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Resource use efficiency of soybean seed production: Evidence from Akola District of Maharashtra

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Abstract

This study examines the resource use efficiency of soybean seed production in Akola district. A total of 120 farmers were selected from two tehsils, namely, Barshitakli and Patur and primary data were collected through personal interviews using a pre-tested schedule. To evaluate the input-output relationship, the Cobb-Douglas production function was employed. The results revealed that soybean seed production was profitable with an average input-output ratio of 1.78 at Cost C_3. The Cobb-Douglas function explained 85% of variation in output. Nitrogen, phosphorus, and machinery were overutilized.

Keywords: Resource use efficiency, soybean seed production, cobb-douglas

1. Introduction

The introduction and widespread use of high-yield seed varieties have been pivotal in driving the Green Revolution, playing a crucial role in ensuring food availability at prices that are both economically viable for farmers and accessible to consumers.

Soybean (*Glycine max L. Merrill*) is one of the important oilseed crops. It belongs to the family Leguminoseae, sub-family Papilloideae, and genus Glycine.

Nutritionally, it contributes about 25 per cent and 65 per cent to the global edible oil and protein concentrate for livestock feeding, respectively most important crop grown in India for dual purposes that is oil seed as well as pulse crop.

Globally, soybean is a vital oilseed and protein crop grown across more than 120 million hectares, with Brazil, the USA, and Argentina being the top producers. In 2023, worldwide production surpassed 370 million metric tons, making soybean a major commodity in international trade.

Soybean plays a vital role in reducing India's dependence on edible oil imports, which currently meet nearly 50-60 per cent of domestic demand. Per capita consumption of edible oils in India has grown from 4 kg/year in 1961 to over 12.6 kg/year today, with future demand projected to reach 19.16 kg/year by 2050. Soybean will be instrumental in bridging this gap.

2. Methodology

1. **Selection of Area:** The present study was undertaken in Akola district of Vidarbha region. The district was selected purposively, where the area under Soybean seed production was concentrated.
2. **Selection of Tehsil:** The multistage sampling design was used. Out of seven tehsils in Akola district two tehsils i.e. Barshitakli and Patur were selected on the basis of potential area under Soybean Seed Production.
3. **Selection of Soybean Seed Growers:** From each village 20 farmers were selected. Total 120 farmers were selected for the present study.
4. **Collection of Data:** Data was collected by personal interview method by using pre-tested schedule.
5. **Analysis of Data:** To work out the resource use efficiency of seed production of soybean, Cobb-Douglas production function was used. The Cobb-Douglas type of production function was specified as follows:

$$Y = a x_1^{b1} . x_2^{b2} . x_3^{b3.} x_4^{b4} . x_5^{b5} . x_6^{b6} . x_7^{b7} . x_8^{b8} . x_9^{b9}$$

Where,

Y = Yield in quintals per hectare

a = Intercept

b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, = Partial Regression Coefficient of respective factor as follows:

X_1 = Human labour in Rs/days

X_2 = Bullock labour in Hr/days

X_3 = Machinery in Rs/hr

X_4 = Manure Rs/ha

X_5 =Nitrogen Rs/ha
X_6 = Phosphorous Rs/ha
X_7 = Potassium Rs/ha
X_8 = Plant protection Rs/ha
X_9 = Seed Kg/ha

- Marginal value product of particular resources represented the "expected addition of one unit of that resource while other inputs are held constant" to the marginal factor cost.

$$MVP = \frac{GM\ (Y_i)}{GM\ (X_i)} pxi$$

Where,
b_1 = Elasticity of output with respect to X_i
GM (Y_i) = Geometric mean of output Y_i
GM (X_i) = Geometric mean of input X_i
P_{xi} = Price of X_i

3. Results and Discussion

1. Resource use efficiency in Soybean seed production

- Cobb-Douglas production function was estimated on per hectare basis for soybean seed producers. The elasticity of production and selected parameters are summarized in Table 1. It is observed from Table 1. that, the explanatory variables included in the production function account for nearly all the variation in input usage at the overall level.
- The regression coefficient for the constant term (intercept) was positive. The coefficient for phosphorus (X_6) was -1.489, indicating a negative and highly significant effect on gross income at the 1 percent level. Additionally, the coefficients for bullock labour (X_2), nitrogen (X_5), and seed (X_9) were 0.552 (positive), -1.068 (negative), and 1.049 (positive), respectively, and all were significant at the 10 percent level. The remaining variables were found to be statistically non-significant.
- In the Cobb-Douglas production function, the regression coefficients represent the elasticity of production; therefore, inputs such as human labour (X_1), machinery (X_3), manure (X_4), potassium (X_7), and plant protection (X_8) did not show a significant influence on soybean seed output. The coefficient of multiple determination (R^2) was 0.8509, indicating that approximately 85 percent of the variation in per hectare productivity of soybean seed is explained by the variables included in the model.

Table 1: The results for Cobb-Douglas production function for Soybean Seed Production

Sr.	Variable	Regression coefficient	Standard error
1	Constant (Intercept)	6.623	(2.955)
2	Coefficients		
a.	Human labour (X_1)	0.318	(0.409)
b.	Bullock labour(X_2)	0.552*	(0.339)
c.	Machinery (X_3)	-0.064	(0.121)
d.	Manures (X_4)	0.082	(0.085)
e.	Nitrogen (X_5)	-1.068*	(0.655)
f.	Phosphorus (X_6)	-1.489***	(0.553)
g.	Potassium (X_7)	0.285	(0.265)
h	Plant protection (X_8)	0.035	(0.118)
i	Seed (X_9)	1.049*	(0.556)
3	Coefficient of Determination (R^2)	0.851	

(***, ** and * indicates significance at 1 per cent, 5 per cent and 10 per cent level of significance, respectively.)

- The marginal value of product to factor cost ratio is measure of resource use efficiency. The ratio of MVP to factor cost indicates the optimum resource use efficiency of particular inputs. The marginal value of product of each input factor was worked out compared with prices of respected inputs presented in Table 2. It is observed from Table 2, that the marginal value productivity (MVP) of resources and their ratio to their respective prices was calculated and analyzed. The results show that inputs like bullock labour (X_2) with MVP 5030.98, seed (X_9) with MVP 38.99, human labour (X_1) with MVP 157.59, manures (X_4) with MVP 3.92, plant protection (X_8) with MVP 1.08, and potassium (X_7) with MVP 1.71 were found to have positive MVP values, which indicates that these resources are underutilized in the current soybean seed production system. Therefore, increasing their usage could lead to higher output and better resource efficiency.
- On the other hand, the inputs like machinery (X_3), nitrogen (X_5) and phosphorous (X_6) with MVP values -177.69, -8.84 and -7.95 respectively, were found to be negative, indicating overutilization of these inputs. This means the cost incurred on these inputs is not yielding proportionate returns, leading to inefficiency in resource use.
- Hence, to optimize soybean seed production, efforts should be made to reduce the usage of overutilized resources like machinery, nitrogen, and phosphorous, and to enhance the use of underutilized but productive inputs like bullock labour, seed, and human labour.

Table 2: Marginal value of product at factor cost

Sr. No.	Variable	MVP
1	Human labour (X_1)	157.59
2	Bullock labour(X_2)	5030.98
3	Machinery (X_3)	-177.69
4	Manures (X_4)	3.92
5	Nitrogen (X_5)	-8.84
6	Phosphorous (X_6)	-7.95
7	Pottassium (X_7)	1.71
8	Plant protection (X_8)	1.08
9	Seed (X_9)	38.99

4. Conclusion

1. The regression coefficient of phosphorus (-1.4885), bullock labour (0.5524), nitrogen (-1.0679), seed (1.0493) was found to be significant. The value of coefficient of multiple determination (R^2) of estimated production function was 0.8509, which indicated that about 85 per cent variation in per hectare productivity of soybean seed is being explained by the explanatory variables included in the function.
2. The value of MVP at machinery, nitrogen and phosphorous is negative i.e. less than one. This indicates over utilization. Hence, there should be reduction in utilization of these resources to optimize soybean seed returns.

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