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Economic Analysis of Production of *Bajra* in Alwar District of Rajasthan, India

Ashish Yadav*, A. N. Ratnaparkhe, H. R. Shinde, A. S. Bhosale, V. R. Bavadekar and Sudarshan Lohar

Department of Agricultural Economics, R.C.S.M. College of Agriculture, Kolhapur, MPKV Rahuri, Maharashtra, India

**Corresponding author*

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A B S T R A C T

The present study entitled, 'Economic analysis of production of *Bajra* in Alwar district of Rajasthan' is based on a sample of 90 *Bajra* farmers drawn from Behror and Neemrana tahsil of Alwar district. The present study was undertaken with per hectare costs and returns of *Bajra* production and resource use efficiency of inputs. The factors affecting yield of *Bajra* production were estimated by using the Cobb-Douglas type production function. The data pertained to the agricultural year 2020-21. The study revealed that per hectare cost of cultivation was Rs.23858.83. Average per hectare gross income was Rs. 33358.50. The benefit-cost ratio was 1.40 at overall level which indicated that *Bajra* production in the study area is profitable. The functional analysis was also carried out by using Cobb-Douglas type of production function. The appropriateness of estimated model and the variable incorporated in model were tested by estimating R^2 value. The result of Cobb-Douglas production function revealed that male labour, female labour, manure, Nitrogen, phosphorus, potassium, irrigation charges and plant protection charges were found significant thereby influencing the productivity of *Bajra*. The resource use efficiency results revealed that there is scope for increasing the use of Manure, Nitrogen, phosphorus, potassium, irrigation charges and plant protection charges for *Bajra* production to obtain higher gross returns.

Introduction

Bajra is popularly known as "Pearl millet". It is one of the most widely grown cereal crops in tropical and semi-arid regions of the world. Its scientific name is *Pennisetum glaucum* L. *Bajra* is the second most important millet crop in India in terms of area and production after sorghum crop (Anupama, *et al*., 2005; Karim, *et al*., 2010; Kumari *et al.*, 2021). Pearl millet is a warm-season crop and grows best between 20 to 28 degrees Celsius. The best temperature for pearl millet to germinate is 23 to 32 degrees Celsius. Pearl millet does not germinate and grows well in cool soil conditions (Kathirvel and Karthika, 2015; Choudhri, *et al*., 2019; Sundarlal *et al.*, 2020). The optimum rainfall required for pearl

millet ranges between 35-50 cm but pearl millet can also survive in areas that receives less than 35 cm of annual rainfall. India produced 9.13 million tonnes of *Bajra* from an area of 7.38 million hectares with an average yield of 1237 kg/ha (Kumar and Singh, 2015; Kumbhar, *et al*., 2015; GOI, 2019). Rajasthan, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh are the major *Bajra* producing states in India. Rajasthan is having the largest area in *Bajra* production of 4.15 M ha and Maximum production of about 4.68 Mt followed by Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh. The nutritional value of *Bajra* seed is quite high with carbohydrate (69.40 per cent), fat (5.00 per cent), marginal protein (9-11 per cent) and minerals (2.70 per cent). It is also a good source of vitamin A and B.

Materials and Methods

The research used a two -stage purposive and random sampling strategy with the sample tehsil functioning as the primary unit of sampling and the village functioning as secondary unit of sampling.

Alwar district is selected for the study because it contains maximum production in state of Rajasthan and it is one of the largest growing regions of *Bajra* in terms of area. On the basis of area under *Bajra* cultivation, three villages each from Behror and Neemrana tehsils were selected for study on the basis of information collected from village revenue office.

A list of *Bajra* growers was constructed for each of the selected villages, together with their operating area and area under *Bajra* cultivation. The *Bajra* growing farmers were arranged in descending order of their area under *Bajra* cultivation for each of the selected villages and farmers from each village categorized under three predetermined size classes based on area under *Bajra* cultivation viz., Group I (below 1ha), Group II (1to 2 ha) and Group III (2 ha and above).

Thereby making a total of 15 farmers from each village was selected randomly. Thus, the total sample size for the study consists of 90 *Bajra* farmers comprising 30 Marginal, 30 Small, 30 large farmers.

Analysis of Data

For achieving the stated objective, following analytical procedure was used.

Cost concepts

Cost 'A'

Contains Hired human labour, machinery charges, value of manures, value of fertilizers, value of seeds, irrigation charges, plant protection charges, land revenue, depreciation and repairs, interest on working capital, and other expenses.

Cost 'B'

Rental value of land and interest on fixed capital represent imputed cost which is added to the Cost A

Cost B = Cost A + rental value of land + interest on fixed capital.

Cost 'C'

It is the total cost of production, which included all the costs items, actual as well as imputed. The value of owned labours is imputed and added to cost B to work out cost C.

Cost C = Cost B + imputed value of family labour.

Functional Analysis

The empirical evidences from previous studies suggested that out of many mathematical functions, the Cobb-Douglas type of production function was used to study the effect of various inputs on *Bajra* production. The data were therefore, subjected to functional analysis by using the following Cobb-Douglas type of production function

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} X_8^{b_8} X_9^{b_9} X_{10}^{b_{10}} . e^{u}$$

a = Intercept

X_1 = Seed (Kg /ha)
X_2= Male Labour (man days/ha)
X_3= Female Labour (man days/ha)
X_4= Machine (hours/ ha)
X_5= Manure (tonnes/ha)
X_6= Nitrogen (kg/ha)
X_7= Phosphorus (kg/ha)
X_8= Potash (kg/ha)
X_9= Irrigation charges (Rs)
X_{10}= Plant protection charges (Rs)

bi's = Regression coefficient of production of respective factors

e^u= Error term

Estimation of Resource Use Efficiency

The resource use efficiency was judged on the basis of the ratio of marginal value products of the resources to its factor price ratio as under

1. MVP/MFC =1 (Optimum use of resources)
2. MVP/MFC> 1 (Underutilization of resources)
3. MVP/MFC<1 (Overutilization of Resources)

Marginal Value Product

The marginal value of products (MVPs) of the individual resources were estimated and compared with the marginal cost (MC). The following formula was used to calculate the MVP of individual resources:

$MVP=b_i*Y/X *P_y$
Where, b_i= Elasticity of production corresponding to the i_{th} input

X = Geometric mean of particular independent variable.

Y = Geometric mean of dependent variable.

P_y= Price of output

Results and Discussion

The cost of cultivation of *Bajra* includes the fixed cost and working cost. The per hectare cost of cultivation of *Bajra* was worked out by using standard cost concepts. The overall level, per hectare cost of cultivation of *Bajra* i.e., Cost 'C' for the marginal, small and large size groups was Rs. 23,605.49, Rs.23,378.88 and Rs.24,592.13 respectively. The overall cost of cultivation was Rs.23,858.83.

Among the different items of cost, rental value of land was the major item of cost which accounted Rs. 5376.75 (22.53 per cent) followed by hired male labour Rs. 5024.13 (21.06 per cent), hired female labour Rs. 2461.24 (10.32 per cent), machine power Rs. 2369.51 (9.93 per cent), family male labour Rs. 1218.44 (5.11 per cent), fertilizer cost Rs. 1188.30 (4.98 per cent), interest on fixed capital Rs. 1039.16 (4.36 per cent), family female labour Rs. 901.65 (3.78 per cent), manure Rs. 864.87 (3.62 per cent), seed Rs. 823.69 (3.45 per cent), interest on working capital Rs. 815.62 (3.42 per cent), depreciation charges Rs. 731.38 (3.07 per cent), irrigation charges Rs. 427.93 (1.80 percent), land revenue Rs. 182.53 (0.77 per cent), plant protection charges Rs.171.08 (0.72 per cent), repairs Rs. 131.52 (0.55 per cent), and incidental charges Rs. 131.43 (0.55 per cent). The cost 'A' for different size group of holding was Rs. 15,859.86, Rs. 14,895.47, Rs. 15,214.35 for marginal, small and large size group of holdings respectively and at overall level cost 'A' was found out to be Rs. 15,323.23.

Costs, Returns, Gross Income and B: C Ratio of *Bajra*

Bajra growers obtained a gross income per hectare for marginal, small, and large holdings, the values are Rs. 31,430.21, Rs. 33,899.81 and Rs. 34,745.47 respectively. It was Rs. 33,358.50 on an overall basis, with 14.37 quintals of *Bajra* produced per hectare. Marginal, small, and large holdings produced 15.10, 14.41 and 13.59 quintals per hectare respectively. It shows that the marginal size

group had the highest per hectare production of *Bajra*.

The small size group (Rs. 10,520.93) had the highest per hectare profit at cost C, followed by the large size group (Rs. 10,153.34) and the marginal size group (Rs. 7,824.72). Overall profit at cost 'C' was 9,499.66. The benefit cost ratio at cost 'C' was highest in the small size holding group (1.45) followed by large size group (1.41) and marginal size group (1.33). The benefit cost ratio was 1.40 at overall level. The cultivation of *Bajra* is economically feasible, since the benefit-cost ratio was more than unity.

Results of Cobb-Douglas Production Function

The Cobb- Douglas production function was found to be the "best fit" for the existing data. Regression coefficients are the elasticity coefficient of production in Cobb-Douglas production function as they show the percent change in output. The co-efficient of multiple determination was estimated to be 92 per cent at the overall level.

Table.1 Per Hectare Cost of Cultivation for *Bajra* production (Rs/ha)

Sr. No.	Particulars	Size Groups			
		Marginal	**Small**	**Large**	**Overall**
1	Hired male labour	5348.30 (22.66)	4763.64 (20.38)	4960.44 (20.17)	5024.13 (21.06)
	Hired female labour	2678.71 (11.35)	2266.59 (9.70)	2438.43 (9.92)	2461.24 (10.32)
	Total	8027.01 (34.01)	7030.23 (30.07)	7398.87 (30.09)	7485.37 (31.37)
2	Machine power	2391.71 (10.13)	2281.13 (9.76)	2435.68 (9.90)	2369.51 (9.93)
3	Seed	856.64 (3.63)	793.71 (3.39)	820.72 (3.34)	823.69 (3.45)
4	Manure	914.39 (3.87)	842.30 (3.60)	837.92 (3.41)	864.87 (3.62)
5	Fertilizer cost	979.05 (4.15)	1318.14 (5.64)	1267.70 (5.15)	1188.30 (4.98)
6	Irrigation charges	439.97 (1.86)	429.73 (1.84)	414.10 (1.68)	427.93 (1.80)
7	Plant Protection charges	174.72 (0.74)	171.63 (0.73)	166.90 (0.68)	171.08 (0.72)
8	Incidental Charges	101.91 (0.43)	123.09 (0.53)	169.29 (0.69)	131.43 (0.55)
9	Repairs	101.68 (0.43)	124.83 (0.53)	168.04 (0.68)	131.52 (0.55)
10	Working Capital (1 - 10)	13987.08 (59.25)	13114.79 (56.10)	13679.22 (55.62)	13593.69 (56.98)
11	Interest on working capital @ 6%	839.22 (3.56)	786.89 (3.37)	820.75 (3.34)	815.62 (3.42)
12	Depreciation charge	852.39 (3.61)	811.29 (3.47)	530.46 (2.16)	731.38 (3.07)

13	Land revenue	181.17 (0.77)	182.50 (0.78)	183.92 (0.75)	182.53 (0.77)
14	**Cost A (10-13)**	15859.86 (67.19)	14895.47 (63.71)	15214.35 (61.87)	15323.23 (64.22)
15	Rental value of land	5058.38 (21.43)	5459.77 (23.35)	5610.91 (22.82)	5376.35 (22.53)
16	Interest on fixed capital @10 %	978.17 (4.14)	821.52 (3.51)	1317.80 (5.36)	1039.16 (4.36)
17	**Cost B (14-16)**	21896.41 (92.76)	21176.76 (90.58)	22143.06 (90.04)	21738.74 (91.11)
18	Family male labour	1131.38 (4.79)	1250.39 (5.35)	1273.54 (5.18)	1218.44 (5.11)
19	Family female labour	577.70 (2.45)	951.73 (4.07)	1175.53 (4.78)	901.65 (3.78)
20	Total	1709.08 (7.24)	2202.12 (9.42)	2449.07 (9.96)	2120.09 (8.89)
21	**Cost C (19-20)**	23605.49 (100.00)	23378.88 (100.00)	24592.13 (100.00)	23858.83 (100.00)
	Gross Income	31430.21	33899.81	34745.47	33358.50
	A) Main produce	25753.90	27387.00	26499.60	26546.83
	B) By-produce	5676.31	6512.81	8245.87	6811.66
	Cost C net of by produce	17929.18	16866.07	16346.26	17047.17
	B:C ratio	1.33	1.45	1.41	1.40
	Per quintal Cost	1187.36	1170.44	1202.82	1186.87

Table.2 Per hectare Profitability of *Bajra* production

Sr. No.	Particulars	Size Groups			
		Marginal	**Small**	**Large**	**Overall**
1	Gross returns	31430.21	33899.81	34745.47	33358.50
2	Costs (Rs.) i) Cost "A"	15859.86	14895.47	15214.35	15323.23
	ii) Cost "B"	21896.41	21176.76	22143.06	21738.74
	iii) Cost "C"	23605.49	23378.88	24592.13	23858.83
3	Profit (Rs.) i) Cost "A"	15570.35	19004.34	19531.12	18035.27
	ii) Cost "B"	9533.80	12723.05	12602.41	11619.75
	iii) Cost "C"	7824.72	10520.93	10153.34	9499.66
4	Production (qtl) A. Main Produce	15.10	14.41	13.59	14.37
	B. By produce	18.92	21.71	20.61	20.41
5	Per qtl cost of production	1187.36	1170.44	1202.82	1186.87
6	B:C ratio	1.33	1.45	1.41	1.40

Table.3 Results of Estimated Cobb-Douglas Production Function

Sr. No.	Variables	Regression coefficient
1	Intercept	-0.7754 (0.2560)
2	Seed (X_1)	0.0578*** (0.0181)
3	Male labour (X_2)	0.0538** (0.0239)
4	Female labour (X_3)	-0.0219*** (0.0080)
5	Machine power (X_4)	-0.0071 NS (0.0294)
6	Manure (X_5)	0.1942*** (0.0272)
7	Nitrogen (X_6)	0.0968*** (0.0339)
8	Phosphorus (X_7)	0.1143** (0.0550)
9	Potassium (X_8)	0.1427** (0.0568)
10	Irrigation Charges (X_9)	0.2467*** (0.0674)
11	Plant Protection Charges (X_{10})	0.2402** (0.1189)
12	R^2	0.92

*** - Significance at 1 % level * - Significance at 10% level
** - Significance at 5 % level NS- Non significant

Table.4 Marginal Value Product in *Bajra* Production

		***Bajra* Production**			
Sr. No.	**Resources**	**M.V.P.**	**F.C. (Px)**	**MVP/ FC**	**Remarks**
1	Seed (X_1)	198.34	200	0.99	Optimum
2	Male labour (X_2)	99.37	300	0.33	Excess
3	Female labour (X_3)	-50.64	200	-0.25	Excess
4	Machine power (X_4)	-14.51	200	-0.07	Excess
5	Manure (X_5)	939.19	335	2.80	Under
6	Nitrogen (X_6)	111.32	7	15.90	Under
7	Phosphorus (X_7)	153.81	9	17.09	Under
8	Potassium (X_8)	209.44	11	19.04	Under
9	Irrigation Charges (X_9)	206.01	1	206.01	Under
10	Plant Protection Charges (X_{10})	236.36	1	236.36	Under

As a result, the value of the co-efficient of multiple determinations indicated that the ten variables collectively explained 92 per cent of the variation in *Bajra* output. The regression co-efficient of Seed, Manure, Nitrogen and irrigation charges were positive and highly significant at 1 per cent level of significance. The regression co-efficient of female labour was negatively significant at 1 per cent level of significance. The regression co-efficient of male labour, phosphorus, potassium and plant protection charges were positively significant at 5 per cent level of significance this indicates that there is scope to increase the use of these resources to increase the production. Positive and significant coefficients indicated that, one per cent increase in the use of seed, Manure, Nitrogen and irrigation charges would increase the yield by 0.0578, 0.1942, 0.0968, 0.2467 per cent, respectively. Hence proved my hypothesis that productivity of *Bajra* varies with the use of level of inputs, while machine power was non-significant.

The total cost of cultivation was Rs. 23858.83 i.e., Cost C, whereas Cost A was 64.22 per cent and Cost B was around 91.11 per cent. The rental value of land, hired human labour, machine power, and fertilizers were the main determinants of cultivation costs. Large farms had the highest cost of cultivation, followed by marginal and small holdings. Small size holdings had the highest profit at Cost C, followed by large and marginal size holdings. The benefit-cost ratio at the overall level was 1.40, which is greater than 1, indicating that *Bajra* is a profitable crop.

The profitability of *Bajra* production can be increased by increasing the usage Manure, phosphate, potassium, irrigation and plant protection. As results of resource use efficiency indicated that the MVP/FC ratio for the variables, manure (X_5), N (X_6), P (X_7), K (X_8), irrigation charges (X_9) and Plant Protection charges (X_{10}) was greater than unity, indicating that higher resource use efficiency was achieved. In the case of these factors, study indicated that increasing the usage these resources could increase the *Bajra* production.

Future Scope

The Continuous research and development in agricultural sciences can lead to the creation of improved *Bajra* varieties that are more resilient to pests, diseases, and adverse environmental conditions. Apart from its use as a staple food, there is potential for developing value-added products from *Bajra*, such as fortified foods, snacks, and beverages. This could create new economic opportunities for farmers. Given the increasing unpredictability of weather patterns due to climate change, adopting climate-resilient farming practices is crucial. This may involve techniques like rainwater harvesting, mulching, and the use of organic matter to improve soil health. Strengthening market linkages and ensuring fair prices for *Bajra* can significantly boost its production.

This could involve establishing better transportation infrastructure, promoting farmer-producer organizations, and facilitating access to larger markets. The adoption of modern agricultural technologies, such as precision farming, drone-based monitoring, and use of GIS for soil and water management, can enhance productivity and efficiency in *Bajra* farming. *Bajra* is a valuable feedstock for livestock. Promoting integrated farming systems that combine *Bajra* cultivation with livestock rearing can lead to synergistic benefits. Given the arid nature of Rajasthan, efficient water management techniques like drip irrigation, sprinkler systems, and use of moisture sensors can be crucial for sustainable *Bajra* production.

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Conflict of Interest

None.

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