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Yash Gautam
Research Scholar, Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

PK Singh
Assistant Professor, Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

OP Singh
Associate Professor, Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Corresponding Author:
Yash Gautam
Research Scholar, Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Financial profitability and resource use efficiency in sorghum production under rainfed condition

Yash Gautam, PK Singh and OP Singh

Abstract
Sorghum is a coarse cereal crop which is cultivated for grain and also as a major food crop. It is one of the important staple food crops for the poor and food insecure people in the semi-arid tropics of Africa and Asia. In India, Maharashtra is the highest sorghum producing state. Earlier, coarse cereals were considered as poor man's food because poor people used to get good amount of nutrition at less cost. But, with time it has become an important part of diet of all income groups. Due to the increasing health problems like diabetes, obesity, etc doctors and dietician are emphasizing on inclusion of coarse cereals in the diet. Rising incomes and urbanization are causing diets to shift towards high protein, fats and sugar. In addition, livestock and bio-fuel production have and will most likely grow at a faster rate than crop production. This is causing a shift away from crops like wheat and rice towards coarse grains and oilseeds to meet demand for food, feed and biofuel. Sorghum cultivation in Maharashtra is carried out mostly in rainfed condition. Considering the importance of the crop following study has been performed to estimate the profitability and resource use efficiency of inputs under irrigated condition. CACP Cost concept was used to estimate the profitability of the crop and Cobb Douglas production function was used to estimate the resource use efficiency.

Keywords: CACP Cost concept, Cobb Douglas, resource use efficiency, Sorghum

Introduction
Sorghum (Sorghum bicolor) is a coarse cereal crop cultivated which probably originated in Ethiopia and has spread to other parts of Africa, India, Southeast Asia, Australia and the United States. It is a major food crop in much of South Asia, Africa, and Central America. It is one of the main staple food crops for the world's poor and food insecure people. It is an important source of feed, fodder and bio-fuel apart from food. The crop is genetically suitable to the hot and dry agro-ecological regions characterized by low rainfall. Because of its easy adaptability to hot and dry agro-ecologies it has become a climate change compliant crop. In India it is commonly known as Jowar. India contributes significantly in world's total sorghum production. India contributes about 16% of world's total sorghum production (Zalkuwi *et al*, 2015) [6].

Maharashtra is the one of the highest sorghum producing state in India. In year 2017-18, Maharashtra contributed up to 33.45 per cent of the total sorghum production of the country followed by Karnataka (23.74 per cent), Tamil Nadu (8.96 per cent), Rajasthan (6.26 per cent) and Andhra Pradesh with (6.26 per cent) (DAC&FW, 2019) [5]. But yield of sorghum in Maharashtra is much lower than that of yield in Andhra Pradesh and Madhya Pradesh. In fact, among major sorghum producing states, yield of sorghum is one of the lowest. According to 4th advance estimates, area under sorghum in 2018-19 was 1.4 million hectares which was 36.35 per cent of total area of India. In 2015-16, area under irrigation was only 9.5 per cent of the total area under sorghum in Maharashtra (DAC&FW, 2019) [5]. Hence, sorghum production in Maharashtra is mostly rainfed.

Distinct trends in production, area and yield of sorghum were observed post independence. Till 1970, a substantial increase in area, production and yield was observed in sorghum throughout India. After 1970, there was a continuous decline in its area, but on an average, yield and production continued to increase till 1990. The increase in production was attributed to the improvement in the yield by the introduction of popular hybrid varieties. Sorghum production increased from 5.5 million tonnes in 1950-51 to 12.90 million tonnes in 1989-90 and thereafter it started to decline with some exception years. In year 2013-14, sorghum production was about 5.54 million tonnes (DAC&FW, 2019) [5]. The area under sorghum in Maharashtra showed a similar declining trend. The growth trend analysis suggests that it was declining with a compound growth rate of -1.18 per cent per annum during 1965-2015.

The total area allocated by the farmers in the state decreased from 6057 thousand hectares to 3288 thousand hectares during 1965-66 to 2014-15 (Gautam and Singh, 2018) [4]. In 1965-66, total sorghum production in Maharashtra state was 2294.8 thousand tonnes and it decreased to the level of 2109 thousand tonnes by the year 2014-15. The growth trend analysis of sorghum production in the state suggests that it was increasing with a compound growth rate of 0.14 per cent per annum (Gautam and Singh, 2018) [4]. This increase was due to increase in yield by the adoption of hybrid verities.

Main focus of green revolution was on wheat and rice so their production increased but, in the process, coarse cereals were highly neglected and hence their production was hampered. There is a noticeable decrease in area and production under coarse cereals like sorghum in last 2 decades. Nutritional value of coarse grains is more than the nutritional value of rice and wheat, a decrease in the availability of coarse grains will lead to in a decrease in the nutrition intake. In recent times, due to the diseases like diabetes etc., doctors and dietician are emphasizing on including coarse cereals in the diet of people. It is an important source of feed, fodder and bio-fuel apart from food. Considering the importance of the crop following srudy was undertaken.

Data and Methodology

Data used

This study was based on secondary data. The time series data was collected from the website of Directorate of Economics and Statistics division, Ministry of Agriculture, Government of India, New Delhi.

Analytical Tools

Cost concept

A) Cost A_1 = All actual expenses in cash and kind incurred in production by the owner (Gautam and Singh, 2020) [1, 2]. It includes:

1) Wages of hired human labour,
2) Wages of permanent labour
3) Wages of contract labour
4) Imputed value of owned animal labour
5) Cost of Animal use
6) Charges of hired machinery
7) Cost of seed
8) Irrigation charges
9) Depreciation on implement, buildings and infrastructure
10) Cost of manures, fertilizers & chemicals
11) Imputed value of owned machinery
12) Miscellaneous charges

a) Cost A_2 = Cost A_1 + rent paid for leased in land
b) Cost B_1 =Cost A_1 + interest on value of owned capital asset (excluding land)
c) Cost B_2 =Cost B_1+ rental value of owned land
d) Cost C_1 =Cost B_1 + imputed value of family labour.
e) Cost C_2 =Cost B_2+ imputed value of family labour
f) Cost C_3= Cost C_2 + 10% of C_2

Average cost and returns per hectare

The cost and returns for sorghum in rainfed condition of Maharashtra was calculated separately by using following formulae:

1. Average cost (per hectare) =Total cost/Total acreage under the crop
2. Average return (per hectare) = Total return/Total acreage under the crop
3. Net return (per hectare) = Gross return per hectare (main and by product)-Total cost per hectare

Returns over different cost concept

Per hectare return over different costs can be calculated as follows:

1. Farm business income or Net return over cost A1 = Gross income – Cost A1
2. Family labour income or Net return over cost B2 = Gross income - Cost B2
3. Net return (per hectare) = Gross income - Cost C2

Productivity of key input factors

Cobb Douglas production function was used to analyse the resource use efficiency of the inputs (Gautam and Singh, 2020) [1, 2]. To work out the productivity, Cobb Douglas type of production function will be used in following form:

$$Y = a\, x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4}$$

Where,

Y = Gross return per hectare in Rs.
a = Constant
x_1 = Labour use per hectare in Rs.
x_2 = Animal use per hectare in Rs.
x_3 = Machine use per hectare in Rs.
x_4 = Fertilizer use per hectare in Rs.
b_1, b_2, b_3, b_4 are the elasticities of production for inputs x_1, x_2, x_3, x_4 respectively.

Results and discussion

A) Cost of cultivation of sorghum under rainfed condition in Maharashtra

Per hectare operational cost and fixed cost incurred in the cultivation of sorghum under rainfed condition is presented in the Table 1. It was found that the average total cost of cultivation per hectare was Rs. 32413.073. Out of this, operational cost was Rs. 21453.35 contributing to the tune of 66.19 per cent in the total cost. Fixed cost was Rs. 8013.08 accounting for 24.72 per cent of the total cost. Human labour was the largest component in the cost of cultivation contributing up to 31.18per cent (Fig 1) of the total cost followed by rental value of owned land which was to the tune of 18.43 per cent. Manure charges, land revenue & taxes, insecticides and interest on working capital had very less contribution in the total cost which was 0.476 per cent, 0.07 per cent, 0.475 per cent and 0.763 per cent respectively.

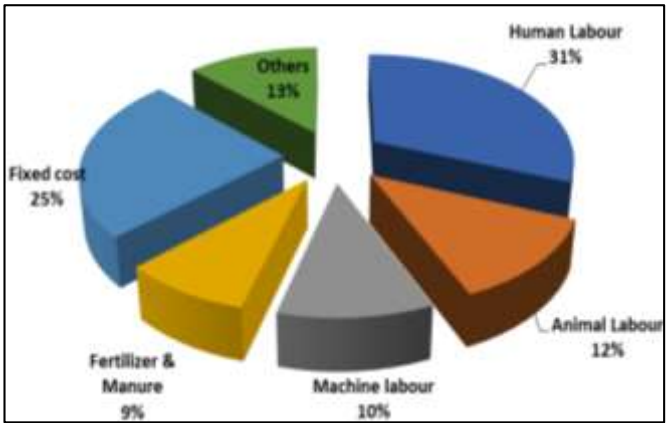

Fig 1: Share of different factors in cost of cultivation of sorghum in rainfed condition

Table 1: Cost of cultivation of sorghum in rainfed condition (Rs/ha)

S. No.	Item wise breakup of cost of cultivation		Rs.	%Total Cost
(i)	Human Labour	Family	2437.11	7.519
		Attached	1230.63	3.797
		Casual	6440.10	19.87
		Total	10107.84	31.18
(ii)	Animal Labour	Hired	398.54	1.23
		Owned	3642.52	11.24
		Total	4041.06	12.47
(iii)	Machine Labour	Hired	2867.83	8.848
		Owned	486.73	1.502
		Total	3354.56	10.35
(iv)	Seed		693.36	2.139
(v)	Fertilizer & Manure	Fertilizer	2678.48	8.264
		Manure	154.32	0.476
		Total	2832.80	8.74
(vi)	Insecticides		154.04	0.475
(vii)	Irrigation Charges		0.00	0
(viii)	Miscellaneous expenditure		22.29	0.069
(ix)	Interest on Working Capital		247.40	0.763
1	Total Operational Cost		21453.35	66.19
(i)	Rental Value of Owned Land		5973.12	18.43
(ii)	Rent Paid for Leased-in-Land		0.00	0
(iii)	Land Revenue, Taxes, Cess		22.68	0.07
(iv)	Depreciation on Implements & Farm Building		1696.76	5.235
(v)	Interest on Fixed Capital		320.52	0.989
2	Total Fixed Costs		8013.08	24.72
3	Total (1+2)		29466.43	90.91
4	Managerial cost (according to CACP)		2946.643	9.091
5	Cost of cultivation [1+2+4]		32413.073	100

Per hectare returns in sorghum cultivation in rainfed condition in Maharashtra

In rainfed condition, per hectare returns from main product was Rs. 21988.83 contributing up to 61.37per cent to the total returns. Rs. 13842.74 was obtained from by-product per hectare which made up to 38.63 per cent of the total returns. A net return received by the farmer was Rs. 3418.497 (Table 2).

Table 2: Per hectare returns of sorghum in rainfed condition

S. No.	Items	Amount (Rs.)	% of Total Return
1	Gross return from:		
(i)	Main product	21988.83	61.37
(ii)	By product	13842.74	38.63
	Total Return	35831.57	100
2	Cost of cultivation	32413.073	
3	Net return	3418.497	

Computation of costs based on CACP cost concept for sorghum production in rainfed condition in Maharashtra

Cost of cultivation based on CACP cost concept for rainfed condition is given in Table 3. Total cost of cultivation i.e. Cost C_3 was estimated to be Rs. 32413.073. It can be seen from the table 3 that the cost A_1in sorghum cultivation was Rs. 20735.68 under rainfed condition. Cost B_1 was found to be Rs. 21056.20. Cost B_2 was estimated to be Rs. 27029.32. Similarly, Cost C_1 was Rs. 23493.31 for sorghum cultivation under rainfed condition. In rainfed condition also, cost A_1 equals to cost A_2 because no farmer did sorghum cultivation on leased-in-land.

Table 3: Per hectare cost of cultivation of sorghum in rainfed condition

S. No.	Particulars	Amount (Rs.)
(i)	Cost A_1	20735.68
(ii)	Cost A_2	20735.68
(iii)	Cost B_1	21056.20
(iv)	Cost B_2	27029.32
(v)	Cost C_1	23493.31
(vi)	Cost C_2	29466.43
(vii)	Cost C_3	32413.073

Computation of returns based on CACP cost concept for sorghum production in rainfed condition in Maharashtra

Net returns over cost A_1 and A_2 are same in rainfed condition also because the farmer did cultivate sorghum on leased land. The net return over direct cost i.e. cost A_1 for rainfed condition was estimated to be Rs. 15095.89. Net return over cost B_1 and cost B_2 was estimated to be Rs. 14775.37 and Rs. 8802.25 respectively. Net return over cost C_1 and cost C_2 was found to be Rs. 12338.26 and Rs. 6365.14 respectively for rainfed condition (Table 4).

Table 4: Net returns over different cost concepts in rainfed condition

S. No.	Particulars	Amount (Rs.)
(i)	Net return over cost A_1	15095.89
(ii)	Net return over cost A_2	15095.89
(iii)	Net return over cost B_1	14775.37
(iv)	Net return over cost B_2	8802.25
(v)	Net return over cost C_1	12338.26
(vi)	Net return over cost C_2	6365.14
(vii)	Net return over cost C_3	3418.497

Resource use efficiency in sorghum production

The value of coefficient of multiple determinations (R^2) in rainfed condition of sorghum was 0.6545. It indicates that 65.45 per cent variation in logarithmic value of gross returns was explained by the independent variables (human labour, animal labour, machine labour and fertilizers) included in the model and the remaining 34.55per cent variation was explained by those variables that were not included in the study. Table 5 shows the value of regression coefficients of all the variables in rainfed condition.

Table 5: Regression coefficients of variables in rainfed condition in sorghum production in Maharashtra.

Particulars	Intercept in log	Regression coefficients of				$\sum b_i$	R^2
		Human Labour	Animal labour	Machine labour	Fertilizer		
Rainfed condition	0.49342	0.66942* (4.5276)	0.05090 (0.5262)	0.13604* (2.5464)	0.18569* (2.2956)	1.042	0.6545

Note: Figures in parenthesis indicate "t" values.
*Significant at 1 per cent level.

In rainfed condition, the coefficient of elasticity of production (regression coefficient) of the human labour turned out to be positive and significant. It means that for every one per cent increase in human labour (value term), there will be an increase in the gross return by 0.66942 per cent increase in rainfed condition keeping the other variable resources considered in the equation constant at their geometric mean level.

The coefficient of elasticity of animal labour was found to be positive but insignificant. Since the elasticity of coefficient was statistically insignificant so it means that no impact of animal labour was visible on the gross returns. This may be because of the uniform rate of application of animal labour (expressed in monetary terms) in the operational practices.

The coefficient of elasticity of machine labour was found to be positive and significant rainfed condition. It indicated that for every one per cent increase in machine labour (value term), there will be an increase in the gross return by 0.13604 per cent increase in rainfed condition keeping the other variable resources considered in the equation constant at their geometric mean level.

The coefficient of elasticity of fertilizer was found to be positive and significant in both irrigated condition and rainfed condition. This infers that for 1 per cent increase in machine labour (value term), there will be an increase in the gross return by 0.18569 per cent increase in rainfed condition keeping the other variable resources considered in the equation constant at their geometric mean level.

In case of rainfed condition, the sum of the regression coefficients of variables which are human labour, animal labour, machine labour and fertilizer was more than one i.e. $\sum bi = 1.042$. It implies that in rainfed condition is also there was increasing returns to scale. So, to use resources optimally, they have to be used in higher quantity and this will also increase the production.

Conclusion

Cost analysis showed that cost of cultivation in rainfed condition was Rs. 32413.073 and net return obtained was Rs. 3418.497 per hectare. Major contribution in the operational cost was of human labor while in fixed cost the highest proportion was of rental value of owned land followed by depreciation. The regression analysis indicates that the important resources such as human labor, machine labor and fertilizers are not used optimally. There is increasing returns to scale in rainfed condition. This implies that there is huge scope to increase the production and profits by optimizing the use of underutilized and overutilized resources.

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