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Yield Gap Analysis of Soybean in Sangli District of Maharashtra

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Abstract

The present investigation was undertaken to examine the resource use and productivity, gap in input use and output levels of soybean, factors affecting the yield gap and constraints in the production of soybean in Sangli district of Maharashtra. The study revealed that, the size of family and its compositions and literacy status of sample farmers were different among the different size groups. The cropping pattern of sample soybean growers, was observed to be diversified in nature and rice, soybean, groundnut, green gram, wheat, gram and tomato were the major crops grown on sample farms. The important inputs such as manures and fertilizers were not used up to the recommended levels in all size groups. This led to gap between the potential yield and actual farm yield. The highest yield gap-II was observed in large group (24.56%) followed by medium group (19.12 %) and small group (11.52%). At the overall level, the per hectare gross return was found to be 79396.77. The per hectare gross returns of soybean in small, medium and large size group was 90797.95, 81080.02 and 75750.00, respectively. At overall level B:C ratio at cost 'C' was 1.12. It clearly indicated that, the soybean cultivation is a profitable venture.

Key words : Soybean, returns, production, methodology, constraints, yield gap.

Soybean (*Glycine max*), a legume native to East Asia, is the world's most economically significant bean, renowned for its exceptional adaptability to diverse soils and climates. As the premier legume and oilseed crop globally, soybean serves as an indispensable source of high-quality protein (40%) and oil (18%), surpassing all food crops in protein content and ranking second among food legumes in oil content. Notably, soybean contributes approximately 50% to global oilseed production. Beyond its culinary applications, soybean boasts extensive industrial uses, including the manufacture of butter, fats, varnishes, soap, glycerine, and printing ink. Furthermore, soybean flour is utilized to produce easily digestible soy milk. The de-oiled soy cakes, rich in protein, are vital in human food and livestock feed production. As a kharif crop, soybean plays a pivotal role in maintaining soil fertility and enhancing physical properties, fixing atmospheric nitrogen at an impressive rate of 15-30 kg ha^{-1} $year^{-1}$. Legumes, including soybean, are esteemed for their protein-rich food, feed, and fodder, earning them the distinction of being a "unique jewel" in Indian crop husbandry.

India ranks fifth globally in soybean production, cultivating 12146 thousand hectares and yielding 12986 thousand tonnes in 2022. However, a significant yield gap persists, exemplified by Maharashtra's 128 kg ha^{-1} difference from the national average. Indian soybean cultivation primarily occurs under suboptimal rainfed conditions, contributing to lower yields. Despite government initiatives and policies supporting farmers, which have driven growth in area and production, yield enhancements have been modest over the past few decades, highlighting the need for targeted interventions to bridge this yield gap and optimize India's soybean potential.

Soybean played a key role in India's Yellow Revolution, contributing 28% to domestic vegetable oil production. Its success is credited to the joint efforts of soybean researchers, state agricultural departments, cooperatives like Oilseed Federation, soy-based industries, and farmers. Despite facing numerous challenges, soybean remains a vital crop for farmers, underscoring its enduring importance in India's agricultural landscape.

Study area : The Sangli district was purposively selected for the present study. As Soybean is a major crop of Sangli district and occupied about 442.71 hundred hactare area which contributes to 14.53 per cent of area of Pune division with 665.79 hundred tonnes of production. Thus, the productivity of soybean in Sangli district was estimated to 1503.90 kg ha^{-1} during 2022-23. In view of the above, Sangli district was selected purposively for the present study.

Data Collection : The data was collected by survey method by conducting personal interviews of sample farmers with the help of questionnaire prepared for study purpose. Data regarding land use pattern, cropping pattern, input utilization and yield for soybean crop for the agricultural year 2023-24 was collected from the sample growers.

Results and discussion

Costs and returns : From the Table 2 results further indicated that, on an average, 1089.50 quintals of jaggery were produced annually. The total cost amounts to Rs.3845644.37 with 99.31 per cent of this being variable costs and only 0.69 per cent being fixed costs, indicating that the production process is highly dependent on fluctuating inputs like raw materials and labour.

Cost of cultivation was estimated by using standard cost concepts and same is presented in Table 2.

At overall level, the per hectare cost of cultivation of soybean was worked out to be Rs. 70944.70. The cost 'A' was Rs. 48392.70 contributing 68.21 per cent share in the cost 'C'. Among the different item of costs, the maximum expenses were incurred on machine charges (Rs. 12775.52 ha^{-1}) contributing 18.01 per cent share, followed by expenditure on hired human labour (Rs. 10595.69 ha^{-1}) contributing 14.94 per cent share of total cost of cultivation. The per hectare expenditure on bullock labour, manure, seed, fertilizer, plant protection charges and weedicide were worked out to Rs. 664.27, Rs. 3024.16, Rs. 7057.33, Rs. 5207.46, Rs. 1001.52 and Rs. 2004.80 which accounted for 0.94, 4.26, 9.95, 7.34, 1.41, and 2.83 per cent share in cost 'C' respectively. In the cost 'B' the major items of expenditure were the rental value of land and interest on fixed capital which worked out to be Rs. 14201.07 ha^{-1} and Rs. 6127.71 ha^{-1} and constituted 20.02 and 8.64 per cent share in the total cost 'C', respectively.

In case of small size group, the per hectare cost of cultivation was Rs. 76533.61 ha^{-1}. Out of which cost 'A' was Rs. 48322.55 ha^{-1} constituting 63.14 per cent in the total cost (i.e., cost 'C'). In the cost 'A' the major item was hired human labour worked out to Rs. 11337.89 ha^{-1} constituting 14.81 per cent share in the total cost 'C'. The per hectare expenditure on seed and fertilizer was worked out to Rs.

Table 1. Sample selection plan for the study

Tahsils	Villages	Size Groups			Total
		I	II	III	
Walwa	Walwa	5	5	5	15
	Ashta	5	5	5	15
	Rethare Dharan	5	5	5	15
Miraj	Kasabe Digraj	5	5	5	15
	Mhaisal	5	5	5	15
	Dudhgaon	5	5	5	15
	Total	30	30	30	90

7255.71 ha^{-1}, Rs. 5695.43 ha^{-1} which accounted for 9.48, and 7.44 per cent share in the total cost 'C', respectively. In case of cost 'B' the major items of expenditures were rental value of land and interest on fixed capital contributing 19.84 and 11.57 per cent share in the total cost 'C', respectively.

In case of medium size group, per hectare cost of cultivation was Rs. 72932.31 ha^{-1}. The per hectare cost 'A' incurred in soybean production was Rs. 49095.29 ha^{-1} which accounted for 67.32 per cent share in the total cost 'C'. The major item of cost 'A' was hired human labour which was worked out to Rs. 10897.2 ha^{-1} and its share in the cost 'C' was 14.94 per cent. The expenditure on fertilizer was Rs. 4896.31 ha^{-1} and contributing 6.71 per cent of total cost. The expenditure on seed constituted 9.24 per cent share in the total cost.

Table 2. Cost of cultivation of soybean

Cost items	Small		Medium		Large		Overall	
	Value	Per cent	Value	Per cent	Value	Per cent	Value	Per cent
Hired Human labour								
a) Male	5150.68	6.73	4331.78	5.94	4115.04	6.04	4532.50	6.39
b) Female	6187.21	8.08	6565.42	9.00	5436.95	7.98	6063.19	8.55
c) T otal human labour	11337.89	14.81	10897.20	14.94	9551.99	14.02	10595.69	14.94
Bullock power	1246.58	1.63	303.74	0.42	442.48	0.65	664.27	0.94
Machine Power	10257.53	13.40	14383.18	19.72	13685.84	20.08	12775.52	18.01
Manures	2794.52	3.65	2859.81	3.92	3418.14	5.01	3024.16	4.26
Seed	7255.71	9.48	6735.98	9.24	7180.31	10.53	7057.33	9.95
Fertilizers	5695.43	7.44	4896.31	6.71	5030.65	7.38	5207.46	7.34
N	1360.05	1.78	1193.90	1.64	1186.41	1.74	1246.97	1.76
P	3490.13	4.56	3062.13	4.20	3045.94	4.47	3199.49	4.51
K	845.25	1.10	640.28	0.88	798.30	1.17	4336.06	6.11
Plant protection charges	1087.21	1.42	851.87	1.17	1065.49	1.56	1001.52	1.41
Weedicide	2263.93	2.96	1902.80	2.61	1847.68	2.71	2004.80	2.83
Incidental charges	423.74	0.55	476.17	0.65	669.36	0.98	523.09	0.74
Repairs	331.96	0.43	352.80	0.48	501.11	0.74	395.29	0.56
Working capital	42694.5	55.79	43659.86	59.86	43393.05	63.66	43249.13	60.96
Int. on Working Capital @ 6%	2561.67	3.35	2619.59	3.59	2603.58	3.82	2603.76	3.67
Depre. on farm implements	2964.10	3.87	2715.84	3.72	1617.13	2.37	2432.35	3.43
Land revenue and taxes	102.28	0.13	100.00	0.14	120.09	0.18	107.46	0.15
Cost 'A'	48322.55	63.14	49095.29	67.32	47733.85	70.03	48392.7	68.21
Rental value of land	15185.96	19.84	13608.43	18.66	14227.35	20.87	14201.07	20.02
Int. on fixed capital @ 10%	8851.58	11.57	7186.53	9.85	4959.75	7.28	6127.71	8.64
Cost 'B'	72360.09	94.55	69890.25	95.83	66920.95	98.18	68721.48	96.87
Family labour								
a. Male	2027.40	2.65	1289.72	1.77	565.42	0.83	971.61	1.37
b. Female	2146.12	2.80	1752.34	2.40	678.50	1.00	1251.61	1.76
Cost 'C'	76533.61	100.00	72932.31	100	68164.87	100.00	70944.7	100.00
Gross income	90797.95		81080.02		75750.00		79396.77	
Per quintal cost	3459.93		3606.94		3527.06		3499.66	

In the cost 'B', the major item of expenditure was rental value of land constituting 18.66 per cent in the cost 'C'.

Functional analysis : The Cobb-Douglas type production function was fitted to analyze the field level data of 90 sample soybean farmers and results are depicted in Table 3.

At overall level, the coefficient of multiple determination was estimated to be i.e., R^2 0.71. It indicated that 71 per cent of variation in soybean output was jointly explained by the selected six variable. The regression coefficient of human labour (X_1), Nitrogen (X_3), and potash (X_5) were positive and significant at one per cent level with the magnitude of 0.4531, 0.2187, and 0.0566, respectively. This indicated that, output will further respond positively towards the increment in these inputs in soybean production. Remaining variables were not significant, indicating that these may or may not have any direct influence on the soybean output. In the small size group, positive and significant coefficients indicated that, one per cent increase in the use of Nitrogen (X_3), phosphorus (X_4), and potassium (X_5), will increase the yield by 0.98, 0.84, and 0.36 per cent, respectively. In case of medium size group of holdings, the estimated parameters of human labour (X_1), Nitrogen (X_3), and Phosphorus (X_4), were significant indicating that for every one unit increase in the expenditure on these resources would results in increased gross return by 0.38 per cent, 0.64 per cent and 0.72 per cent, respectively. The value of coefficient of multiple determinations (R^2) was found to be 0.73, that means 73 per cent variation in output was jointly explained by the six independent resource variables under consideration. However, Bullock labour (X_2) not significant but positive, it indicates that it has positive impact on output.

In case of large size group of holdings, the value of coefficient of multiple determination R^2 was found to be 0.69 that means 69 per cent variation in output was jointly explained by the six independent variables under consideration. The regression coefficient of Phosphorus (X_4), was positive and significant at 5 per cent level of significance. However, Bullock labour (X_2), Potassium (X_5) and plant protection (X_6) not significant but positive, it indicates that it has positive impact on output. Ahirwar *et al.* (2007), Namdev (2014) and Di mauro *et al*. (2022) revealed similar results and suggested to increase the level of inputs substantially to reduce the yield gap.

Suggestions

Awareness about adaption of technology and efficient use of these inputs was lacking among the Soybean cultivars in the Sangli district of Maharashtra, therefore, intensive extension activities be carried out to disseminate the technologies by SAU's and state agriculture department.

Table 3. Results of Cobb-Douglas production function

Particulars	Size groups			Overall
	Small	Medium	Large	
Intercept (a)	-1.48	0.71	0.74	0.65
Hired Human labour (X_1)	0.011 (0.3185)	0.9518** (0.3814)	-0.1621 (0.1052)	0.4531*** (0.1786)
Bullock labour (X_2)	-0.0045 (0.0032)	0.0021 (0.0293)	0.0003 (0.0015)	-0.0485 (0.1778)
N (X_3)	1.8011** (0.9875)	1.848*** (0.6446)	-0.3388 (0.2394)	0.2187*** (0.0073)
P (X_4)	1.6159** (0.8480)	1.8843** (0.7232)	0.7245** (0.3032)	0.0351 (0.1472)
K (X_5)	0.8865** (0.3692)	-0.1536 (0.0971)	0.0844 (0.0971)	0.05661*** 0.0214)
Plant Protection (X_6)	-0.0143 (0.3693)	-0.0891 (0.1445)	0.003 (0.0388)	0.009 (0.0070)
R^2	0.68	0.73	0.69	0.71
D.F.	23	23	23	83
Fcal	4.49	10.50	7.42	8.68

(***, **, * indicates significant at 1, 5 and 10 per cent level, respectively). (Figures in parenthesis are the Standard errors of the respective regression coefficient)

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