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Cost of Cultivation and Constraints Analysis of Soybean Production in Khagaria district of Bihar State: An Exploratory Study

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ABSTRACT

India is the 5th largest oilseed producing country in the world after USA, Brazil, Argentina and China with 2.74 per cent of world production. Among different oilseeds crops grown in India, soybean is the one of the most important cultivated in 12.19 ha (DES: 2019-20). Multistage Sampling Technique was used to collect the samples from study area using Snow Ball Sampling process. The data were analyzed using standard statistical and economic analytical tools and constraints faced by sample farmers in cultivation of soybean were analysed using Garrett's Ranking Technique. The average cost of cultivation of soybean was estimated as ₹ 29929 per ha. The average total return received from soybean was estimated as ₹ 39842 per farm and ₹ 45113 per ha. The return to cost ratio was 1.51 on overall basis. The constraints affecting soybean cultivation were broadly classified into agro-ecological, technological, economic. Rainfall was the most limiting factor in soybean production among agro-ecological constraints (Garrett Score 70.54) whereas suitable variety-the most limiting factor (Garrett Score 65.25) among technological constraints. Economic constraints included the subsidy on inputs was the major limiting constraints with Garrett Score of 68.37. It was concluded from the study that for strengthening of soybean production marketing system needs to be supported to ensure remunerative price and better profitability to the farmers. There is also need for availability of suitable variety and training to the farmers in adoption of appropriate agro-techniques in production of the crop to increase the production efficiency.

Keywords: Soyabean, snow ball sampling, costs & returns, constraints

India is the 5th largest oilseed producing country in the world after USA, Brazil, Argentina, and China with 2.74 per cent of world production. There are nine important oilseeds crops grown in India, out of which seven namely; soybean, groundnut, rapeseed-mustard, sunflower, sesame, safflower and niger are of edible oils and two are of non-edible oils (castor

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and linseed). In terms of acreage, production and economic value, oilseeds are second only to food grains. In India, Soybean, rapeseed & mustard, groundnut, and sunflower are cultivated in 12.19, 6.86, 4.82 and 0.23 m ha, respectively (DES: 2019-20). Soybean as an oilseed crop was introduced in India in the year 1970-71. In India, the total area under soybean crop had increased from 6.11 m ha in 2002 to 12.19m ha and production from 4.65 million MT to 11.22 million MT in the year 2019-20 (Ministry of Agriculture, GOI). The major soybean growing states in the country are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, and Chhattisgarh.

In Bihar, since introduction of soybean in 2012 in Begusaria district of Agro Ecological Zone II, has led to a shift in cropping system during rainy (*kharif*) season from rice - wheat, rice - maize, maize - maize to soybean – wheat and soybean – maize system. Soybean has helped in improving soil fertility and productivity after *kharif* season in wheat, maize, and other crops. It is one of the most resilient crops for the rainfed *kharif* season. The area under soybean is spreading in Begusarai and its neighbouring districts like *Khagaria* and Samastipur during last few years (Shahi et al. 2018).

Soybean (*Glycine max* (L.) *Merill*) is an important food legume and plays vital role in human livelihood. It is also known as "golden bean," "miracle crop" etc, because of its several uses. It is good source of protein and oil. It contains high quality of proteins (43 per cent), carbohydrate (21 per cent), minerals (5 per cent), moisture (8 per cent), fat (20 per cent), fibre (4 per cent) and rational amounts of vitamins (Ali, 2003). Soybean also contains about 20 per cent oil with an important fatty acids, lecithin and vitamin A and D. Though, it is legume crop yet it is widely used as oilseed. It cannot be utilized as pulse due to poor cooking ability and digestibility on account of inherent presence of trypsin inhibitor. Soybean meal acts as high-quality protein source for livestock feed rations (Mary *et al*. 2013). It is the world's most important seed legume, which contributes 25% of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding (Agarwal *et al.* 2013).

The Bihar state is predominated by over 90 per cent of marginal & small farmers with average land holding size of less than one acre, facing challenges for their transformation from subsistence to self-sufficient economic status since its bifurcation in the year 2000. In view of this the government has planned for its development and economic upliftment through implementation of Agriculture Road Map since 2008. One of the objectives of the Road Map is promotion and cultivation of commercial crops in the state. Soybean is one of such crops, under cultivation since 2012 in selected districts of the state. It has also been observed that there is no information or any study about status of production and marketing of soybean since its adoption in the area. Therefore, the present study has been taken to estimate the costs and return of Soybean production in the study area and to assess constraints faced by farmers during cultivation of soyabean crop.

MATERIAL AND METHODS

The data were collected for crop year 2019-20. Study area was *Khagaria* district, situated in the Zone II (North-Eastern Zone) of Bihar state. The study was based on a sample of 90 soybean growers selected through Multi-Stage Sampling Technique using Snow Ball sampling technique. In this method the researcher started with a small group of individuals and gradually sample were expanded by relying on referrals from the initial participants.

Snowball sampling is a non-probability sampling technique commonly used in exploratory studies. In the context of studying soybean production, it involves initially identifying a few key participants or informants who are knowledgeable about the topic. These informants are then asked to refer or "snowball" additional participants who might have valuable insights or information.

Economics of Soybean cultivation: It involves costs and return analysis of soybean cultivation. The costs include variable cost which covers expenditure on different inputs, like land preparation, manures, seeds, fertilizer, plant protection chemicals, labour etc. and fixed cost covers depreciation, interest on variable cost, interest on fixed cost, rental value of land, land revenue etc. Further the returns will be estimated in terms of Gross Income, Net Income and Returns to Cost Ratio as below;

(i) Gross Income = Yield (Q) × Price (₹/Q)

(ii) Net Income = Gross Income – Total Cost

(iii) Returns to Cost Ratio = Gross Income / Total Cost

Interest on working capital estimated @ 4% (Interest on working capital in agriculture is estimated at around 4% due to the relatively low-risk nature of agricultural operations and the prevailing interest rates in the financial market. This rate aims to cover the cost of borrowing or financing the capital needed for day-to-day farming activities, such as purchasing seeds, fertilizers, and labor, FAO, 2020), Rate of Interest and Interest on fixed capital estimated @ 8% Rate of Interest (An 8 percent interest rate on fixed capital or depreciation in agricultural machinery is considered significant because it reflects the opportunity cost of capital invested in machinery. This rate represents the potential return that could be earned if the capital were invested elsewhere. It helps cover the cost of financing the machinery, including maintenance and replacement expenses FAO 2019).

Constraints analysis: The constraints faced by soybean growers related to production and marketing was prioritized by employing Garrett's Ranking Technique. In this method the farmers were asked to rank the given problem/constraints according to the severity. The order of merit given by farmers was converted into rank by using the following formula: -

$$Percentage\ Position = 100\ (R_{ij} - 0.5) / N_j$$

Where, R_{ij} = Rank given for i^{th} variable (i = 1, 2….5) by j^{th} respondent (j = 1, 2……., n)

N_j = Number of variables ranked by j^{th} respondent

RESULTS AND DISCUSSION

Cost of cultivation of soybean

The cost of cultivation of soybean is presented in table 1. It was found that most popular soybean variety grown in the study area was JS 335. The

Table 1: Cost of cultivation of soybean in the study area (₹ ha^{-1})

Item	Category of farmer				
	Marginal & Small (n_1=16)	Semi Medium (n_2=30)	Medium (n_3=35)	Large (n_4=9)	Overall (N=90)
Area under soybean (ha)	0.38	0.67	1.27	1.84	0.97
(A) Variable Cost					
(a) Material Cost					
Land preparation & sowing	5172	4538	3907	3333	4285
Seed	5824	5272	6309	4961	5742
Irrigation	2258	1433	1243	1250	1488
Plant Protection	1500	1200	1200	1333	1267
Total Material Cost (a)	14754 (52.26)	12443 (44.69)	12659 (38.81)	10877 (33.03)	12782 (42.71)
(b) Labour cost					
Land preparation & sowing	3000	2588	2421	2333	2571
Weeding	1000	767	764	681	799
Irrigation	890	865	845	820	795
Harvesting	4250	3975	3664	3417	3847
Threshing & winnowing	1875	1725	1625	1375	1676
Total Labour Cost (b)	11015 (39.02)	9920 (35.63)	9319 (28.57)	8626 (26.20)	9688 (32.37)
(A) Variable Cost (a+b)	25769 (91.28)	22363 (80.32)	21978 (67.38)	19503 (59.23)	22470 (75.08)
(B) Interest on Variable Cost @ 4%	1030	895	879	780	899
(C) Total Variable Cost (A+B)	26799 (94.92)	23258 (83.54)	22857 (70.07)	20283 (61.60)	23369 (78.08)
(D) Overhead Cost					
Land Revenue	200	200	200	200	200
Depreciation	685	2435	6740	9413	4496
Interest on fixed cost @ 8%	548	1948	2092	3032	1864
Total Overhead Cost (D)	1433 (5.08)	4583 (16.46)	9232 (28.30)	12645 (38.40)	6560 (21.92)
(E) Total Cost (C+D)	28232 (100.00)	27841 (100.00)	32620 (100.00)	32928 (100.00)	29929 (100.00)

Note: Figures in parenthesis indicates percentage to total.

sowing time of the crop was from second fortnight of June to first fortnight of July. Normally the crop is harvested from last week of October to second week of November. The normal crop duration was of 95-100 days.

The table 1 showed that the average cost of cultivation of soybean was ₹ 29929 per ha. The highest total cost of ₹ 32928 was incurred by large farmers followed by medium farmer (₹ 32620 per ha), marginal & small (₹ 28232 per ha) and semi medium (₹ 27841 per ha). Of the total average cost, 75.08 per cent (₹ 22470) was attributed to total variable cost, which consisted of 42.71 per cent (₹ 12782) as total material cost and 32.37 per cent (₹ 9688) as labour cost. The overhead cost was estimated as ₹ 6560 per ha (21.92 per cent).

The total variable cost varied from ₹ 25769 per ha (91.28 per cent) on marginal and small farms to ₹ 19503 per ha (59.23 per cent) on large farms. It is also revealed from the table that the material cost was highest on small farms (52.26 per cent) while it was lowest on large farm (33.03 per cent) among four categories of farms. As far as labour cost was concerned, it was highest (39.02 per cent) on marginal & small farms while lowest (26.20 per cent) on large farms.

Return from soybean production

The yield, price and gross income from soybean is presented in table 2.

The table 2 showed that yield of soybean was 4.83, 8.43, 14.01 & 21.47 q/farm on marginal & small, semi medium, medium, and large farms, respectively. The average gross income received from soybean was estimated as ₹ 39842 per farm. The table 2 also revealed that yield of soybean was estimated as 11.67, 12.33, 13.25 & 14.50 q/ha on marginal & small, semi medium, medium, and large farms, respectively. The variation in soybean yield among different categories of farmers is primarily due to disparities in resource access, agricultural practices, scale of operation, risk management, market access, infrastructure, and government policies. Larger farms tend to have an advantage in these areas, resulting in higher yields per hectare compared to smaller farms. The average price of soybean received by sample farmers ranged from ₹ 3178 per quintal (marginal & small farmers) to ₹ 3560 per quintal (large farmers). The average total income received from soybean was estimated as ₹ 45113 per ha. The highest Income was received by large farmers (₹ 54714 per ha) followed by medium (₹ 47146 per ha), while semi medium and marginal &

Table 2: Production and return from soybean cultivation

Item	Category of farmer				
	Marginal & Small(n_1=16)	Semi Medium (n_2=30)	Medium (n_3=35)	Large (n_4=9)	Overall (N=90)
(A) Grain (Soybean)					
Yield (q/farm)	4.83	8.43	14.01	21.47	11.26
Yield (q/ha)	11.67	12.33	13.25	14.50	12.78
Price (Rs/q)	3178	3230	3360	3560	3304
Income (A) per farm	15350	27229	47074	76433	37203
Income (A) per ha	36917	39825	44520	51620	42225
(B) By product					
Crop residue (q/farm)	2.58	4.69	7.66	11.78	6.18
Crop residue (q/ha)	6.39	6.77	6.34	6.80	6.57
Price (₹/q)	406	455	399	450	427
Income (B) per farm	1047	2134	3056	5301	2639
Income (B) per ha	2674	3149	2626	3094	2888
Total Income (A+B) per farm	16397	29363	50130	81734	39842
Total Income (A+B) per ha	39591	42974	47146	54714	45113

Source: Compiled by Authors.

small farmers obtained gross income of ₹ 42974 and ₹ 39591 per ha, respectively. The variation in the price per quintal of soybeans across different categories of farmers can be attributed to several factors, leading to disparities in their income and profitability. It is essential for policymakers to consider these disparities when designing interventions to support small and marginal farmers and promote a more equitable agricultural sector. Larger farms often benefit from economies of scale, allowing them to produce larger quantities more efficiently. This can result in cost savings, enabling them to negotiate better prices or absorb fluctuations in market prices.

Average Net Return and Return to Cost Ratio of Soybean production

The net income over variable cost and total cost, as well as return to cost ratio has been estimated and presented in table 3.

The table showed that net income over total variable cost was ₹ 15667, ₹ 22410, ₹ 26858, and ₹ 36714 per ha, on marginal & small, semi medium, medium, and large farms, respectively. The return to cost ratio was 1.40, 1.54, 1.44 and 1.66 on four category of farms, respectively.

Constraints in cultivation of soybean

To study the constraints in production and marketing of soybean, the sample farmers were questioned for their experience about the framed constraints during interview and their response were recorded. These were broadly classified into agro-ecological, technological, and economic. The results have been presented (rank-wise) in the following sub-sections: -

Production Constraints

(i) Agro-Ecological Constraints

The results of agro-ecological constraints faced by sample farmers are presented in table 4. The agro-ecological factors included suitability of weather, land situation, rainfall during *Kharif* and availability of irrigation water. Among these constraints' rainfall was the most limiting factor in soybean production considered by the farmers (70.54 Garrett Score) followed by suitability of weather (58.13 Garrett Score) on overall basis. The land situation and irrigation water were also considered as limiting factors with Garrett Score of 43.76 and 27.76, respectively.

(ii) Technological Constraints

The technological factors included were suitable variety, fertilize/nutrient management, weed management and plant protection. Among these suitable variety was considered as the most limiting factor (65.25 Garrett Score) followed by weed management (63.61 Garrett Score). The fertilizer/ nutrient management and plant protection were also considered limiting factor with Garrett Score 36.07 and 35.20, respectively.

Table 3: Costs and return of soybean production on sample farms (₹/ha)

Items	Category of farmer				
	Marginal & Small (n_1=16)	Semi Medium (n_2=30)	Medium (n_3=35)	Large (n_4=9)	Overall (N=90)
Fixed Cost	1433 (5.08)	4583 (16.46)	9232 (28.30)	12645 (38.40)	6560 (21.92)
Variable Cost	26799 (94.92)	23258 (83.54)	22857 (70.07)	20283 (61.60)	23369 (78.08)
Total Cost	28232 (100.00)	27841 (100.00)	32620 (100.00)	32928 (100.00)	29929 (100.00)
Gross Return	39591	42974	47146	54714	45113
Net Return against					
Variable Cost	15667	22410	26858	36714	24314
Total Cost	12132	15890	14526	19571	14721
Return to total cost ratio	1.40	1.54	1.44	1.66	1.51

Source: Compiled by Authors.

Note: Figures in parenthesis indicate percentage to total.

Table 4: Constraints in production of soybean faced by sample farmers in production of soybean

Sl. No.	Constraints	Overall (N=90)	
		Garrett Score	Rank
(A)	**Agro-Ecological Constraints**		
1	Rainfall	70.54	I
2	Suitability of weather	58.13	II
3	Land situation	43.76	III
4	Irrigation water	27.76	IV
(B)	**Technological Constraints**		
1	Suitable variety	65.26	I
2	Weed management	63.61	II
3	Fertilizer/Nutrient Management	36.07	III
4	Plant protection	35.20	IV
(C)	**Economic Constraints**		
1	Subsidy on inputs	68.37	I
2	Credit and rate of interest	48.37	II
3	Labour availability	31.00	III

Source: Compiled by Authors.

(iii) Economic Constraints

The economic constraints included were source of credit and their rate of interest, subsidy on inputs and labour availability. The subsidy on inputs was the major limiting constraints with Garrett Score 68.37 followed by credit and rate of interest and labour availability having Garrett Score 48.37 and 31.00, respectively.

CONCLUSION AND POLICY IMPLICATION FOR OPPORTUNITIES IN CULTIVATION OF SOYBEAN

The following conclusions were drawn from the forgoing analysis:

1. Looking into the input/cost intensive nature of rice and maize grown during *kharif* season the farmers in the study area (district *Khagaria*, Bihar) have diversified their farming and started cultivation of soybean at their own. Further in view of the crop being less input and cost intensive, has attracted more farmers and the area under the crop is increasing year after year.
2. Only one variety namely JS 335 was found cultivated in the year. The farmers are also using different management practices at their own in consultation among themselves. Therefore, there is need for testing/developing soybean varieties including management practices, viz. nutrient management, water management, plant protection management etc. suitable for the area.
3. There is also need for training to the farmers on cultivation of the soybean crop.

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