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Economic Analysis of Sorghum Production Under Irrigated Condition in Maharashtra

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ABSTRACT

Sorghum (*Sorghum bicolor*) is a coarse cereal crop cultivated for grain and as a major food crop. It is one of the main staple food crops for the world's poor and food insecure people in the semi-arid tropics of Africa and Asia. Maharashtra is the highest sorghum producing state in India. Coarse grains have been an important part of the poor person's food due to their lower prices with respect to rice and wheat. Hence, coarse cereals were considered as poor man's food. Poor people used to get good amount of nutrition at less cost. In recent times, due to the diseases like diabetes etc., doctors and dietician are emphasizing on including coarse cereals in the diet of people. external factors, such as rising incomes and urbanization are causing diets to shift towards diets that are higher in 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. Considering the importance of the crop following study has been performed to estimate the profitability and resource use efficiency of inputs under irrigated condition. Considering the importance of the crop, following study was undertaken. 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*

Sorghum (*Sorghum bicolor*) is a coarse cereal crop cultivated for grain and as a major food crop. It is one of the main staple food crops for the world's poor and food insecure people in the semi-arid tropics of Africa and Asia (Gautam and Singh, 2018). 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. Being a short-day C4 plant, and 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 about 16% of world's total sorghum production (Zalkuwi *et al*, 2015). In India, sorghum is a staple food for the people of Rajasthan, Maharashtra, Karnataka, Gujarat etc. In Haryana, Punjab and Western UP sorghum is cultivated mostly as fodder crop.

Maharashtra is the highest sorghum producing state in India. In year 2017-18, Maharashtra contributed up to 33.45 % of the total sorghum production of the country followed by Karnataka (23.74%), Tamil Nadu (8.96%), Rajasthan (6.26%) and Andhra Pradesh with 6.26 % (DAC&FW,2019). Sorghum is cultivated in over 2.23 million hectares in the state with high-yielding varieties (HYV's), accounting for major portion of the total area under crop (DAC&FW,2019). In terms of production, however, the crop ranks second next to rice. Sorghum is mainly produced in the *Kharif* season in Maharashtra.

Distinct trends in production, area and yield of sorghum have been observed since post-independence. The crop which once covered more than 18 million hectares in the country has been declining continuously. Most of the decline in the area has occurred in *kharif* sorghum in the country. The area under *kharif* sorghum in Maharashtra showed a similar declining trend. In 2014, area under sorghum was only five million hectares in the country. In early 1970s production was nine million tones which

increased to 12 million tones in early 1980s. Since then it has shown a declining trend in production.

All India level total sorghum production has registered a constant growth rate of 0.10% per annum during the period 1967-2011, which can be mainly attributed to negative production of *kharif* sorghum rather than positive growth in *rabi* sorghum production (Zalkuwi, 2014). Even though the yield rates of *kharif* sorghum was higher but still it could not neutralize or off set the decreasing growth rate in production because of the highly negative growth rate of area in *kharif* sorghum. While in case of *rabi* sorghum, yield growth rate was positive and so high that it did reverse the effect of the negative growth rate in area under *rabi* sorghum.

Since green revolution mainly focused on wheat and rice so their production increased but, in the process, coarse cereals were neglected and their production was hampered. There is a significant decrease in area and production under coarse cereals like sorghum in last 2 decades. This is important because 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. Coarse grains have been an important part of the poor person's food due to their lower prices with respect to rice and wheat. Hence, coarse cereals were considered as poor man's food. Poor people used to get good amount of nutrition at less cost. In recent times, due to the diseases like diabetes etc., doctors and dietician are emphasizing on including coarse cereals in the diet of people. According to the 2015 statistical pocketbook of FAO, external factors, such as rising incomes and urbanization are causing diets to shift towards diets that are higher in 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. Considering the importance of the crop following study has been performed to estimate the profitability and resource use efficiency of inputs under irrigated condition.

DATA AND METHODOLOGY

The 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, Cooperation and Farmers Welfare, 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. It includes:

(i) Wages of hired human labor,

(ii) Wages of permanent labor

(iii) Wages of contract labor

(iv) Imputed value of owned animal labor

(v) Cost of Animal use

(vi) Charges of hired machinery

(vii) Cost of seed

(viii) Irrigation charges

(ix) Depreciation on implement, buildings and infrastructure

(x) Cost of manures, fertilizers & chemicals

(xi) Imputed value of owned machinery

(xii) Miscellaneous charges

b) Cost A_2 = Cost A_1 + rent paid for leased in land

c) Cost B_1 =Cost A_1 + interest on value of owned capital asset (excluding land)

d) Cost B_2 =Cost B_1+ rental value of owned land

e) Cost C_1 =Cost B_1 + imputed value of family labor.

f) Cost C_2 =Cost B_2+ imputed value of family labor

g) Cost C_3= Cost C_2 + 10% of C_2

Average cost and returns per hectare

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

(i) Average cost (per hectare) =Total cost / Total acreage under the crop

(ii) Average return (per hectare) = Total return / Total acreage under the crop

(iii) 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:

(i) Farm business income or Net return over cost A1 = Gross income – Cost A1

(ii) Family labor income or Net return over cost B2 = Gross income - Cost B2

(iii) Net return (per hectare) = Gross income - Cost C2

Productivity of key input factors

To work out the productivity, Cobb Douglas type of production function was used in following form:

$$Y = a\, x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5}$$

Where,

Y = Gross return per hectare in Rs.

a = Constant

x_1 = Labor 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.

x_5 = Irrigation per hectare in Rs.

b_1, b_2, b_3, b_4 and b_5 are the elasticities of production for inputs x_1, x_2, x_3, x_4 and x_5 respectively.

RESULTS AND DISCUSSION

A. Cost of cultivation of sorghum in irrigated condition in Maharashtra

Per hectare operational cost and fixed cost incurred in the cultivation of sorghum in irrigated condition is presented in the Table 1. It was found that, the average total cost of cultivation per hectare was found to be Rs. 45640.95. Out of this, operational cost was Rs. 29315.16 which accounted for 64.23 per cent of the total cost. Fixed cost in irrigated condition was Rs. 12176.61 which accounted for 26.68per cent of the total cost. Human labor was the largest component in the total cost contributing up to 32.75per cent (Fig 1) of the total cost followed by rental value of owned land which was to the tune of 20.008per cent. Irrigation charges contributed to about 7.597 per cent of the total cost under irrigated condition. Since none of the farmers did farming on leased-in-land so the contribution of rent for leased-in-land was zero. Also, it was found that manure

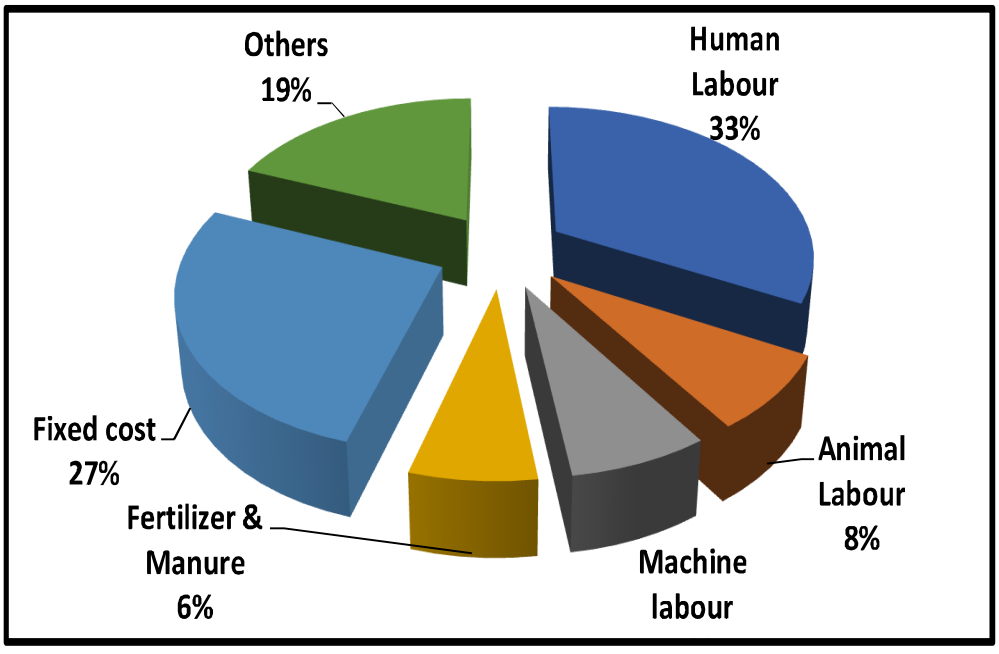

Fig 1: Share of different factors in cost of cultivation of sorghum in irrigated condition

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

S. No.	Item wise breakup of cost of cultivation		Rs.	% Total Cost
(i)	Human Labor	Family	4618.43	10.12
		Attached	1707.40	3.741
		Casual	8620.88	18.89
		Total	**14946.71**	**32.75**
(ii)	Animal Labor	Hired	564.32	1.236
		Owned	3023.71	6.625
		Total	**3588.03**	**7.861**
(iii)	Machine Labor	Hired	2740.46	6.004
		Owned	570.62	1.25
		Total	**3311.08**	**7.255**
(iv)	Seed		588.37	1.299
(v)	Fertilizer & Manure	Fertilizer	3001.23	6.576
		Manure	0.00	0
		Total	**3001.23**	**6.576**
(vi)	Insecticides		69.94	0.153
(vii)	Irrigation Charges		3467.16	7.597
(viii)	Miscellaneous expenditure		4.57	0.01
(ix)	Interest on Working Capital		338.07	0.741
1	**Total Operational Cost**		**29315.16**	**64.23**
(i)	Rental Value of Owned Land		9164.59	20.08
(ii)	Rent Paid for Leased-in-Land		0.00	0
(iii)	Land Revenue, Taxes, Cess		23.56	0.05
(iv)	Depreciation on Implements & Farm Building		2501.40	5.48
(v)	Interest on Fixed Capital		487.06	1.067
2	**Total Fixed Costs**		**12176.61**	**26.68**
3	**Total (1+2)**		**41491.77**	**90.91**
4	**Managerial cost (according to CACP)**		**4149.17**	**9.091**
5	**Cost of cultivation [1+2+4]**		**45640.94**	**100**

Table 2: Per hectare returns of sorghum in irrigated condition

S. No.	Items	Amount (Rs.)	% of Total Return
1	Gross return from:		
(i)	Main product	36439.29	66.28
(ii)	By product	18537.26	33.72
	Total Return	54976.55	100
2	Cost of cultivation	45640.95	
3	Net return	9335.6	

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

S. No.	Particulars	Amount (Rs.)
(i)	Cost A_1	27221.69
(ii)	Cost A_2	27221.69
(iii)	Cost B_1	27708.75
(iv)	Cost B_2	36873.34
(v)	Cost C_1	32327.18
(vi)	Cost C_2	41491.77
(vii)	Cost C_3	45640.94

application in irrigated condition was not done by farmers. Land revenue & taxes, insecticides and interest on working capital had very less contribution in the total cost which was 0.05per cent, 0.153per cent and 0.741per cent respectively.

B. Per hectare returns in sorghum cultivation for irrigated condition in Maharashtra

Per hectare returns under irrigated condition is given in Table 2. In irrigated condition, the return from main product was Rs. 36439.29 which formed 66.28 per cent of the total returns. By product yielded Rs. 18537.26 per hectare contributing to the tune of 33.72per cent in the total returns. Net return obtained by the farmers from sorghum production in the state was Rs. 9335.6 per hectare (Table 2).

C. Computation of costs based on CACP cost concept for sorghum production in irrigated condition in Maharashtra

Cost of cultivation suggested by cost concept Commission on Agricultural Cost and Prices (CACP) for irrigated condition is given in Table 3. Total cost of cultivation i.e. Cost C_3 was estimated to be Rs. 45640.94. It is evident from the Table 3 that the cost A_1 i.e. direct cost involved in sorghum cultivation was Rs. 27221.69 for sorghum cultivation under irrigated condition. Cost B_1 was found to be Rs. 27708.75. Cost B_2 was estimated to be Rs. 36873.34. Similarly, Cost C_1 was calculated to be Rs. 32327.18 for irrigated condition. Cost A_1 and A_2 are equal because, farming was not done on leased-in-land by any farmer in the state.

D. Computation of returns based on CACP cost concept in sorghum production for irrigated condition in Maharashtra

Net returns over cost A_1 and A_2 are same in irrigated condition because the farmer did not do farming on leased-in-land. The net return over direct cost i.e. cost A_1 for irrigated condition was estimated to be Rs. 27754.86. Net return over cost B_1 and cost B_2 was estimated to be Rs. 27267.80 and Rs. 18103.21 respectively. Net return over cost C_1 and cost C_2 was found to be Rs. 22649.37, Rs.13484.78 respectively for sorghum production under irrigated condition (Table 4).

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

S. No.	Particulars	Amount (Rs.)
(i)	Net return over cost A_1	27754.86
(ii)	Net return over cost A_2	27754.86
(iii)	Net return over cost B_1	27267.80
(iv)	Net return over cost B_2	18103.21
(v)	Net return over cost C_1	22649.37
(vi)	Net return over cost C_2	13484.78
(vii)	Net return over cost C_3	9335.6

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

Particulars	Intercept in log	Regression coefficients of					$\sum b_i$	R^2
		Human Labor	Animal labor	Machine labor	Fertilizer	Irrigation		
Irrigated condition	0.20490	0.67184* (7.3157)	-0.01044 (-0.1656)	0.24348* (4.1393)	0.25296* (3.8589)	0.00993 (0.2254)	1.167	0.8586

E. Resource use efficiency in sorghum production

The value of coefficient of multiple determinations (R^2) in irrigated 0.8586. It indicates that 85.86 per cent variation in logarithmic value of gross returns was explained by the independent variables (human labor, animal labor, machine labor, fertilizers and irrigation) included in the model, while the rest of 14.14per cent variation in gross return was explained by the variables which are not included in the model. Table 4.5 shows the value of regression coefficients of all the variables in irrigated condition.

The coefficient of elasticity of production (regression coefficient) of the human labor turned out to be positive and significant. It means that for every one per cent increase in human labor (value term), there will be an increase in the gross return by 0.67184 per cent in irrigated condition keeping the other variable resources considered in the equation constant at their geometric mean level.

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

The coefficient of elasticity of machine labor was found to be positive and significant. It indicated that for every one per cent increase in machine labor (value term), there will be an increase in the gross return by 0.24348 per cent in irrigated 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 unirrigated condition. This infers that for 1 per cent increase in machine labor (value term), there will be an increase in the gross return by 0.25296 per cent in irrigated condition and 0.18569 per cent increase in unirrigated condition keeping the other variable resources considered in the equation constant at their geometric mean level.

The regression coefficient of irrigation was found to be positive and insignificant in irrigated condition. The obvious reason for insignificant coefficient of irrigation resource could be the practice of adherence to uniform rate of application of irrigation in the crop in the state as almost all the farmers applied the same but a smaller number of irrigation as it is a well-known fact that in Maharashtra irrigation water is available in a very limited quantity.

The sum of the regression coefficients of variables in irrigated condition viz. human labor, animal labor, machine labor, fertilizer and irrigation are more than one i.e. "b_i = 1.167. It implies that there is increasing returns to scale. Also, the variables were not used optimally and if the variables which were positive and significant like human labor, machine labor and fertilizer are increased, production will also increase. So, to use resources optimally, they have to be used in higher quantity and this will also increase the production.

CONCLUSION

Cost concept analysis showed that cost of cultivation in irrigated condition was Rs. 45640.94 and net return obtained was Rs. 9335.6 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. The regression analysis indicates that the important resources such as human labor, machine labor and fertilizers are underutilized. There is increasing returns to scale in irrigated condition. This implies that there is huge scope to increase the production and profits by optimising the use of underutilized and overutilized resources.

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