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Resource productivity and resource use efficiency in cotton production

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Abstract
Investigation was carried out during the year 2014-15. About 48 non-mechanised Famrs were randomly selected from sixteen villages of two tehsils in Parbhani district of Maharashtra. Data were related to cotton output and input like area under crop, hired human labour, bullock labour, machine labour, seed, manure, nitrogen, phosphorus, Potash and plant protection. The results revealed that partial regression coefficient of Bullock labour was 0.130 followed by Manure was 0.111 significant at 1 per cent level and plant protection (0.108) was significant at 5 per cent level. Partial regression coefficient of area under crop, hired human labour, nitrogen, phosphorus, irrigation, plant protection were positive but non-significant. Marginal product of area under crop was 0.448q followed by manure (0.148q). MVP to price ratio with respect to nitrogen was 23.26 followed by plant protection (7.78), manure (4.73). Optimum resource use of nitrogen was 944.82 and irrigation was 1684.6.

Keywords: Lentil, fusarium, fungicides, evaluation, neem

Introduction
Cotton (*Gossypium spp*.) is one of the most important commercial crop playing a key role in economics, political and social affairs of the world. 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.
India is the third largest producer of cotton in the world with production of around 3.95 million tones (approximately 15.71 per cent of the world production). Area under cotton is around 9.50 million hectares. India ranks third in the world output of cotton due to its low average yield of 415 kg against world average of 721 kg per hectare.
Cotton is cultivated in almost all the state in the country. However, the 9 states like Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Karnataka account for more than 95 per cent of the area under cotton. Maharashtra is the first in area and production of cotton in the country. It has 2.83 million hectares area under cotton crop with production of 0.68 million tonnes of lint (6.04 million bales) in the year 2010-2011. The productivity of cotton during this year was 176 kg per hectare lint yield (686 kg/ha seed cotton yield) Thus, state is contributing 22.70 per cent of total production in the country.

Methodology
Sampling design
Multistage sampling design was adopted for selection of district, tehsils, villages and non-mechanised farms. In the first stage, the Parbhani district was purposively selected because of mostly existence of non-mechanised farmings. In the second stage, Parbhani and Jintur tehsils were selected on the basis of higher area under non-mechanised farms. In the third stage, eight villages were selected from the each of tehsils on the basis of higher area under non-mechanised farms. From Parbhani tehsil villages were selected namely Takli, Jamb, Parwa, Digras, Mandwa, Lohgaon, Sayala and Wangi while from Jintur tehsil villages were selected namely Bhogaon, Pachlegaon, Ridaj, Nandgaon, Dudhgaon, Nagapur, Chandaj and Jawla. In the fourth stage, from each village, the list of non-mechanised farmers along with their holding sizes was obtained. Three non-mechanised farmers were randomly selected from each of the villages. In this way, from sixteen villages, 48 farmers were selected for the present study.The data were related to use of resources namely area under cotton, human labour, bullock labour, machine labour, seed, fertilizer, plant protection and irrigation.

Cobb-Douglas production function was fitted to the data to estimate resource use efficiency with respect to each of the explanatoryvariables. The fitted equation was as follows.

$\hat{Y} = aX_1^{b1} \times X_2^{b2} \times X_3^{b3}$ -------- $X_n^{bn}.e^u$

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 coefficients of the respective resource variables. The regression coefficients obtained from this function directly represent the elasticities of production, which remain constant throughout the relevant ranges of inputs. The sum of coefficients 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,

$\text{Log } Y = \log_a + b_1 \log X_1 + b_2 \log X_2 + \ldots\ldots b_n \log X_n + u \log e$

The main consequences of multicollinearity are (a) the sampling variances of the estimate coefficients increases as the degree of collinearity increases between the explanatory variables (b) estimated coefficients 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 coefficients. This results in non significance of regression coefficients sometimes it so happens that more of the regression coefficients are significant but the value of R^2 is very high. The equation fitted was of the following formula.

$\hat{Y} = aX_1^{bi}.X_2^{b2}.X_3^{b3}.X_4^{b4}.X_5^{b5}.X_6^{b6}.X_7^{b7}.X_8^{b8}.X_9^{b9}.X_{10}^{b10}.X_{11}^{b11}.X_{12}^{b12}$

Where

$\hat{Y}$ = Estimated cotton production in quintals per farm

a = Intercept of production function, bi = Partial regression coefficient of the respective resource variable (i=1, 2,…,9), X_1 =Area under cottonin hectares per farm, X_2 = Human labour in man days per farm, X_3 = Bullock labour in pair days per farm, X_4 = machine labour in hour per farm, X_5 = seed in kg per farm, X_6= manure in quintals per farm, X_7= Nitrogen in kg per farm X_8 = Phosphorus in kg per farm,X_9= potashin kg per farm,X_{10} = Irrigation in m^3 per farm, X_{11} =plant protection in liter per farm and X_{12} = Family human labour.

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.

Marginal value product (MVP)

It refers to the product of MP and Py where, MP is marginal productivity and P_y is the price of produce major crops per quintal. The MVP with respect to input factor is worked out by the following formula

$$MVP = bi \frac{\overline{Y}}{\overline{X}} p_y$$

Where,

bi = Partial regression coefficient of particular independent variable

X = Geometric mean of particular independent variable

$\bar{Y}$ = Geometric mean of dependent variable P_y = Price of dependent variable

Discussion

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

Elasticity of cotton production

The results revealed that partial regression coefficient of bullock labour was 0.130 which was positive and highly significant at one percent level. It inferred that when one percent increased in use of bullock labour over its geometric mean, it would lead to increase production of cotton by 0.130 percent. Similarly manure and potash were significant at 1 percent level. Partial regression coefficient of plant protection was 0.108 which was positive and significant at 5 percent level. Coefficient of multiple determination (R^2) was 0.947, it means that there was 94.70 percent effect of all independent variables together on cotton production. Return to scale was found to be 0.336, which indicated that production of cotton was found in decrease returns to scale.

Resource productivity

Resource productivity could indicate marginal product of individual independent variable. The results revealed that in existing condition area of cotton was 0.61 hectares. Use of hired human labour was 30.20 mandays. Bullock labour and machine labour showed 5.75 and 1.23 hours, respectively. Use of seed was 1.04 kg. Applications of manures were 5.99 quintals. In existing condition nitrogen, phosphorus and potash was 40.62 kg, 11.38 kg and 8.75 kg, respectively. Use of plant protection was 1.07 liters.

Resource use efficiency

In regard to resource use efficiency, it was also evident from the table that use of nitrogen in cotton production indicated MVP to price ratio as 23.26 followed by plant protection (7.78). It implied that there was scope to increase these resources in cotton production.

Optimum resource use

In regards to optimum resource use it was observed that optimum use of irrigation was 1684.6 followed by nitrogen (944.82) manure (28.33).

Table 1: Estimates of Cobb-Douglas production function in cotton production on non mechanised farm

	Independent variable	Partial regression coefficient (bi)	Standard error (SE)	't' value	Geome-tric mean (Xi)	Marginal product (q)	Marginal value product (Rs.)	Price of input (Rs.)	MVP to price ratio	Optimum resource use (Xi)
1.	Area under cotton (ha/farm)	0.034	0.025	1.326	0.61	0.448	2150.40	8683.62	0.25	0.15
2.	Hired human labour (manday/farm)	0.007	0.007	0.982	30.20	0.001	4.80	200	0.02	0.60
3.	Bullock labour (pairday/farm)	0.130	0.046	2.822**	5.75	0.181	868.80	662.64	1.31	7.53
4.	Machine labour (hour / farm)	-0.349	0.185	-1.884	1.23	-2.282	-10953.60	500	-21.90	---
5.	Seed (kg/farm)	-0.121	0.080	-1.500	1.04	-0.935	-4488	2000	-2.24	---

6.	Manure (q/farm)	0.111	0.034	3.213**	5.99	0.148	710.40	150	4.73	28.33
7.	Nitrogen (kg/farm)	0.319	0.233	1.364	40.62	0.063	302.40	13	23.26	944.82
8.	Phosphorus (kg/farm)	0.007	0.009	0.713	11.38	0.004	19.20	46	0.42	4.78
9.	Potash (kg/ farm)	-0.172	0.064	-2.699**	8.75	-0.158	-758.40	27	-28.08	---
10.	Irrigation (m^3/farm)	0.143	0.141	1.012	443.21	0.002	9.60	2.52	3.80	1684.6
11.	Plant protection (L/farm)	0.108	0.044	0.446*	1.07	0.811	3892.80	500	7.78	8.32
12.	Family human labour (manday)	0.119	0.063	1.884	7.40	0.129	619.20	200	3.09	22.87

* Significant at 5 per cent
** Significant at 1 per cent

Intercept (log a) ---------- 0.82 Note:- Geometric mean of ($\bar{Y}$) cotton production was
F-value ----------16.22 ** 8.04 q per farm and price was Rs 4800/q
R^2---------- 0.947
Return to scale (Σb_i) ---------- 0.336

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