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Resource Use Efficiency in Sugarcane Production in Kawardha and Balod District of Chhattisgarh

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Abstract
The functional analysis was carried out to know the contribution of independent variables in yield of sugarcane. From the estimated Cobb-Douglas production function (log linear production function), it was observed that, the estimated regression co-efficient of variables (inputs) pertaining to the data for production of sugarcane was highly significant under all the three methods of irrigation, which was found to be two value of R^2 0.5495, 0.5980 and 0.4181 for flood, sprinkler and drip irrigation method, respectively. It indicates that variable inputs have functional relationship contributed as 54.95, 59.80 and 41.81 percent for respective method of sugarcane cultivation. Whereas, MVP to FC ratios was more than unity for zinc indicated under utilization of these resources in sugarcane cultivation which underlines scope of expanding the use of these inputs.

Keywords: Resource use efficiency, MVP, MFC ratio, Allocative efficiency

Introduction
Considering the importance of sugarcane in economy of farmers, state and country the present study was conducted in kawardha and balod district of Chhattisgarh state, since this district is witnessing development rapidly as sugarcane producers from the non-traditional areas of the state. The study was conducted to know the per hectare cost of production and profitability of sugarcane. The results of economics of sugarcane cultivation would help to the cane growers for taking decisions, regarding investment in scarce resources such as land, labour and capital for cost minimization and profit maximization by keeping their resource use efficiency optimally. In view of this study on resource use efficiency in sugarcane production in kawardha and balod district of Chhattisgarh was undertaken.

Methodology
The present study was carried out in Kawardha and Bodla block of Kabirdham district and Balod itself and Gunderdehi block of Balod as district area under sugarcane cultivation was maximum in these four blocks. The final sample consisted of 20 villages and 200 sugarcane cultivators. The sugarcane cultivators were classified into three groups on the basis of type of irrigation method for sugarcane grower *i.e.* i) flood irrigation ii) sprinkler irrigation and iii) Drip irrigation. The field level data was collected from randomly select sugarcane growers on well designed questionnaire schedule through personal interviews with the sugarcane cultivators.

Functional analysis
The Cob b -Douglas (1928) production function (non- linear production function) was used to determine the resource use efficiency. The functional analysis was carried out by using the following from of equation.

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

In this functional from 'Y' is dependent variable, 'X ' are independent resource variables, 'a' is the constant representing intercept of the production function and X bi are the regression co-efficient of the respective resource variables.

The equation fitted was of the following type.

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

Where,

Y	=	Yield in tonnes/ha
X_1	=	Seed /ha
X_2	=	Nitrogen (kg/ha)
X_3	=	Phosphorus (kg/ha)
X_4	=	Potassium (kg/ha)
X_5	=	Sulphur (kg/ha)
X_6	=	Zinc sulphate (kg/ha)
X_7	=	Human labour (□./ha)
X_8	=	Machine hours (□/ha)
X_9	=	Harbicide (□/ha)
X_{10}	=	Pesticide (□/ha)
X_{11}	=	Fungicide (□./ha)
a	=	Intercept

Marginal product (MP)

The Cobb-Douglas production function allows constant, increasing or decreasing marginal productivity. The marginal product equation used is as follows:

$$\mathbf{MP} = \frac{\mathbf{dy}}{\mathbf{dx}} = \mathbf{baX^{b-1}} = \frac{\mathbf{bax^b}}{\mathbf{X}} = \mathbf{bi}\frac{\bar{\mathbf{Y}}}{\mathbf{X}}$$

Marginal value product (MVP)

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

$$\mathbf{MVP} = \mathbf{bi}\frac{\bar{\mathbf{Y}}}{\mathbf{Xi}}\mathbf{Py} \quad -$$

where,

bi =Partial regression co-efficient of particular independent variable

Xi = Geometric mean of particular independent variable.

Y = Geometric mean of dependent variable.

_ Py = Price of dependent variable.

Marginal factor cost (MFC)

MFC = Price per unit of the input.

Observations and Analysis

1. Resource productivities of inputs in sugarcane cultivation

The importance of this to provide the elasticity of production of inputs (x_i) and the estimated functional relationship is presented in table 1**.** It reveals that the estimated regression co-efficient of variables (inputs) pertaining to the data for production of sugarcane was highly significant under all the three methods of irrigation, which was found to be two value of R^2 0.5495, 0.5980 and 0.4181 for flood, sprinkler and drip irrigation method, respectively.

It indicates that variable inputs have functional relationship contributed as 54.95, 59.80 and 41.81 percent for respective method of sugarcane cultivation.

The input seed, fertilizer potassium such as (K_2O), zinc and human labour were contributed significantly to the productivity of sugarcane under flood method of irrigation and found to be 0.0244, 0.0321, 0.0562 and 0.0406 value of co-efficient, respectively.

The functional relationships between sugarcane productivity and different variable inputs have also been indicated the similar findings under sprinkler method of irrigation as noticed in flood method of irrigation. It reveals that seed, fertilizer such as potassium, zinc and human labour were contributed significantly to productivity of sugarcane and noticed to be 0.0106, 0.0473, 0.0634 and 0.3727 co-efficient values, respectively.

Drip method is considered as the precision farming of sugarcane cultivation. The co-efficient value of seed and human labour as 0.05 and 0.2814 and it was found to be significant contribution to productivity of sugarcane.

Table 1: Regression co-efficient of independent variables in estimated Cobb-Douglas type of production function in sugarcane cultivation

S. N.	Variables	Estimated regression co-efficient		
		Flood	Sprinkler	Drip
1.	Seeds (□)(X_1)	0.0244***	0.0106***	0.05***
		(0.0024)	(0.0024)	(0.0114)
2.	Nitrogen (Kg.)(X_2)	0.0127	0.0139	0.0204
		(0.0202)	(0.0239)	(0.0315)
3.	Phosphorus (Kg.)(X_3)	-0.00937	-0.0846***	-0.0673
		(0.0255)	(0.0289)	(0.0417)
4.	Potassium (Kg.)(X_4)	0.0321**	0.0473***	0.0067
		(0.0135)	(0.0141)	(0.026)
5.	Sulphur (Kg.)(X_5)	0.0117	0.0236	0.0132
		(0.0147)	(0.0145)	(0.0279)
6.	Zinc (Kg.)(X_6)	0.0562***	0.0634***	0.0383
		(0.0163)	(0.0146)	(0.0329)
7.	Human labour (□)(X_7)	0.0406***	0.3727***	0.2814***
		(0.0423)	(0.053)	(0.0826)
8.	Machine hours (□)(X_8)	-0.0848***	-0.014	-0.0594***
		(0.0125)	(0.0135)	(0.0193)
9.	Harbicide (□)(X_9)	0.0041	0.0129	0.0002
		(0.0101)	(0.0123)	(0.0133)
10.	Pesticide (□)(X_{10})	0.0097	0.0051	0.0006
		(0.0081)	(0.0114)	(0.0159)
11.	Fungicide (□)(X_{11})	0.0024	-0.0042	-0.0106
		(0.0029)	(0.0031)	(0.0059)
12.	Intercept (a)	0.1204	0.1374	0.7952
		(0.1884)	(0.226)	(0.3693)
13.	R^2	0.5495	0.598	0.4181
14.	F value	32.8301***	15.6892***	3.1353***

Figures in parenthesis indicate standard errors to total *,**, *** indicate significance of values at P=0.10,0.05 and 0.01, respectively

2. Resource use efficiencies in flood irrigation system for sugarcane production

The allocative resource use efficiency in flood irrigation system for sugarcane production was calculated and results are presented in Table 2.

It seems from the Table 1that in production of sugarcane under flood irrigation system MVP to FC ratio is less than unity for seed (0.00079) followed by nitrogen (0.21268), phosphorus(-0.43484), potassium (0.07695), sulphur (0.19662), human labour (0.00085), machine hours (0.00108), herbicide (0.00005), pesticide (0.00041) and fungicide (0.0456) indicated over utilization of these resources in flood irrigation system for sugarcane cultivation whereas, MVP to FC ratio was more than unity for zinc (1.6684) indicated under utilization of these resources in flood irrigation system for sugarcane cultivation which underlines scope of expanding the use of these inputs.

Table 2: Marginal value product and resource use efficiency for flood irrigation system for sugarcane crop

S.N.	Variable	Marginal value product (MVP)	Marginal factor cost (MFC)	MVP/MFC ratio
1.	Seeds (□)(X_1)	0.02701	300.00	0.00079
2.	Nitrogen (Kg.)(X_2)	2.72787	12.826	0.21268
3.	Phosphorus (Kg.)(X_3)	-2.49253	43.125	-0.0578
4.	Potassium (Kg.)(X_4)	9.52253	28.00	0.34009
5.	Sulphur (Kg.)(X_5)	16.9045	77.77	0.21736
6.	Zinc (Kg.)(X_6)	5.1508	146.03	1.6684
7.	Human labour (□)(X_7)	0.0168	150.00	0.000112
8.	Machine hours (□)(X_8)	-0.09178	600.00	-0.00015
9.	Harbicide (□)(X_9)	0.06858	1278.83	0.00005
10.	Pesticide (□)(X_{10})	0.37531	849.83	0.00041
11.	Fungicide (□)(X_{11})	0.0456	432.86	0.000105

3.3: Resources use efficiencies in sprinkler irrigation system for sugarcane production

The allocative resource use efficiency in sprinkler irrigation system for sugarcane production was calculated and results are presented in Table 3.

The empirical findings of allocative efficiencies of input use under sprinkles irrigation system (table 02) indicated that MVP to FC ratio is less than unity for seed (0.00004) followed by nitrogen (0.24373), phosphorus (-0.52777), potassium (0.53768), sulphur (0.38166), human labour (0.00108), machine hours (-0.00003), herbicide (0.00015), pesticide (0.00012) and fungicide (-1.92898) indicated over utilization of these resources in sprinkler irrigation system for sugarcane cultivation whereas, MVP to FC ratio was more than unity for zinc (2.46598) indicated under utilization of these recourses in sprinkler irrigation system for sugarcane cultivation which underlines scope of expanding the use of these inputs.

Table 3: Marginal value product and resource use efficiency for sprinkler irrigation system for sugarcane crop

S.N.	Variable	Marginal value product (MVP)	Marginal factor cost (MFC)	MVP/MFC ratio
1.	Seeds (□)(X_1)	0.01376	300	0.00004
2.	Nitrogen (Kg.)(X_2)	3.12609	12.826	0.243730
3.	Phosphorus (Kg.)(X_3)	-22.7603	43.125	-0.52777
4.	Potassium (Kg.)(X_4)	15.05529	28.00	0.53768
5.	Sulphur (Kg.)(X_5)	29.68202	77.77	0.38166
6.	Zinc (Kg.)(X_6)	360.1075	146.03	2.46598
7.	Human labour (□)(X_7)	0.16242	150.00	0.00108
8.	Machine hours (□)(X_8)	-0.01998	600.00	-0.00003
9.	Harbicide (□)(X_9)	0.19129	1278.83	0.00015
10.	Pesticide (□)(X_{10})	0.10599	849.83	0.00012
11.	Fungicide (□)(X_{11})	-834.9798	432.86	-1.92898

3.4: Resources use efficiency in drip irrigation system for sugarcane production

The allocative resource use efficiency in drip irrigation system for sugarcane production was calculated and results are presented in Table 4.

It is being observed that in production of sugarcane under drip irrigation system MVP to FC ratio is less than unity for seed (0.00034) followed by nitrogen (0.36307), phosphorus (-0.43484), potassium (0.07695), sulphur (0.19662), human labour (0.00085), machine hour (-0.00020), herbicide (0.000002), pesticide (0.00001) and fungicide (-0.00065) indicate over utilization of these resources in drip irrigation system for sugarcane cultivation whereas, MVP to FC ratio was more than unity for zinc (1.5907) indicated under utilization of these resources in drip irrigation system for sugarcane cultivation which underlines scope of expanding the use of these inputs.

Table 4: Marginal value product and resource use efficiency for drip irrigation system for sugarcane crop

S.N.	Variable	Marginal value product (MVP)	Marginal factor cost (MFC)	MVP/MFC ratio
1.	Seeds (□)(X_1)	0.10209	300.00	0.00034
2.	Nitrogen (Kg.)(X_2)	4.65675	12.826	0.36307
3.	Phosphorus (Kg.)(X_3)	-18.7527	43.125	-0.43484
4.	Potassium (Kg.)(X_4)	2.1547	28.00	0.07695
5.	Sulphur (Kg.)(X_5)	15.2915	77.77	0.19662
6.	Zinc (Kg.)(X_6)	232.2926	146.03	1.5907
7.	Human labour (□)(X_7)	0.1289	150.00	0.00085
8.	Machine hours (□)(X_8)	-0.12081	600.00	-0.00020
9.	Harbicide (□)(X_9)	0.00382	1278.83	0.000002
10.	Pesticide (□)(X_{10})	0.0139	849.83	0.00001
11.	Fungicide (□)(X_{11})	-0.2823	432.86	-0.000652

Conclusion

The functional analysis was carried out to know the contribution of independent variables in yield of sugarcane. From the estimated Cobb-Douglas production function (log linear production functions). The resource use efficiency under flood irrigation was positively significant for seed (0.0244), potassium (0.0321), zinc (0.0562) and human labour (0.0406), which reveals that by increasing dose of these inputs the productivity will increase where as machine hours was negatively significant. In other two method of irrigation i.e. sprinkler and drip were significant contribution of seed, potassium, zinc, human labour to productivity of sugarcane where as seed and human labour were contributed significantly. It also reveals that the amount of phosphorus and machine hours were used in excessive amount in sugarcane farming under flood irrigation, sprinkler and drip method of irrigation.

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