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Economics of production and Resource use efficiency of soybean production in India

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ABSTRACT

Soybean is one of the most important oilseed crops in Madhya Pradesh where it is grown 5.56 million ha area with the annual production of 6.67 million tones. It cultivation is pre dominantly done in Mandsaur district. The study finds that the total cost increased with the increase in the farm size. All costs increased with increase in farm size. The net income, family labour income, farm business income and farm investment income is increases with increase in farm size. Output input ratio indicates that which indicates that the return to every rupee of investment in soybean cultivation increased with increase in farm size. Manure, chemical fertilizer and machine works have significantly influenced the production of soybean in the study area. The agencies working in this area should plan their future course of action regarding soybean cultivation technology for enhanced production

Keywords: Soybean, production, regression coefficient

Soybean (*Glycine max* (L) Merrill) is known as the "golden bean", "miracle crop" etc, because of its several uses. It is an excellent source of protein and oil. It is a major oilseed crop in the world covering 102.55 million hectares under oilseed crops and contributing around 58 per cent (258.4 million metric tons) of the total 444.2 million metric tons during 2011 which makes it as the leading oilseed crop in the world. In fact, it proved to be a fortune crop in terms of edible oil production, export earnings and rural prosperity. Today USA, Brazil, Argentina, China and India are the five major soybean producing countries. They produce 90 per cent of the world's total soybean production. India ranked fifth both in area (9.55 million hectare) and production (12.73 million metric tons) in the world during 2010-11 (www.faostats.fao.org.). To the edible oil pool, soybean has attained a prominent position in India's agro-economy with 12 per cent contribution. Soybean is making a head way in oilseed front both in area and production immediately after groundnut, rapeseed and mustard.

India ranks fifth after USA, Argentina Brazil and China in production of soybean. In the recent past, soybean cultivation has increased manifold as compared to any other oilseed crop in India and stands next only to groundnut. Soybean was a minor crop during the early 1970s but at present it occupies third place in oilseed production in India. The area under soybean in India has rapidly increased from 0.03 million ha in 1970 and to 9.55 million ha in 2010-10. The productivity of this crop was also increased from 426 kg per hectare to 1325 kg per hectare in the same period. There has been a slow but steady growth in the production of soybean in India, which is attributed to erratic monsoon, poor management, incidence of pests and disease, shattering of pods, soybean rust and above all low input technology (Singh *et al.*, 2003). Though soybean crop was introduced in Madhya Pradesh during the later part of 1960's, its spread in the state has been remarkable. The area under the crop in the state during 2010-11 was 5.56 million hectare and the production was 6.67 million metric tons. Soybean is extensively

Table 1. Cropping pattern of sample farmers Area (Hectares)

Sl. No.	Crops	Small farmers	Medium farmers	Large farmers	Average
I	Kharif				
1	Soybean	1.78 (45.18)	2.83 (45.65)	11.97 (51.15)	5.53 (49.43)
2	Maize	0.09 (2.28)	0.18 (2.90)	0.89 (3.80)	0.39 (3.46)
3	Jowar	0.04 (1.02)	0.06 (0.97)	0.18 (0.77)	0.09 (0.83)
	Sub total	1.91 (48.48)	3.07 (49.52)	13.04 (55.73)	6.01 (53.73)
II	Rabi				
1	Wheat	1.25 (31.73)	1.57 (25.32)	7.2 (30.77)	3.34 (29.87)
2	Gram	0.5 (12.69)	1.21 (19.52)	2.5 (10.68)	1.40 (12.55)
3	Coriander	0.13 (3.30)	0.15 (2.42)	0.23 (0.98)	0.17 (1.52)
4	Garlic	0.15 (3.81)	0.2 (3.23)	0.43 (1.84)	0.26 (2.33)
	Sub total	2.03 (51.52)	3.13 (50.48)	10.36 (44.27)	5.17 (46.27)
	Gross Cropped Area (GCA)	3.94 (100.00)	6.2 (100.00)	23.4 (100.00)	11.18 (100.00)

Note: Figures in parentheses indicate percentage to gross cropped area.

cultivated in the state of M.P., Rajasthan, Maharastra and Uttar Pradesh. Madhya Pradesh has emerged as the soy state of the country with over 58 per cent of the total area under this crop in the country and contributes about 53 per cent of the total national production (2010-11). Therefore, in the present study was undertaken with the following objectives:

- ❒ To study the economics of production of soybean on various category of farms.
- ❒ To examine the input output relationship and resource use efficiency in soybean production on different size of farms.

Research Methodology

Madhya Pradesh is a leading producer of soybean which contributes about 58 per cent of area and 53 per cent of production in the country. In Madhya Pradesh, soybean has emerged as an important crop in the malwa plateu agro-climatic zone of the state which occupying about 45 per cent area (2.50 lakh ha.) and 40 per cent (2.67 lakh tonnes) in production during 2010-11. Importance of this agro-climatic zone in the production of soybean, Mandsaur district of this agro-climatic zone was purposively selected for the present study. A multistage stratified random sampling was used to select the block, cluster of villages and the respondent i.e. soybean growers. A sample of 60 growers was selected from the universe of 2 villages of Mandsaur block of district Mandsaur. The soybean growers were divided into three groups viz. small farmers (< 1 ha) medium farmers (1-2 ha) and large farmers (> 2 ha). Thus, 30 small farmers, 20 medium farmers and 10 large farmers were finally selected. The primary data required for the study were colleted through personal interview method with the help of well structured and pre-tested schedule. The data on general characteristics, cropping pattern, area under cultivation, details of cost of cultivation of soybean inputs used and returns and their constraints were elicited from the sample farmers. The data on this aspect were collected from sample farmers of soybean pertained the agricultural year 2010-11.

Table 2. Inputs use pattern in soybean cultivation Per hectare

Sl. No.	Inputs	Units	Small farmers	Medium farmers	Large farmers	Overall	Recommended level*
1.	Seed	Kg	65.09	69.20	72.33	68.47	70-80
2.	Manure (FYM)	Ton	5.24	5.45	5.66	5.32	15-20
3.	Chemical fertilizer						
(a)	N	Kg	15.02	15.27	15.88	15.35	20
(b)	P	Kg	25.57	25.65	26.77	25.93	60
(c)	K	Kg	-	-	5.07	5.07	20
4.	Bio fertilizer	g	120.09	265.97	298.10	210.47	500
5.	Herbicide	Kg	1.02	1.23	1.53	1.09	-
6.	Plant protection chemicals	Kg	1.20	1.37	1.40	1.20	-
7.	Human labour	MD	52.43	54.6	55.03	52.42	-
a	Hired labour	MD	19.92	20.75	20.91	19.92	
b	Family labour	MD	32.51	33.85	34.12	32.50	
8.	Bullock labour	BPD	5.28	4.70	4.35	4.83	-
9.	Machine hours	Hours	10.53	11.40	11.69	11.03	-

Note : * As per Modern Techniques of Raising Field Crops by Chidda Singh (2003)
MD - Man days
BPD - Bullock pair days

Table 3. Costs of cultivation of soybean in different size groups of sample farmers

₹ per ha

	Particulars	Small farmers	Medium farmers	Large farmers	Overall
I.	Variable cost				
	Seeds	1806 (10.09)	1938 (10.46)	2025 (10.53)	1945 (10.43)
	Manure (FYM)	1048 (5.85)	1090 (5.88)	1132 (5.89)	1184 (6.35)
	Chemical fertilizer	229 (1.28)	231 (1.25)	299 (1.56)	292 (1.57)
	Bio fertilizer	12 (0.07)	28 (0.15)	30 (0.16)	24 (0.13)
	Plant protection chemicals	709 (3.96)	683 (3.69)	745 (3.87)	697 (3.74)
	Hired human labour	1992 (11.13)	2075 (11.20)	2091 (10.87)	2092 (11.22)
	Bullock labour	807 (4.51)	695 (3.75)	658 (3.42)	713 (3.82)
	Machine works	3686 (20.59)	3990 (21.53)	4092 (21.28)	3966 (21.27)
	Interest on working capital @ 8%	462 (2.58)	486 (2.62)	493 (2.56)	481 (2.58)
	Cost A (∑I)	10751 (60.06)	11216 (60.54)	11565 (60.15)	11394 (61.12)

II	Rental value of land	3500 (19.55)	3500 (18.89)	3500 (18.20)	3500 (18.77)
	Depreciation	148 (0.83)	173 (0.93)	467 (2.43)	234 (1.26)
	Interest on fixed capital @ 15%	251 (1.40)	254 (1.37)	284 (1.48)	258 (1.38)
	Sub Total	3899 (21.78)	3927 (21.19)	4251 (22.11)	3992 (21.41)
	Cost B	14650 (81.84)	15143 (81.73)	15816 (82.26)	15386 (82.53)
III	Family labour	3251 (18.16)	3385 (18.27)	3412 (17.74)	3256 (17.47)
	Cost C (Cost B+III)	17901 (100.00)	18528 (100.00)	19228 (100.00)	18642 (100.00)

Note; figures in parentheses is the percentage of cost C.

The collected data was subjected to various statistical and econometric analyses to draw meaningful inferences. The tabular presentation technique was followed to study the economic characteristics of different size groups of sample farmers such as size of land holding, cropping pattern, costs and returns expressed by the farmers in case of soybean. For studying the economics of soybean cultivation, tabular presentation was followed. The cost incurred in soybean production were tabulated under cost A, cost B and cost C (Raju and Rao, 1993).

Cost 'A1': It included wages of hired human labour, cost of bullock labour, cost of seed, value of organic manure and chemical fertilizers, value of plant protection components, interest on working capital, depreciation on farm machinery, implements, equipments, farm buildings etc.

Cost 'A2': Cost A1 + Rent paid for leased-in land.

Cost 'B': Cost A2 + Imputed rental value of owned land + Interest on owned fixed capital.

Cost 'C': Cost B + Imputed value of family labour.

Cost-C is the total cost of cultivation.

Functional Analysis

In order to assess the profitability and economic viability in soybean cultivation, various components of costs were estimated. The Cobb-Douglas production function which gave the best fit was selected to establish input-output relations per farm. The variables i.e. Land, Seed, Manure (FYM), Chemical Fertilizer, Human labour, Bullock labour, Machine labour and Plant protection chemical expenditure were taken as independent variables. The usual form of the Cobb-Douglas production function is as follows (Sankhyan, 1983; Raju and Rao, 1993) :

$$Y = a.x_1^{b1}.x_2^{b2}.x_3^{b3} \ldots\ldots\ldots .x_n^{bn}.e^{\mu}$$

Where,

Y = output (dependent variable)

a = constant or intercept,

$b_1, b_2 \ldots . b_n$ = Regression (partial) coefficients

$x_1, x_2, x_3 \ldots . x_n$ = initial factors (independent variables

μ = error term.

In log form, the equation is expressed as :

$$\text{Log } y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 \ldots . b_n \log^{x}{}_n + \mu .$$

Returns to scale (RTS) = $\sum_{i=1}^{n} b$

Specific form of the Cobb-Douglas production function fitted for pooled data is given below:

Soybean: Y = $a x_1^{b_1}.x_2^{b_2}.x_3^{b_3}.x_4^{b_4}.x_5^{b_5}.x_6^{b_6}$ and

Where,

Table 4. Costs and returns structure in soybean cultivation

₹ per ha

Sl. No.	Costs/ Returns	Small	Medium	Large	Overall
A	Costs (Rs)				
(a)	Cost A1	10751	11216	11565	11394
b)	Cost A2	10751	11216	11565	11394
(c)	Cost B	14650	15143	15816	15386
d)	Cost C	17901	18528	19228	18642
B.	Returns (₹)				
1)	Yield (qtls)				
a)	Main product	11.23	11.89	12.66	12.03
(b)	By product	8.11	7.59	8.43	8.14
2)	Price (Rs/ qtls)				
(a)	Main product	1966	1983	2053	1987
(b)	By product	93	97	89	78
3)	Gross returns	22832	24314	26741	24539
4)	Farm Profits (Rs)				
(a)	Net income	4931	5786	7513	5897
(b)	Family labour income	8182	9171	10925	9153
(c)	Farm Business income	8644	9657	11418	9634
(d)	Farm Investment Income	8682	9540	11297	9655
5)	BC ratio	1.27	1.31	1.39	1.32

Y = gross income in soybean production in Rupees

a = intercept

x_1 = land in hectares

x_2 = Cost of seed in Rupees

x_3 = Manure (FYM) in Ton

x_4 = Chemical Fertilizer (Kg)

x_5 = human labour in man days

x_6 = bullock labour charges in Rupees

x_7 = machine labour charges in Rupees

x_8= cost of plant protection chemical in Rupees

b_1 to b_8= regression coefficients of respective input variables.

Marginal value product (MVP)

The MVPs were computed by multiplying the regression coefficients of the respective resources (bi) with the ratio of geometric mean of the output (GM of $\bar{y}$) to the geometric mean of the resources (GM of x_i), for example MVP x_i will be :

$$MVP = \frac{\bar{y}}{\bar{x}_i} x \, b$$

where,

$\bar{y}$ = Geometric mean output

$\bar{x}_i$ = Geometric mean of ith independent variable

b_i = Partial regression coefficient of ith input

Economic efficiency of resources

In order to evaluate the economic efficiency of resources, the MVP of input factor resources were compared with their respective acquisition costs, *i.e.* input price. The ratio of MVPs of different resources to their acquisition costs (MVP/ input price) were calculated. A ratio, that is equal to unity (MVP = input price or MVP/ input price = 1), indicates the optimum use of the resources. A ratio more than unity indicate the under use of resources and the returns could be increased by using more of that resource and ratio less than unity indicates excess use of resources, which should be decreased to maximise the profit.

Results and Discussion

Cropping pattern of the sample farmers in the study area

It is worth noting that majority of the sample farmers (49.43 %) have cultivated soybean in *kharif* season (Table 1) followed by wheat (29.87%) and gram (12.55%) in *rabi* season. A similar pattern of cropping was observed across the different size of farmers. In *kharif*, maize and jowar were grown sample farmers as compared to garlic and coriander during *rabi* season.

Table 5. Regression coefficients of production function in

soybean

Sl. No.	Particulars	Parameter	Small farmers	Medium farmers	Large farmers	Overall
1.	Intercept	A	-0.81 (3.42)	5.64 (1.40)	5.63 (5.35)	3.33 (1.29)
2.	Land (Hectares)	X1	0.06 (0.11)	0.015 (0.25)	0.15 (0.42)	0.03* (0.02)
3.	Seed (Kg)	X2	0.60 (0.32)	0.49 (0.11)	-0.13 (0.92)	0.55 (0.13)
4.	Manure (FYM) (Ton)	X3	0.18 (0.10)	0.210* (0.06)	0.21 (0.20)	0.20* (0.04)
5.	Chemical Fertilizer (Kg)	X4	0.27 (0.16)	-0.079** (0.07)	-0.17 (0.28)	0.03 (0.08)
6.	Human labour (Man days)	X5	-0.06 (0.17)	0.01 (0.06)	-0.10 (0.16)	-0.04 (0.06)
7.	Bullock labour (Bullock pair days)	X6	0.47 (0.34)	0.013 (0.14)	0.51 (0.79)	0.29 (0.15)
8.	Machine work (Hours)	X7	0.23 (0.43)	-0.015** (0.01)	0.04 (0.16)	-0.01** (0.01)
9.	Plant protection chemicals (Rs)	X8	0.07 (0.14)	0.038 (0.17)	0.29 (0.18)	0.03 (0.39)
10.	R2		0.85	0.80	0.75	0.80
11.	'F' value		0.06*	0.009**	0.019*	0.007**

Note: Figures in parentheses indicate standard error
* Significance at 5% probability level
** Significance at 1% probability level

Table 6. Ratio of MVP to MFC of soybean production

Sl. No.	Particulars	Parameter	Small farmers	Medium farmers	Large farmers	Overall
1.	Land (Hectares)	X1	5.90	1.23	2.71	1.87
2.	Seed (Kg)	X2	4.19	3.54	2.84	3.83
3.	Manure (FYM) (Ton)	X3	1.82	1.25	1.09	1.57
4.	Chemical Fertilizer (Kg)	X4	10.61	8.72	5.85	8.90
5.	Human labour (Man days)	X5	-4.28	0.69	-9.26	-3.13
6.	Bullock labour (Bullock pair days)	X6	4.02	3.23	4.83	2.55
7.	Machine work (Hours)	X7	0.17	-0.014	0.03	-0.007
8.	Plant protection chemicals (Rs)	X8	4.34	4.03	2.89	3.80

Inputs use pattern

It is revealed from Table 2 shows that the quantity of material inputs like seeds, manures, chemical fertilizers and biofertilizers used by the farmers were less than the recommended level. Similar pattern was observed in all the categories of farmers. In case of seed, on an average, 68.47 kg per hectare was used as against recommendation of 70-80 kg per hectare. The extent of manure used was less than half of the recommended level. The application of 'N' with 15.35 kg per hectare was lower by half of the recommended level (20 kg/ha). In case of phosphorus, application was less than half of the recommendation. It is also observed that the only large farmer have applied potash. Similarly, even though the cost of biofertilizers was lower, its use (210 g/ha) was less

than half of the recommended level (500 g/ha). This is more so in case of small farmers (120 g/ha) as compared to medium (266 g/ha) and large (298 g/ha) farmers.

Cost of cultivation

The cost of cultivation for soybean has been given in Table 3, for small, medium and large farmers as well as for all farmers. It can be observed in table the total cost of cultivation of soybean was ₹ 18642.00 per hectare of which variable cost and fixed cost formed about 78.59 and 21.41 percent respectively. The total cost increased with the increase in the farm size. It was also observed from the table that among the costs, cost of human labour (hired + family) was the major component followed by machine works, rental value of land and seed. Similar pattern of components of total cost of cultivation was observed in all categories of farmers namely small, medium and large farmers. However, the extent of total cost and its component in large farmers was relatively higher than those in medium and small farmers.

Returns

The details of yields and various income measures for soybean were worked out and presented in Table 4. It was observed that the gross returns as ell as yield per hectare increases with the increase in the size of farms. Cost of cultivation per hectare on the basis of Cost A1, A2, B and C for soybean were presented in Table 6. Cost A1 and A2 are same because there was no leased in land in the study area. It is evident from the table that all costs increased with increase in farm size. Various measures of farm profits were also estimated *i.e.* net income, family labour income, farm business income and farm investment income according to size of farms for soybean cultivation. It can be observed from the table 6 that net income, family labour income, farm business income and farm investment income is increases with increase in farm size. Output input ratio indicates that which indicates that the return to every rupee of investment in soybean cultivation increased with increase in farm size.

Resource use efficiency in soybean cultivation

It is revealed from table 5 that manure, chemical fertilizer and machine works have significantly influenced the production of soybean in the study area as indicated by their significant regression coefficients. Manure positively influenced the production of soybean whereas chemical fertilizer and machinery works had negative influence. Other inputs like seeds, plant protection chemicals, human labour and bullock labour were positively associated with the production of soybean even though their influence was not significant. The 'F' value was significant in all the group of farmers.

It was also observed in Table 6 that the ratio of MVP to MFC was positive and more than one for seeds, manures, chemical fertilizers, bullock labour, plant protection chemicals and land indicating that resources were used advantageously. Whereas, it was less than one in case of human labour and machine work indicating over utilization of inputs in soybean cultivation. Similar trend was observed in all categories of farmers except human labour in medium farmers and machinery use in small farmers and large farmers

Conclusion

The findings of the study clearly revealed the total cost increased with the increase in the farm size. The extent of total cost and its component in large farmers was relatively higher than those in medium and small farmers. All costs increased with increase in farm size. The net income, family labour income, farm business income and farm investment income is increases with increase in farm size. Output input ratio indicates that which indicates that the return to every rupee of investment in soybean cultivation increased with increase in farm size. Manure, chemical fertilizer and machine works have significantly influenced the production of soybean in the study area as indicated by their significant regression coefficients. The ratio of MVP to MFC was positive and more than one for seeds, manures, chemical fertilizers, bullock labour, plant protection chemicals and land indicating that resources were used advantageously. Whereas, it was less than one in case of human labour and machine work indicating over utilization of inputs in soybean cultivation. The agencies working in this area should plan their future course of action regarding soybean cultivation technology for enhanced production

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