bt cotton production system use of phosphorus was highly under utilization. Hence, preference might be give to increase phosphorus the

Table 1: Estimates of Cobb-Douglas production function in Bt cotton production

Sr. No.	Independent variable	Regression co-efficient (bi)	Standard error (SE)	't' value	Geometric mean (Xi)	Marginal produce (q)	Marginal value produce (Rs.)	Price of input (`Rs.)	MVP to price ratio	Optimum resource use
1.	Area under Bt-cotton (ha/farm)	0.247	0.092	2.684**	1.16	6.803	32382.28	21382.96	1.51	1.76
2.	Human labour (man day/farm)	0.234	0.102	2.294*	75.60	0.098	466.48	180	2.33	197.70
3.	Bullock labour (pair day/farm)	-0.129	0.062	-2.080*	17.87	-0.230	-1094.80	400	-2.73	-
4.	Seed (kg/farm)	0.092	0.098	0.938	2.78	1.057	5031.32	2000	2.51	6.99
5.	manure (q/farm)	0.142	0.048	2.958**	21.69	0.209	994.84	250	3.97	86.38
6.	Nitrogen (kg/farm)	-0.093	0.034	-2.375**	96.40	-0.030	-142.80	13.47	-10.60	-
7.	Phosphorus (kg/farm)	0.079	0.089	0.887	54.45	0.046	218.65	41.47	5.27	289.71
8.	Potash (kg/farm)	0.025	0.051	0.490	43.80	0.018	85.68	27.33	3.13	139.11
9.	Plant protection (lit./farm)	0.036	0.029	1.241	3.464	0.332	1580.32	810.32	1.95	6.75

Note: Geometric mean of ($\bar{Y}$) cotton production was 31.95 q per farm and price was Rs.4760/q
Intercept (log a) ---------- 0.513 F value ------- 2.54** R^2 -------- 0.847 Return to scale(Σbi) ---- 0.633
* and ** indicate significance of values at P=0.05 and 0.01, respectively

priority basis in Bt cotton production. Similarly, use of manure, potash could be increased in order to resource use efficiency in terms of money in Bt cotton production than important to be give for use seed as well as human labour in Bt cotton production. On the contrary, in regard to Bullock labour and nitrogen, MVP to price ratio was negative. Use of bullock labour and nitrogen in Bt cotton production was excess.

Optimum resource use in Bt cotton production :

In regards to optimum resource use, it was observed that optimum area under Bt cotton was 1.76 hectares. Use of human labour and manure could be increased upto 197.70 man days and 86.38 quintals, respectively. Use of bullock labour and nitrogen was over utilisation in Bt cotton production while the optimum resource use of phosphorus, potash, seed and plant protection in Bt cotton production could be 289.71 kg and 139.11 kg, 6.99 kg and 6.75 lit., respectively.

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