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Cost and Return Analysis of *Kharif* Sorghum (*Sorghum bicolor*) in Bhilwara District, Rajasthan

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ABSTRACT

Background: Sorghum is a heat and drought resistant crop that is widely grown in arid and semi-arid regions for food, feed and bio-energy. The sorghum crop is important to the majority of farmers for income, nutritional security and environmental sustainability. They grow sorghum not for profit, but because it is the only crop that can withstand the harsh climatic conditions that exist. The present study aimed to investigate the economics of sorghum in the Bhilwara district of Rajasthan during the year 2020-21 using primary data from 60 sample households from four different villages.

Methods: The standard cost concept method of the Commission for Agricultural Cost and Price (CACP) was used to calculate the cost of cultivation (COC) of sorghum crop. It includes Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3. Farm income measures, which include gross income, farm business income, family labour income and net income, are used to determine crop profitability and return on investment.

Result: The results of study revealed that total cost (Cost C_2) of sorghum cultivation per ha was found to be ` 25149.69. The cost of producing one quintal of sorghum was calculated to be ` 1383.18. Sorghum cultivation generated a net income, farm business income and family labour income of ` 23658.44, ` 30680.32 and ` 26527.74 per ha, respectively.

Key words: Cost of cultivation, Income measures, Minimum support price, Production.

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench], also popularly known as *jowar*, is a drought- and heat-resistant crop. It is widely cultivated in arid and semi-arid regions for food, feed and bio-energy (Kimber *et al*., 2013). More than 90.00 per cent of the sorghum cultivation area is mainly concentrated in Africa and Asia, with only a small portion in developed countries (Esipisu, 2011). Sorghum is a staple food for the world's poorest and most food insecure people in the Semi-Arid Tropics (ICRISAT, 1996, Basavaraja *et al*., 2005). India is the world's sixth largest producer of sorghum (4.40 million metric tonnes), accounting for 7.62 per cent of total world production (USDA, 2021). Sorghum has adaptable characteristics that allow it to grow in areas where other staple cereals such as wheat, maize and rice would not be suitable (Haussmann *et al.,* 2000; Rami *et al*., 1998). It is grown both in the *kharif* and *rabi* seasons. Approximately half of the *kharif* sorghum produce is used for alternative purposes such as poultry feed, alcohol and animal feed, whereas *rabi* sorghum is solely used for human food consumption (Rao *et al*., 2010). Sorghum has a high biomass in terms of green and dry fodder yield and plays an important role in meeting the enormous demand for fodder (Singh *et al*., 2012).

Indian farmers in the different parts with good irrigation facilities have switched from millets and sorghum to rice, wheat, maize and other high-value crops (Seetharam *et al*., 1989; Kelley and Rao, 1993; Hall, 2000). On the other hand, farmers' demand for millet crops like sorghum in arid and semi-arid regions such as Rajasthan, Maharashtra, Karnataka, Andhra Pradesh and Gujarat is unlikely to decrease in the near future, as there are few crops to substitute in the fragile growing environments for low-income farmers (Pray and Nagarajan, 2009). Thus, sorghum crop plays a critical role in ensuring income, nutritional security and environmental suitability for millions of farmers. Sorghum is grown by the majority of farmers not for profit, but because it is the only crop that can withstand the extreme climatic conditions found in many parts of the country, Bhilwara district of Rajasthan is no exception. Area, production and productivity of sorghum in Bhilwara district of Rajasthan was 68598 ha, 64435 mt and 939 kg per ha during the year 2019-20. Despite the fact that only a few studies have looked at the economic aspects of *Kharif* sorghum crop in Rajasthan in general and in the Bhilwara district in particular. This study looks at the economics of *Kharif* sorghum cultivation in Bhilwara district of Rajasthan.

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MATERIALS AND METHODS

The present study has been carried out in Bhilwara district of Rajasthan during the *kharif* season of the agricultural year 2020-21. Two tehsils in Bhilwara district, Shahpura and Jahazpur, were chosen for the study based on the highest area under sorghum crop. Based on the maximum area under sorghum, two villages from each tehsil were chosen, a sample of four villages was ultimately chosen for the current study. All sorghum grower-farmers were divided into three groups based on the size of their operational land holdings. Using the cumulative frequency square root technique (Delenius and Hodges, 1950), the farmers were classified as small, medium and large farmers, with operational land holdings of less than 2 ha, 2 to 5 ha and more than 5 ha, respectively. Following that, a sample of 15 sorghum growers was drawn at random from each village based on the probability proportion to the number of households in each category. Finally, 60 sorghum growers from four villages were chosen as a sample. Thus, the sample included 30, 19 and 11 farmers in the small, medium and large size of land holding categories, respectively. Table 1 shows the distribution of farmers' land sizes by category.

Cost concepts

Standard method of cost concepts employed by Commission for Agricultural Cost and Price (CACP) were-used in order to calculate the cost of cultivation (COC). It comprises Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3.

Cost A_1 = Cost A_1 accounts for all actual expenses incurred by the owner in cash and kind during production. It includes the 14 cost items *viz;* (i) hired human labour (permanent and casual), (ii) owned bullock labour, (iii) hired bullock labour, (iv) owned machinery labour, (v) hired machine labour, (vi) fertilizers, (vii) manure (produced on farm and purchased), (viii) seed (both farm-produced and purchased), (ix) insecticides, pesticide and fungicides, (x) irrigation charges, (xi) canal-water charges, (xii) land revenue, cesses and other taxes, (xiii) depreciation on farm implements and (xiv) interest on the working capital.

Cost A_2 = Cost A_1 + Rent paid for leased in land.

Cost B_1 = Cost A_2 + Interest on value of owned fixed capital assets (excluding land).

Cost B_2 = Cost B_1 + Rental value of owned land.

Cost C_1 = Cost B_1 + Family labour (imputed value).

Cost C_2 = Cost B_2 + Family labour (imputed value).

Cost C_3 = Cost C_2 + 10 per cent of Cost C_2.

Now a days, the Government of India announces minimum support price (MSP) based on 1.50 times that of Cost A_2 + Family labour, whereas farmers always demand MSP based on 1.50 times that of Cost C_2. Hence, valid comparison of MSP and cost of production has been accomplished in both ways.

Farm income measures

Farm income measures are used to assess return on investment at various levels and to determine profitability of crops. The important income measures are:

Gross income (GI)

Gross income includes the income received from both main and by-product.

GI = Value of main product + Value of by-product

$$GI = Q_{mp} \times P_{mp} + Q_{bp} \times P_{bp}$$

Where,

GI = Gross income.

Q_{mp} = Quantity of main product.

P_{mp} = Price of main product.

Q_{bp} = Quantity of by-product.

P_{bp} = Price of by-product.

Profit at Cost A_2

It is also termed as farm business income (FBI). It provides an estimate of returns to the farmers for his labour, investment and profit.

FBI = Gross income-Cost A_2.

Profit at Cost B_2

It is also termed as family labour income (FLI). It provides an estimate of returns to the farmer for his labour and profit.

FLI = Gross income-Cost B_2.

Profit at Cost C_2

It is also known as net income (NI). It provides an estimate of returns to the farmers purely of profit.

NI = Gross income - Total cost (Cost C_2)

Return per rupee: It is defined as follows:

$$\text{Return per rupee} = \frac{\text{Gross income}}{\text{Cost } C_2}$$

RESULTS AND DISCUSSION

Cost of sorghum cultivation

The per ha cost incurred in sorghum cultivation is presented in the Table 2. It was found out that, the total cost of cultivation for overall category was ` 25149.69, which constitute ` 20203.48 of variable cost and ` 4946.21 of fixed cost. The component wise break up of cost of cultivation

Table 1: Distribution of sorghum growing households across various land size category. (Number of households)

Category of farmers	Shahpura tehsil		Jahazpur tehsil		Total
	Shahpura village	Tehnaal village	Baavdi village	Pander village	
Small	7	8	7	8	30 (50.00)
Medium	5	4	5	5	19 (32.00)
Large	3	3	3	2	11 (18.00)
Total	15	15	15	15	60.00 (100.00)

indicated that variable cost and fixed costs accounted for 80.33 and 19.67 per cent of total cost, respectively. This study found that fixed costs account for one-fifth of total costs, which is consistent with the findings of Rao *et al.* (2017); Burark and Sharma (2017); Kumar and Singh (2015); Zalkuwi *et al.* (2015); Gautam *et al.* (2020) and Gautam *et al.* (2021) found that fixed costs account for one-third of total cultivation costs. Machine labour was observed to be the most important variable cost, accounting for nearly 26.61 per cent of the total cost of sorghum cultivation. This study showed that machine labour is a major component of variable cost, which is consistent with Zalkuwi *et al.* (2015); Grover and Kumar (2013); Kumar *et al.* (2016); Rao *et al.* (2017); Gautam *et al.* (2020); Gautam *et al.* (2021) found that human labour is the major component of variable cost as well as total cost in sorghum cultivation. The machinery was used in the study area for ploughing, sowing and harvesting operations. Seeds, human labour, manures, plant protection chemicals and fertilisers were the next major variable cost items, accounting for 14.97, 14.51, 11.05, 3.36 and 2.53 per cent of total cost, respectively. Bullock labour cost was zero, which means that not a single farmer in the study area used bullock power for land preparation or sowing operations. This showed that farmers were interested in mechanisation. Rental value of owned land, followed by depreciation of farm implements and machinery, were observed to be the major contributors of total fixed cost, accounting for approximately 14.72 and 3.16 per cent of total costs, respectively. Zalkuwi *et al.* (2015); Rao *et al.* (2017), Gautam *et al.* (2020); Gautam *et al.* (2021) were also observed similar findings of rental value of owned land as major part of fixed cost in sorghum cultivation. It was found that per ha total cost of cultivation was highest for small farmers followed by medium and large farmers *i.e.,* ` 25394.40, ` 25052.48 and ` 24650.21, respectively. Similar findings of rental value of owned land as a major part of fixed cost in sorghum cultivation were observed by Zalkuwi *et al.* (2015); Rao *et al.* (2017); Burark and Sharma (2017); Gautam *et al.* (2020); Gautam *et al.* (2021). Small farmers had the highest total cost of cultivation per ha, followed by medium and large farmers, at ` 25394.40, ` 25052.48 and ` 24650.21, respectively. The per ha total cost of cultivation was higher for small farmers, which contributed the most to overall total variable cost and total fixed cost, followed by medium and large farmers, accounting for variable costs of ` 20394.60, ` 20144.08 and ` 19784.03, respectively and fixed costs of ` 4999.50, ` 4908.40 and ` 4866.18, respectively. Due to the more mechanised nature of farming in comparison to the small farmers, the cost of machine labour and hired human labour was highest among large farmers, followed by medium and small farmers. Total labour cost increased with increasing land holding size, which is consistent with the findings of Kumar *et al.* (2016), whereas Grover and Kumar (2013) found the opposite. Small farmers paid the most for family labour, manure and fertiliser application, followed by medium and large farmers. Depreciation costs were higher for small farmers and lower for large farmers; this could be due to large farmers' use of heavy machinery year round, requiring good care and maintenance. As a result of the study's findings, it is possible to conclude that total cost decreased as household land size increased. The same was true for variable and fixed costs across all land size categories. With increasing land size categories, the share of hired human labour, total human labour and machine labour increased, while the opposite trend was observed for family labour.

Standard cost concepts

The standard cost concepts are presented in Table 3. The overall per ha Cost A_1, *i.e.* the direct cost involved in sorghum cultivation, was estimated to be ` 18127.81. Because no land was taken on lease-in-land, the Costs $A_1$ and $A_2$ were determined to be the same. Gautam *et al.* (2020) reported a similar finding of no farming on leased-in land by any farmer. The Cost $B_1$, Cost $B_2$, Cost $C_1$ and Cost $C_2$ were calculated to be ` 18577.46, ` 22280.42, ` 21446.74 and ` 25149.69, respectively. The Cost $C_3$, which takes into account the managerial function performed by farmers, was ` 27664.66. All costs were comparatively higher for small

Table 2: Cost of sorghum cultivation across different land size categories. (`/ha)

Cost items	Small	Medium	Large	Overall
Labour (family)	2970.75 (11.70)	2824.94 (11.28)	2669.03 (10.83)	2869.26 (11.41)
Labour (hired)	659.25 (2.60)	843.35 (3.37)	1004.95 (4.08)	780.93 (3.11)
Total labour (human)	3630.00 (14.29)	3668.29 (14.64)	3673.98 (14.90)	3650.19 (14.51)
Labour (machine)	6534.70 (25.73)	6645.80 (26.53)	7201.30 (29.21)	6692.09 (26.61)
Seed	3749.93 (14.77)	3794.05 (15.14)	3749.93 (15.21)	3763.90 (14.97)
Manure	3228.45 (12.71)	2636.09 (10.52)	1806.78 (7.33)	2780.23 (11.05)
Fertilizer	673.59 (2.65)	603.02 (2.41)	587.92 (2.39)	635.54 (2.53)
Plant protection charges	724.17 (2.85)	965.56 (3.85)	965.56 (3.92)	844.86 (3.36)
Interest on working capital	1854.06 (7.30)	1831.27 (7.31)	1798.56 (7.30)	1836.67 (7.30)
Sub total (variable cost)	20394.90 (80.31)	20144.08 (80.41)	19784.03 (80.26)	20203.48 (80.33)
Rental value of owned land	3711.75 (14.62)	3698.62 (14.76)	3686.50 (14.96)	3702.96 (14.72)
Depreciation on farm implements	833.25 (3.28)	763.56 (3.05)	737.30 (2.99)	793.59 (3.16)
Interest on fixed capital	454.50 (1.79)	446.22 (1.78)	442.38 (1.79)	449.66 (1.79)
Subtotal (fixed cost)	4999.50 (19.69)	4908.40 (19.59)	4866.18 (19.74)	4946.21 (19.67)
Total cost	25394.40 (100.00)	25052.48 (100.00)	24650.21 (100.00)	25149.69 (100.00)

farmers, followed by medium and large farmers. Because the farm mechanised equipment purchased by large farmers was used continuously season after season, there was no need to hire machineries, lowering costs. The overall per quintal cost of sorghum production was found to be ` 1383.18, with small farmers spending the most (` 1435.52), followed by medium farmers (` 1349.81) and large farmers spending the least (` 1298.06). The cost of producing sorghum decreased as land size categories increased.

Comparison of cost of production

The minimum support price (MSP) of crops in the country is declared by the Government of India on the basis of Cost A_2 plus family labour and its 50.00 per cent. M.S. Swaminathan recommended that MSP be at least 50.00 per cent higher than the cost of production. Table 4 compares the cost of production to the minimum support price. The cost of sorghum production was calculated using both approaches and the cost of sorghum production in the study area was found to be less than its MSP (` 2630 per q). Based on Cost $A_2$ plus family labour and its 50.00 per cent, the cost of sorghum production was calculated to be ` 1625.62, which was found to be ` 994.38 less than its MSP for the overall category. Similarly, according to farmer demand, it was observed to be ` 1947.05, which was also ` 672.95 less than its MSP. Considering the minimum support price of year 2020-21 ` 2620 per 100 Kg of sorghum, farmers can obtain a higher sorghum price than farmers demand. However, none of the agencies in Bhilwara district of Rajasthan have procured sorghum at the announced price during the year 2020-21. Hence, the MSP should be followed by procurement to provide farmers with market support. If the government purchases the entire quantity of sorghum produce at the announced MSP from sorghum producers, it could be a good step toward doubling the farmer's income.

Measures of farm Income of sorghum cultivation

Table 5 summarises various farm efficiency measures such as farm business income (FBI), family labour income (FLI) and net farm income (NI) from sorghum cultivation. The estimated gross income per ha is ` 4808.13. Large farmers had the highest gross income (` 50584), followed by medium farmers (` 49416) and small farmers (` 47772). Though gross income is a measure for analysing farm business efficiency, it does not help us judge farm business success. Therefore, another measure namely net income which represents surplus over the total costs was estimated. Higher net income reflects the degree of success of farm business. The net income was highest for large (` 25933.79) followed by medium (` 24363.52) and small (` 22377.60) farmers with overall average of ` 23658.44. Large farmers' higher output value may be associated with higher expenditure on modern farm inputs such as hybrid seeds, tractors, reapers, threshers and so on. Net income increased with increase in size of land holding is in close conformity with the findings of Grover and Kumar (2013). While Kumar *et al.* (2016) observed offsite findings. However, reported negative net income in sorghum production in Rajasthan based on data 2010-11. Family labour income is a measure of farm efficiency that represents the returns to farmer-owned labour and family labour-and it was ` 26527.74 per ha. Farm business income is another measure that indicates the return on owned resources such as land, labour and capital and it was ` 30680.32 per ha. The overall return per rupee was calculated to be 1: 1.94.

Table 3: Cost structures across various land size categories. (`/ha)

Cost items	Small	Medium	Large	Overall
Cost A_1/ Cost A_2	18257.40	18082.70	17852.30	18127.81
Cost B_1	18711.90	18528.90	18294.70	18577.46
Cost B_2	22423.65	22227.50	21981.20	22280.42
Cost C_1	21682.65	21353.90	20963.70	21446.74
Cost C_2	25394.40	25052.48	24650.21	25149.69
Cost C_3	27933.80	27557.70	27115.20	27664.66
Cost of production (` per q)	1435.52	1349.81	1298.06	1383.18

Table 4: Comparison of cost of production with minimum support price (MSP). (` /q)

Particulars	Small	Medium	Large	Overall
Minimum support price of Sorghum (2020-21)	2620.00	2620.00	2620.00	2620.00
Cost of sorghum production based on Cost A_2 plus family labour and its 50.00 per cent approach	1686.82	1587.47	1524.62	1625.62
Difference (1-2)	933.18	1032.53	1095.38	994.38
Cost of sorghum production based on Cost C_2 and its 50.00 per cent approach	2017.88	1902.18	1831.37	1947.05
Difference (1-4)	602.12	717.82	788.63	672.95

Table 5: Category wise measures of farm income of sorghum cultivation. (` /ha)

Particulars	Small	Medium	Large	Overall
Gross income	47772.00	49416.00	50584.00	48808.13
Net income	22377.60	24363.52	25933.79	23658.44
Family labour income	25348.40	27188.50	28602.80	26527.74
Farm business income	29514.60	31333.30	32731.70	30680.32
Return per rupee	1.88	1.97	2.05	1.94

CONCLUSION

It is evident from the results of the study that the component wise break up of cost of cultivation indicated that variable cost and fixed costs accounted for 80.33 and 19.67 per cent of total cost, respectively. The most expensive part of cultivation was machine labour followed by human labour, both accounted for almost 40.00 per cent of the total cost. The cost of producing one quintal of sorghum was determined to be ` 1383.18, which decreased as the size of land holding increased. The cost of sorghum production was calculated to be less than its minimum support price as announced by Government of India. Sorghum produce has not been procured at MSP in the study area. Hence, in order to provide farmers with market support, the minimum support price should be followed by procurement. Sorghum farming yielded a net profit of ` 23658.44 per ha.

Conflict of interest: None.

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