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Research Paper

Resource productivity and resource use efficiency in soybean production on dryland farm

■ P. U. KAUTHEKAR, B.R. PAWAR AND K.V. DESHMUKH

See end of the paper for authors' affiliations

Correspondence to :

P. U. KAUTHEKAR
Department of Agricultural Economics, College of Agriculture
PARBHANI (M.S.) INDIA
Email: pandurangk15@gmail.com

ABSTRACT : Investigation was carried out during the year 2013-14. About 48 dryland farms were randomly selected from sixteen villages of two tehsils in Nanded district of Maharashtra. Data were related to soybean output and input like human labour, bullock labour, machine labour, seed, manure, fertilizer and plant protection as resources. Cobb- Douglas production function was fitted to the data. The result revealed that partial regression co-efficient of area under soybean was 0.498 followed by that manure (0.175) positive at 1 per cent level and positive at per cent level, respectively. Partial regression co-efficient of bullock labour, machine labour and potash were positive but non-significant. Marginal product of area under soybean was 6.924 quintals followed by that of manure (0.182 q), plant protection (0.144 q), human labour (0.057q) and MVP to price ratio with respect to nitrogen was 11.10 followed by manure (6.64), area under soybean (3.04) and phosphorus (2.27). Optimum use of area under soybean was found to be 2.56 hectares and optimum use of plant protection was 2.69 litres.

KEY WORDS : Soybean, Resource productivity, Marginal productivity, Optimum resource

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INTRODUCTION :

Soybean (*Glycine max* L.) belongs to leguminoceae family. Origin of soybean is China. In India, soybean as an oilseed crop introduced in 1970-71 onwards. It is one of the fastest growing and short durational crops in India. Oilseeds are an important segment of Indian agricultural economy as they contribute one tenth total output of crop sector in the country.

Soybean is known as 'golden bean' in India and most important crop grown in India for dual purposes that is oil seed as well as pulse crop. It is important natural source of protein with number of amino acids essential for good health. It has emerged as one of the important commercial crop in many countries. Due to its world wide popularity, the international trade of soybean is spread globally. Soybean to supplement their domestic requirement for human consumption and cattle feed.

Soybean has a great potential as an exceptionally nutritive and very rich protein food. Soybean also contains about 20 per cent oil with an important fatty acid, lecithin and Vitamin A and D. Soybean was introduced in Maharashtra during the year 1984-85. It becomes popular because of its short durational nature (90-110 days) with higher productivity as compared to other pulses and oilseed crop. In Maharashtra soybean is grown in 38.704 lakh hectares with average productivity of 12.55 quintals per hectares against the national average of about 10.79

quintal. In Maharashtra Buldhana district rank first in area 4.21 lakh hectares while Yavatmal rank first in production 5.39 lakh MT during the year 2013-14.

MATERIALS AND METHODS :

Sampling design :

Multistage sampling design was adopted for selection of district, tehsils, villages and dryland farms. In the first stage, the Nanded district was purposively selected because of mostly existence of dryland farmings. In the second stage, Himayatnagar and Naigaon tehsils were selected on the basis of higher area under dryland farms. In the third stage, eight villages were selected from the each of tehsils on the basis of higher area under dryland farms. From Himayatnagar tehsil villages were selected namely Borgadi, Dhanora, Jawalgaon, Karla, Pawan, Sarsum, Siranjani and Sonariwhile from Naigaon tehsil villages were selected namely Aluwadgaon, Balegaon, Benderi, Degaon, Lalwandi, Salegaon, Sangvi and Suilegaon. In the fourth stage, from each village, the list of dryland farmers along with their holding sizes was obtained. Three dryland 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 soybean, human labour, bullock labour, machine labour, seed, fertilizer and plant protection. 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.

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

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 :

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

The main consequences of multicollinearity are (a) the sampling variances of the estimate 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.

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

where,

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

a = Intercept of production function, bi = Partial regression co-efficient of the respective resource variable (i=1, 2,…,10), X_1 =Area under soybean in 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= Potash in kg per farm and X_{10} = Plant protection in liter 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.

Marginal value product (MVP) :

It refers to the product of MP and p_y 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:

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

where,

bi = Partial regression co-efficient of particular independent variable

$\bar{X}$ = Geometric mean of particular independent variable

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

P_y = Price of dependent variable.

RESULTS AND DATA ANALYSIS :

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

Elasticity of soybean production :

Regression co-efficients with respect to various explanatory variables were calculated and are presented in Table 1. It was observed from the table that partial regression co-efficient of area under soybean was 0.498 which was positive and highly significant at one per cent level. It inferred that when one per cent increased in use of area under soybean over its geometric mean, it would lead to increase production of soybean by 0.498 per cent. Partial regression co-efficient of manure was also positive and significant. When use of manure was increased by one percent, it would lead to increase soybean production by 0.175 per cent. Partial regression co-efficients of bullock labour, seed, nitrogen and potash were positive but non-significant. On the contrary, partial regression co-efficient of potash was negative and significant. Co-efficient of multiple determinations (R^2) was 0.816; it means that there was 81.60 per cent effect of all independent variables together on soybean production. Return to scale was found to be 0.797 which indicated that production of soybean was found in decrease returns to scale.

Marginal productivity of soybean:

Resource productivity with respect to various explanatory variables is also presented the in Table 1. It was obvious that the marginal productivity with respect to area under soybean was the highest as 6.924 quintals followed by that of manure (0.182q), plant protection (0.144 q), human labour (0.057q) and nitrogen (0.026q). It inferred that if area under soy bean production was increased by one hectare at its geometric mean level, it would lead to increase production of soybean with 6.924 quintals. Similarly, per unit of manure, plant protection human labour and nitrogen could be increased then it would cause to increase production of soybean by 0.182q, 0.144q, 0.057q and 0.026q, respectively.

Resource use efficiency in soybean production :

In regards to resource efficiency, it was also evident from the Table 1 that use of nitrogen in soybean production indicated MVP to price ratio as 11.10 followed by manure (6.64), area under soybean (3.04) and plant protection (1.50) which were greater than unity. It implied that there was scope to increase these resources in soybean production. On the contrary, in regard to potash, MVP to price ratio was negative. Use of potash in soybean production was excess.

Optimum resource use in soybean production :

In regards to optimum resource use, it was observed that optimum use of area under soybean was 2.56

Table 1 : Estimates of Cobb-Douglas production function in soybean production on dryland farm

Sr. No.	Independent variable	Partial regression co-efficient (bi)	Standard error (SE)	't' value	Geometric mean (Xi)	Marginal product (q)	Marginal value product (Rs.)	Price of input (Rs.)	MVP to price ratio	Optimum resource use (xi)
1.	Area under soybean (ha/farm)	0.498	0.167	2.982**	0.84	6.924	25272.60	8291.65	3.04	2.56
2.	Human labour (manday/farm)	0.146	0.172	0.848	29.73	0.057	208.05	160.00	1.30	38.90
3.	Bullock labour (pairday/farm)	-0.170	0.112	-1.517	6.20	-0.320	-1168.00	390.00	-2.99	---
4.	Machine labour(hours/farm)	-0.048	0.038	-1.263	4.46	-0.125	-458.81	470.00	-0.97	---
5.	Seed (kg/farm)	0.082	0.093	0.881	57.80	0.016	58.40	42.00	1.39	83.23
6.	Manure (q/farm)	0.175	0.082	2.134*	11.20	0.182	664.30	100.00	6.64	74.60
7.	Nitrogen (kg/farm)	0.067	0.061	1.098	18.95	0.041	149.65	13.47	11.10	212.05
8.	Phosphorus (kg/farm)	0.074	0.054	1.370	32.03	0.026	94.90	41.75	2.27	75.56
9.	Potash (kg/farm)	-0.051	0.024	-2.125*	7.40	-0.080	-292.00	27.33	-10.68	---
10.	Plant Protection (litre/farm)	0.024	0.018	1.333	1.94	0.144	525.60	380.00	1.38	2.69

Intercept (log a) ------------- 4.558 Note: Geometric mean of ($\overline{Y}$) soybean production was 11.68 q per farm and price was Rs. 3650/q
F value ----------------------- 14.55** R^2 -----------------------------0.816
Return to scale ($\sum$ bi) ------- 0.797 * and ** indicate significance of values at P=0.05 and 0.01, respectively

hectares over its geometric mean followed by that of nitrogen (212.05 kg), seed (83.23), phosphorus (75.56) and manure (74.60 q).

Authors' affiliations:
B.R. PAWAR AND K.V. DESHMUKH, Department of Agricultural Economics, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

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