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Soybean Cultivation in Dharwad District of Karnataka - Economics and Resource Use Efficiency Analysis

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Abstract

Soybean (*Glycine max* L.) is known as 'golden bean' and grown in India for dual purpose that is oil seed as well as pulse crop. In the year 2022-23, the study was undertaken to assess the economics of soybean cultivation in Dharwad district, focusing on Dharwad and Kalaghatgi taluks in Karnataka, India. The data was gathered from a sample of 90 respondents, comprising 30 small & medium farmers, 30 large farmers and 30 market intermediaries. Cost of cultivation of soybean showed that large farmer incurred higher costs per acre (Rs.55,501) compared to small & medium farmers (Rs.48,147). Returns per rupee of expenditure indicated a marginally higher profitability for large farmers (1.27) compared to the small & medium farmers (1.25). Resource use efficiency was attempted using Cobb-Douglas type of production function. For small & medium farmers, under-utilization was observed for seed, FYM, chemical fertilizer, plant protection chemicals, human labour and over-utilization for weedicide and machine labour. Similarly, large farmers exhibited under-utilization for FYM, chemical fertilizer, plant protection chemicals, human labour, weedicide and over-utilization for seed and machine labour. As observed from the results there is scope for reallocation of inputs for optimum level of usage. Implementing recommended packages of practices can optimize returns, ensuring sustainable soybean cultivation in the study area.

Keywords : Soybean cultivation, Cobb-douglas production function, Resource use efficiency, Cost of cultivation, Package of practices

Soybean (*Glycine max* L.) is known as the 'miracle crop' or 'golden bean' because of its versatile nutritional qualities (Lyngdoh *et al.,* 2019). Originating in East Asia around 1100 BC, this globally cultivated legume has evolved into a key player, contributing approximately 25 per cent to the world's edible oil production and constituting around two-thirds of the total protein concentrate produced worldwide, serving as an economical and substantial source for livestock feed (Chawan *et al*., 2023). Brazil emerged as the largest producer, accounting for 38.7 per cent of the world production, followed by the United States (31%), Argentina (13.50%), China (5%) and India at 3 per cent (Anonymous, 2022a). India, ranking fourth in soybean cultivation area and fifth in production, significantly influences the global soybean landscape. In Karnataka, during 2021-22, soybean covered 3.81 lakh hectares, Bidar district claimed the highest area (48.70%) under soybean cultivation followed by Belagavi (26.10%), Dharwad (10.47%), Kalaburgi (4.70%), Haveri

(4.52%) and Bagalkot districts (0.40%) (Anonymous, 2022b).

Recognizing the emerging significance of soybean cultivation, in response many research on soybean taken up in Belagavi (Vasudeva, 2018)) and Bidar (Vijaykumar *et al.,* 2017) the researcher shifted the focus to Dharwad district, which has third largest area under soybean in the state as the improved seed varieties DSB series were released by University of Agricultural Sciences, Dharwad and increasing area due to demand from the agro-processing units and better price for produce. Hence, soybean cultivation is a noteworthy concern that demands attention and further investigation. With this background the researcher undertook the study during 2022-23 to analyze the cost of cultivation and resource use efficiency in soybean cultivation in Dharwad district of Karnataka.

METHODOLOGY

Study Area

Dharwad district was purposively selected and the two taluks *viz.,* Dharwad (33.64%) and Kalaghatgi (33.14%) were selected as they had the highest area under soybean in the district (Anonymous, 2021). The newly released varieties of DSB series in Dharwad has encouraged farmers to take up more area and increasing demand from processing units. Five villages from each taluk were selected and six respondents from each village comprising three sample respondents each belonging to 'small & medium' and 'large' landholding size classification. From each category 30 farmers were interviewed, amounting to total sample size of 60 farmers. The sample farmers were interviewed on various aspects such as general farm and household characteristics, socio-economic parameters like education *etc.* Details on cultivation practices adopted in soybean and cost of cultivation were collected.

Tabular analysis, farm management cost and return concept *viz*., Cost-A, Cost-B, Cost-C (Palanisami *et al*., 2002), profitability analysis and Cob-Douglas production function were employed to analyse the data.

Interest on Working Capital

It was calculated for the crop season. The interest was assessed at an annual rate of 7 per cent, in line with the seasonal agricultural loan lending rates of the nationalized banks.

Interest on Fixed Capital

It was calculated at the rate of 12 per cent, as the fixed deposits in commercial banks fetched this rate of interest. Interest was considered on the value of the assets after deducting the depreciation cost for the year and apportioned for the total duration of the crop which is approximately three months hence six per cent is taken.

Profitability Analysis

Farm Business Income

$$\text{Farm business income} = \text{Gross income} - \text{Cost } A_2$$

Farm Investment Income

$$\text{Farm Investment income} = \text{Farm business income} - \text{Imputed value of family labour}$$

Returns Per Rupee of Investment

$$\text{Returns Per Rupee of Investment} = \frac{\text{Total returns}}{\text{Tota costs}} \quad \ldots\ldots (1)$$

Resource use Efficiency

The resource use efficiency in soybean cultivation was studied by fitting the Cobb-Douglas type of production function given below to the farm level data given by Cobb and Douglas in 1928.

$$\mathbf{Y = aX_1b_1X_2b_2X3b_3X_4b_4X5b_5X_6b_6X_7b_7} \quad \ldots\ldots. (2)$$

Where,

Y = Output (q/farm)

X_1 = Seeds (kg/farm)

X_2 = FYM (kg/farm)

X_3= Chemical Fertilizers (Rs./farm)

X_4 =Plant Protection Chemicals (PPC) (Rs./farm)

X_5 = Human Labor (mandays/farm)

X_6 = Weedicide (Rs./farm)

The Mysore Journal of Agricultural Sciences

X_7 = Machine (hr/farm)

a = Constant

u = Random Variable

b_1 to b_7 = elasticity coefficients of respective inputs

Results and Discussion

Table 1, presents various socio-economic attributes such as average age, average years of schooling, average family size, average landholding size and average soybean cultivation area per farm for the surveyed respondents. Notably, these characteristics exhibited higher values among large farmers as compared to small and medium farmers. The socio-economic profile outlined in Table 1 aligns with the observations made by Nandini and Kiresur (2013) in terms of age distribution, educational attainment and family size of the respondents.

Economics of Cultivation of Soybean

The economic aspects of soybean cultivation for small & medium farmers, large farmers in Dharwad and Kalaghatgi taluks of Dharwad district have been summarized in Tables 2, 3 and 4.

Table 1

Socio-economic profiles of respondents in the study area

Particulars	Small & medium farmers (n=30)	Large farmers (n=30)
Average age (years)	47.53	50.13
Average no. of years of schooling	6.27	6.73
Average family size (No.)	7.00	8.00
Average size of landholding (acre)	6.43	20.31
Average area under soybean per farm (acre)	2.95	5.98

Table 2

Cost of cultivation of soybean (per acre)

Particulars	Units	Small & medium farmers			Large farmers		
		Qty.	Value (Rs.)	Per cent	Qty.	Value (Rs.)	Per cent
Seed	Kg	30.62	1776	4.02	33.88	1965	3.79
Human labour	md	24.82	10176	23.02	33.44	13710	26.47
Machine labour	hr	2.92	4380	9.91	3.45	5175	9.99
Bullock labour	pair day	0.43	421	0.95	1.01	989	1.91
Manures	t	2.67	6702	15.16	2.8	7028	13.57
Chemical fertilizers	Rs.		1232	2.79		1453	2.81
PPC	Rs.		1633	3.69		1821	3.52
Miscellaneous	Rs.		510	1.15		760	1.47
Interest on working capital @ 7 per cent per annum	Rs.		939	2.12		1152	2.22
Total variable Costs (TVC)	Rs.		27770	62.82		34054	65.74
Land revenue	Rs.		50	0.11		50	0.10
Depreciation	Rs.		2560	5.79		3165	6.11
Rental value of owned land	Rs.		10120	22.89		10120	19.54
Interest on fixed capital @ 12 per cent per annum	Rs.		930	2.10		1004	1.94
Managerial cost @10 per cent of working capital	Rs.		2777	6.28		3405	6.57
Total fixed costs (TFC)	Rs.		16437	37.18		17745	34.26
Total cost (TVC+ TFC)	Rs.		44208	100.00		51799	100.00

TABLE 3

Cost structure of soybean cultivation

(Rs. /acre)

Particulars	Small & medium farmers(n=30)		Large farmers (n=30)	
	Rs.	Per cent	Rs.	Per cent
Value of hired human labour	8126	17.90	12685	23.92
Value of hired machine labour	2891	6.37	3105	5.86
value of owned machine labour	1489	3.28	2070	3.90
Value of purchased seed	1776	3.91	1965	3.71
Value of Bullock labour	421	0.93	990	1.87
Value of owned farmyard manure	1675	3.69	1945	3.67
Value of purchased farmyard manure	5027	11.08	5083	9.38
Value of chemical fertilizers and PPC	2866	6.31	3274	6.17
Land revenue	50	0.11	50	0.09
Interest on working capital@ 3.5 per cent	939	2.07	1152	2.17
Depreciation	2560	5.64	3165	5.97
Miscellaneous expenses	510	1.12	760	1.43
Cost A1	28330	62.42	36243	68.34
Cost A2 (Cost A1+ Rent paid for leased in land)	28330	62.42	36243	68.34
Interest on fixed capital@ 6 per cent	762	1.68	822	1.55
Cost B1(Cost A1 + Interest on fixed capital)	29092	64.10	37065	69.89
Rental value of owned land	10120	22.30	10120	19.08
Cost B2 (Cost B1 + Rent paid for leased in land + Rental value of owned land)	39212	86.39	47185	88.98
Imputed value of family labour	2050	4.52	1025	1.93
Cost C1 (Cost B1 + Imputed value of family labour)	31142	68.61	38090	71.83
Cost C2 (Cost B2 + Imputed value of family labour)	41262	90.91	48210	90.91
Management cost (10 % of Cost C2)	4126	9.09	4821	9.09
Cost C3 (Cost C2 + Management cost i.e., 10 % of Cost C2)	45389	100	53032	100

The cultivation cost was higher for large farmers at Rs.51,799 compared to small and medium farmers at Rs.44,208 (Table 1). Among small and medium farmers, approximately 37.18 per cent of the total cost was attributed to fixed costs, while 62.82 per cent was variable costs. Similarly, among large farmers, fixed costs constituted 34.26 per cent of the total cost, with variable costs making up the remaining 65.74 per cent (Table 2). Among the variable cost the human labour accounted for larger proportion in case of both large and small and medium farmers and in the fixed cost the rental value of owned land accounted maximum.

The Table 3 expressed the cost structure and their per cent share in total cost of soybean cultivation (Cost C_3) in Dharwad district. The cost incurred by large farmers was more compared to small & medium farmers in the study area (Fig. 1). These findings are on par with Medat *et al.* (2016) and Purushottam (2018).

There Exist a Discrepenacy in Cost of Cultivation of Soybean in Traditional and CACP cost Concepts Method. As Author as Considered the Additional Management Cost in the CACP Concepts.

The Table 4, revealed that large farmers had more main product yield and by-product yield than small &

TABLE 4

Farm business analysis of soybean

(per acre)

Particulars	Small & medium farmers (n= 30)	Large farmers (n= 30)
Total cost of cultivation (Rs./ac)	45389	53032
Total variable cost (Rs./ac)	27770	34054
Total fixed cost (Rs./ac)	17618	18978
Main product yield (q/ac)	10.22	11.84
Market price of main product (Rs./q)	5310	5420
By-product yield (q/ac)	6.32	7.95
Market price of by-product (Rs./q)	390	390
Cost of production (Rs./q)	4200	4217
Gross income (Rs./ac)	56733	67273
Net income over total cost (Rs./ac)	11344	14242
Net income over variable cost (Rs./ac)	28963	33220
Returns per rupee of investment	1.25	1.27
Farm business income (Rs./ac)	28403	31030
Family labour income (Rs./ac)	17521	20088
Farm investment income (Rs./ac)	26353	30005

medium farmers. The large farmers had more gross income than small & medium framers. The Returns per rupee of investment for large farmers was 1.27 which was Slightly more than the small & medium farmers (1.25). The large farmers had more farm business income, family labour income and farm investment income over small & medium farmers (Table 4). These results are in similar line with the study conducted by Pachpute *et al.* (2017) cost and returns of soybean in Marathwada Region of Maharashtra stated that, the output-input ratio of soybean was 1.36. The current study results are on par with that of Agarwal and Singh (2015) on soybean cultivation in the Ratlam district of Madhya Pradesh, the output-input ratio for overall farmers was 1.54 which indicates that the soybean crop is profitable. A similar study was conducted by Perke *et al.* (2018) to study the economics of soybean in Hingoli district of Maharashtra where the output-input ratio was 1.46 indicating that soybean is a profitable enterprise. Introduction of soybean had helped to improve their socio economic conditions, large number of small and marginal farmers probably because even under minimum agricultural inputs, management practices and climatic adversities, it fetches profitable returns to the farmers, as it was evident from the cost of cultivation of soybean.

Resource use Efficiency in Case of Small & Medium Farmers

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratio provides valuable insights.

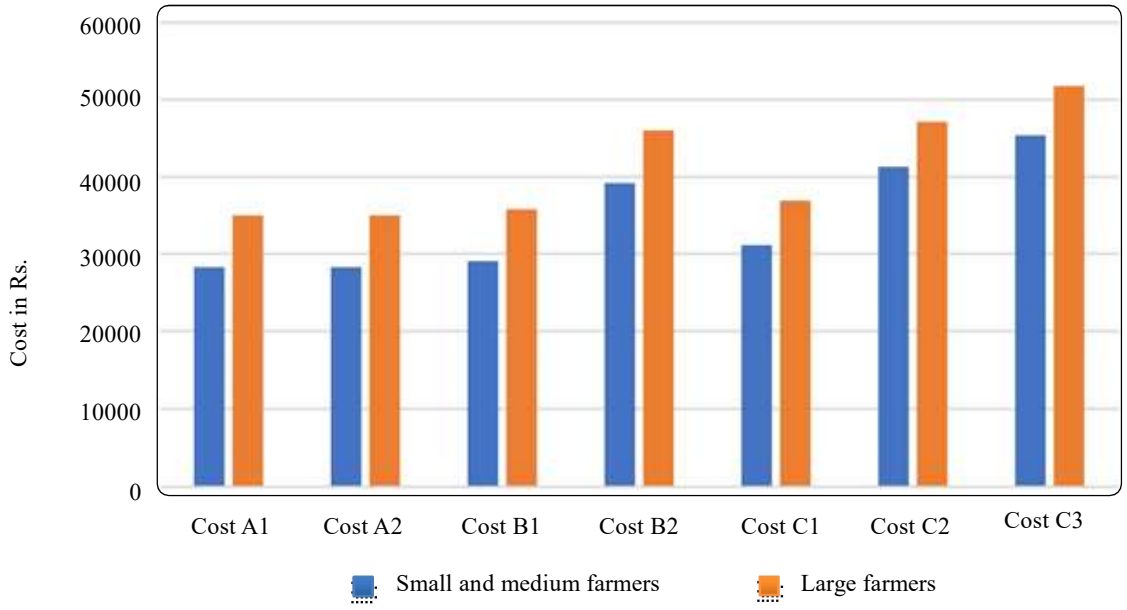

Fig. 1 : Comparison of cost structure of the small & medium and large farmers in the study area

The efficiency ratio (MVP: MFC) for seed (11.12), FYM (2.01), Chemical fertilizer (1.63), Plant protection chemicals (6.81), human labor (1.77) and weedicide (1.13) surpasses one. This implies the underutilization of these resources, suggesting an untapped potential for increased soybean production through their enhanced utilization. These findings align with the research conducted on resource use efficiency and resource use pattern of soybean in Dharwad district of Karnataka by Priyadarshini *et al.* (2018) while only the plant protection chemicals contradicted as it was overutilized in Priyadarshini's finding. Conversely, the profitability ratio for machine labor (-1.35) is less than one, indicating an over-utilization of this resource. Therefore, a reduction in the application of machine labor is recommended to achieve an optimal level of soybean production. The sum of elasticities (1.08) almost indicating constant returns to scale (Table 5). Despite a recommended package of practice suggesting 73.75 kgs of seed per farm and 2.4 tons of FYM per acre, small & medium farmers, with an average landholding of 2.95 acres, are using around 90.33 kgs of seed and 7.88 tons of FYM. It emphasized that these resources should be optimally utilized, considering the significant contributions of seeds and FYM to soybean yield.

Resource use Efficiency in Case of Large Farmers

The efficiency ratio (MVP: MFC) for FYM (2.33), Chemical fertilizer (3.54), Plant protection chemicals (5.99), human labor (1.04), weedicide (1.28) and machine labor (4.28) exceed one, suggesting underutilization of these resources in soybean production. This implies the potential for increased soybean production by enhancing the use of these

TABLE 5

Resource use efficiency of small & medium farms (per farm)

Particulars	Units	Geometric mean level of use of input	Elasticity coefficient		MVP	MFC (Rs.)	r
Yield (Y)	q/farm	31.80					
Seeds (X_1)	kg	89.11	0.33 (2.16)	**	652.48	58.66	11.12
FYM (X_2)	t	8.62	0.25 (3.21)	***	5035.23	2510	2.01
Chemical Fertilizers (X_3)	Rs.	3888.11	0.04 (0.18)		1.63	1	1.63
Plant protection chemicals (X_4)	Rs.	5748.44	0.22 (1.19)		6.81	1	6.81
Human labor (X_5)	md	70.45	0.28 (1.81)	*	706.90	409	1.77
Weedicide(X_6)	Rs.	2860.73	0.02 (0.33)		1.13	1	1.13
Machine Labor (X_7)	hr	4.22	-0.06 (0.61)		-2439.41	1800	-1.35
Returns to scale	∑bi		1.08				
Coefficient of multiple determination	R^2	0.94					

Note : 1. r=MVP/MFC, where MFC = Marginal factor cost (^{1}) ; MVP = Marginal value product(^{1})

2. ***, ** and * indicate significance at one per cent, five per cent and ten per cent level of probability, respectively.

3. Figures in parentheses represent 't' value

resources. The results align with the findings of Priyadarshini *et al*. 2018, but the plant protection chemicals contradict the results. On the other hand, the profitability ratio of seed (-5.15) is less than one, indicating an over-utilization of this resource. Therefore, reducing the application of seeds is recommended to achieve an optimal level of soybean cultivation (see Table 6). These findings align with a study conducted to analyse the resource use efficiency of soybean in Belagavi district of Karnataka by Vasudeva *et al.* (2018) where as it contradicts the result findings of Priyadarshini *et al.* 2018, Similar results have been found in the study conducted by Pawar and Tawale (2011) on the resource use efficiency of soybean. Despite a recommended package of practice suggesting 2.4 tons of FYM per acre for an average large farm with 5.98 acres, farmers are using 16.74 tons. It is emphasized that farmers should optimally utilize FYM and machine labor, given their significant contributions to soybean yield.

There is no significant difference between small and medium farmers and large farmers, as small area was allocated for soybean cultivation in case of both the categories of farmers.

Soybean contributing to human nutrition, animal feed and a myriad of industrial application, making it a key stone for both food security and economic growth. The Cost C3 of soybean cultivation was Rs.45,389 for small and medium farmers, Rs.53,032 for large farmers. Despite the higher cultivation costs, large farmers achieved a per-acre gross return of Rs.67,273; outperforming the returns of Rs.56,733 for small & medium farmers. Large farmers also demonstrated higher returns per rupee of cost of cultivation (1.27) compared to small and medium farmers (1.25). The results obtained from the resource use efficiency

Table 6

Resource use efficiency of large farms (per farm)

Particulars	Units	Geometric mean level of use of input	Elasticity coefficient	MVP	MFC (Rs.)	r
Yield	q/farm	78.05				
Seeds (X_1)	kg	203.97	-0.15 (1.21)	-323.53	62.80	-5.15
FYM (X_2)	t	17.75	0.24 *** (2.96)	5884.42	2525	2.33
Chemical Fertilizers (X_3)	Rs.	9713.06	0.08 (0.62)	3.54	1	3.54
Plant protection chemicals (X_4)	Rs.	12141.47	0.17 (1.02)	5.99	1	5.99
Human labour (X_5)	md	203.43	0.20 (1.67)	430.25	415	1.04
Weedicide (X_6)	Rs.	7164.98	0.02 (0.41)	1.28	1	1.28
Machine Labor (X_7)	hr	9.91	0.18 ** (2.01)	7855.42	1835	4.28
Returns to scale	∑bi		0.74			
Coefficient of multiple determination	R^2	0.94				

Note : 1. r =MVP/MFC where, MFC = Marginal factor cost ([1]); MVP = Marginal value product ([1])
2. ***, ** indicates significant at one per cent and five per cent level of probability, respectively.
3. Figures in parentheses represent 't' value.

using Cobb - Douglas production function revealed the underutilization of resources like farmyard manure, chemical fertiliser, plant protection chemicals *etc* and over - utilization of machine labour. These trends emphasize the untapped potential for resource reallocation, particularly in optimizing the use of seeds, manure, machine labor and human labor, encouraging the adoption of Good Agricultural Practices (GAP) and recommended package of practices for enhanced returns from soybean cultivation.

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