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Costs, Returns, Profitability and Resource use Efficiency of Chickpea Production in Rain-fed Micro Farming Situation in Irrigated North Western Plain of Rajasthan

Pradeep Kumar [a*#] and I. P. Singh [a†]

[a] Department of Agricultural Economics, Swami Keshwanand Rajasthan Agricultural University, Bikaner, 334006, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

An investigation on cost, returns, profitability and resource use efficiency of chickpea production was conducted in Hanumangarh district of Rajasthan, India in 2018-19. A sample of 50 farmers from Nohar tehsil of Hanumangarh district were interviewed to collect relevant information related to various expenses incurred in the cultivation of chickpea. In all 50 cultivators were selected for present study with equal distribution in small, medium and large groups. The techniques like cost concept of cost-A, cost-B and cost-C and Cobb-Douglas production function used for resource use efficiency. The results revealed that cost total cost of per hectare was small, medium and large farms Rs.17911.68, Rs.18982.34 and Rs.19990.89 respectively. The output-input ratio on C_3 cost was 2.35 on small farm followed by that of 2.55 and 2.72 on medium and large farm, respectively. Coefficient of multiple determinations (R^2) in the fitted Cobb-Douglas production function was use for resource use efficiency, R^2 was found 0.665 indicating the included variables explained 66 per cent variations in dependent variable.

[#]Ph. D. Scholar;
[†]Professor;
**Corresponding author: E-mail: pradeepagriculturaleconomics@gmail.com;*

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1. INTRODUCTION

Role of pulses in Indian agriculture needs hardly any emphasis. India is a premier pulse growing country. The pulses are an integral part of the cropping system of the farmers all over the country because these crops fit in well in the crop rotation and crop mixtures followed by them [1]. Chickpea (*Cicer aritinum*) also known as Gram or Bengal Gram. Chickpea is a king of pulse crop consists of more than 1/3rd of area and 40 percent of the total production of pulses in India and therefore is the largest chickpea producing country. Rajasthan have comparatively large area in rain-fed to other states of India. Raising productivity in agriculture will certainly lead to availability of food and reduce the real price of food. Increased food production will have to come from increased yield. It is, therefore, necessary to examine cost and returns and resource use efficiency among chickpea farmers. In the wake of modernization of Agriculture, the Endeavour is to increase Productivity, profitability, adoptability, stability and sustainability of the farm for the efficient utilization of farm resources. Significant of efficient utility of resources the present study has been taken into consideration with the following objectives

- To study economics of chickpea crop on different land size holdings in Rain-fed area.
- To study the resource use efficiency in chickpea crop in Rain-fed area.

2. RESEARCH METHODOLOGY

The study was conducted in the year 2018-19 and confined to Hanumangarh district of Rajasthan. The Hanumangarh district comprises six blocks viz. Hanumangarh, Pilibangah, Rawatsar, Tibbi, Sangria and Nohar Out of these six blocks Nohar block was selected purposively.

Two villages were selected from Nohar block on the basis of Rain-fed area under chickpea viz. Sheyorani A and Megana. The farmer were categorized into three size groups based on their size of holdings viz. small (up to 2 ha), medium (2.01 to 4 ha) and large size (above 4 ha). From each village 25 farmers were selected randomly, thus the total number of farmers was 50 for detail investigation. The primary data were collected from selected farmers through personal interview by survey method using pretested interview schedules.

Following Cost concepts analysis was done on different cost concepts basis. These are as follows;
Cost A_1:

- Value of hired human labour.
- Value of owned and hired animal labour.
- Value of owned and hired machine labour.
- Value of seed (both farm produced and purchased).
- Value of manure, fertilizer, insecticides and pesticides.
- Irrigation charges.
- Depreciation.
- Land revenue.
- Interest on working capital.
- Miscellaneous.

Cost A_2: Cost A_1 + rent paid for leased-in land.
Cost B_1: Cost A_2 + interest on fixed capital assets (excluding land)
Cost B_2: Cost B_1 + rental value of owned land + rent paid for leased-in land
Cost C_1: Cost B_1 + imputed value of family labour
Cost C_2: Cost B_2 + imputed value of family labour
Cost C_3:Cost C_2 +10 per cent of cost C_2 as management cost

$$\textbf{Cost of production per quintal} = \frac{\textbf{Cost of cultivation/ha}}{\textbf{Quantity of main product/ha}}$$

Farm business income = Gross income – Cost A_1
Family labour income = Gross income – Cost B_2
Net income = Gross income – Cost C_2
Returns to management = Gross income – Cost C_3
The Cobb-Douglas production function was used for estimating the resources used in Chickpea production.

Cobb-Douglas production function was fitted to analyse the resource use efficiency. The model is as follows:

$$\mathbf{Y = a.X_1^{b1}X_2^{b2}X_3^{b3} \dots\dots\dots X_n^{bn}U_i}$$

Different variables uses in the production function are as under:
Where,

Y = Output in quintals per hectare.
X_1 = Quantity of seed (kg) per hectare.
X_2 = Quantity of F.Y.M. (in quintal) per hectare.
X_3 = Quantity of Nitrogen (in kg) per hectare.
X_4 = Quantity of Phosphorus (in kg) per hectare.
X_5 = Human labour (Man days) used per hectare.
X_6 = Animal labour (days) used per hectare.
X_7 = Machine labour (hrs) used per hectare.
X_8 = Number of irrigations per hectare.
X_9 = Number of sprays per hectare.
X_{10} = Number of weedings per hectare.

Where:

a = Constant
b_1, b_2, ….b_n = Regression coefficients / elasticises of production.
U_i = Error term.

The regression coefficients, their significance, standard error and co-efficient of multiple determination (R^2) were worked- out. Marginal physical product and marginal value productivity were worked out for each statistically significant input.

2.1 Marginal Physical Product and Marginal Value Productivity

The marginal physical product of the input, used in each crop was worked out with the help of following equation;

$$\mathbf{MPP} = \mathbf{Bi}\frac{\overline{\mathbf{Y}}}{\overline{\mathbf{X}}}$$

The MVP was worked out as follows:

MVP = MPP x Price/quintal

Where:

b_i = Elasticity of production of i^{th} input.
Y= Geometric mean of output per hectare.
X= Geometric mean of input per hectare.
MPP = Marginal physical product of i^{th} input.
MVP = Marginal value productivity of i^{th} input.

$$\textbf{Resource use efficiency} = \frac{\mathbf{MVP_{Xi}}}{\mathbf{MFC_{Xi}}} = \mathbf{1}$$

Where,

MFC_{x1} is marginal factor cost

3. RESULT AND DISCUSSION

The findings obtained from the present study are presented below:

3.1 Physical Inputs:

Per hectare physical inputs in chickpea production were calculated and are presented in Table 1. Overall Use of seed was 52.60 kg/ha. Use of fertilizer with respect to Urea and Diammonium phosphate Thus, in overall use of Urea and Diammonium phosphate was 43.40 and 45.85 kg/ha respectively. In general, use of Farm yard manure was 2.23 tonnes/ha.

3.2 Operation Wise Labour use Pattern on Different Land Size Holdings in Chickpea Cultivations

On an average, use of family human labour was 150.37 hr/ha. Thus, use of family human labour was more than hired human labour in chickpea production in all size of holdings. Use of family human labour was 156.68 hr/ha on small farm followed by 154.10 hr/ha on medium farm and 140.33 hr/ha on large farm. It inferred that, as farm size increased, use of family human labour also decreased. On an average, use of causally hired human labour was found to be 46.51 hr.

Table 1. Physical inputs and outputs: (ha)

Input	Size of holdings			Overall Average
	Small	Medium	Large	
1. Seed (kg)	54.00	50.88	52.92	52.60
2. Prepatory tillage(No.)	1.00	1.00	1.00	1.00
3. Farm yard manure (tonnes/ha)	2.13	2.19	2.37	2.23
4. Fertilizer (kg/ha)				
(a) Urea	38.67	44.16	47.38	43.40
(b Diammonium phosphate	45.33	45.76	46.46	45.85
5. Plant protection (No.)	1.42	1.64	1.85	1.63
6. Interculture operation	1.17	1.28	1.46	1.30

Table 2. Operation wise labour use pattern on different land size holdings in Chickpea cultivation (hours/ha)

Operation	Small			Medium			Large			Overall Average		
	FL	CHL	ML	FL	CHL	ML	FL	CHL	ML	FL	CHL	ML
Preparatory tillage	28.00	0.00	1.69	27.84	4.16	1.72	22.77	4.92	1.83	26.20	3.03	1.75
Sowing	0.00	0.00	1.36	0.00	0.00	1.34	0.00	0.00	1.30	0.00	0.00	1.33
Irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fertilizer	2.42	0.00	0.00	2.40	0.00	0.00	2.38	0.00	0.00	2.40	0.00	0.00
Interculture operation	38.28	2.89	0.00	49.74	6.68	0.00	41.66	15.15	0.00	43.23	8.24	0.00
Plant protection	1.89	0.00	0.00	1.88	0.20	0.87	1.83	0.22	0.93	1.87	0.14	0.60
Harvesting & Picking	84.72	31.00	1.00	70.83	35.41	1.00	70.43	38.18	1.00	75.33	34.86	1.00
Transportation	1.38	0.14	5.00	1.41	0.23	5.00	1.26	0.36	5.00	1.35	0.24	5.00
Total	156.68	34.03	9.05	154.10	46.68	9.93	140.33	58.82	10.06	150.37	46.51	9.68

FL- Family labour, CHL- Casually hired labour, ML- Machine labour

Table 3. Breakup cost of cultivation on different land size holdings in Chickpea production (Rs/ha)

Item	Size of holdings			Overall Average
	Small	Medium	Large	
Machine labour	2263.68 (12.63)	2402.03 (12.65)	2439.62 (12.2)	2368.44 (12.49)
Casually hired labour	1190.97 (6.64)	1633.76 (8.6)	2058.86 (10.29)	1627.86 (8.58)
Imputed value of family labour	4308.79 (24.05)	4237.62 (22.32)	3859.13 (19.3)	4135.18 (21.8)
Seed	3510 (19.59)	3307.2 (17.42)	3440 (17.2)	3419.06 (18.03)
Farm yard manure	469.33 (2.62)	482.24 (2.54)	521.23 (2.6)	490.93 (2.58)
Fertilizer	1301.44 (7.26)	1342 (7.06)	1376.64 (6.88)	1340.02 (7.06)
Plant protection chemical	1958.78 (10.93)	2246.9 (11.83)	2626.66 (13.13)	2277.45 (12.01)
Irrigation charge	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Depreciation	350 (1.95)	550.4 (2.89)	750.44 (3.75)	550.28 (2.9)
Land revenue	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Interest on working capital	133.67 (0.74)	142.67 (0.75)	155.78 (0.77)	144.04 (0.75)
Interest on fixed capital	225 (1.25)	437.5 (2.3)	562.5 (2.81)	408.33 (2.15)
Rental value	2200 (12.28)	2200 (11.58)	2200 (11)	2200 (11.6)
TOTAL	17911.68 (100)	18982.34 (100)	19990.89 (100)	18961.64 (100)

On the contrary, use of causally hired labour was higher as 58.82 hr/ha on large farm while that was 46.68 and 34.03 hr/ha on medium and small farms, respectively. It was clear that use of use causally hired labour increased with increase in the farm size while use of machine labour increased with increase in farm size. Hence, small farmer was giving preference to custom hired service of machine labour. On an average, use of machine labour was 9.68 hours. Machine labour was high because transport takes 5 hours from farm to market.

3.3 Cost of Cultivation of Chickpea Production

Per hectare item wise expenditure in Chickpea production was estimated and is presented in Table 3. The results revealed that, total cost per hectare highest was Rs.19990.89 on large farm followed by Rs.18982.34 on medium farm and Rs.17911.68 on small farm [2]. In general, total cost increase with an increase in the farm size. In consideration of share of each item of expenditure in total cost, it was observed that, Chickpea cultivation proportionate expenditure was higher on family human labour in the study decreased with the increase in farm size and at overall level it was 21.80 per cent. On the contrary share of hired human labour increased with the increase in farm size and in general it was 8.58 per cent. It inferred that, large farm was dependent on hired labour as compared to family labour.

3.4 Cost Concepts of Chickpea Production

Table 4 reveals that on different cost concepts wise on different size of farms group per hectare. Cost A_1 was higher in large size farms (Rs.13369.26) followed by medium size farms (Rs.12107.22/ha) and small size farms (Rs. 11177.89/ha) similar findings Sharma at el. [3]. Cost A_1 and A_2 no difference because in sample farm no farmer had leased-in land. Cost B_2 was higher in large size farms (Rs. 16131.76/ha) as compared to medium size farms (Rs. 14744.72/ha) and lowest in small size of farms (Rs. 13602.89/ha). Cost C_3 was higher in large size farms (Rs.21989.98/ha) and lowest in small size farms (Rs. 19702.85/ha) similar findings verma at el. [4]. Sample average for Cost A_2 Cost B_2 and Cost C_3 was Rs. 12218.12/ha, Rs. 14826.46/ha and Rs. 20857.81/ha respectively in different size of farms group.

Table 4. Cost of cultivation of Chickpea on different cost concepts basis on different land size holdings (Rs/ha)

Cost	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	11177.89	12107.22	13369.26	12218.12
Cost A_2	11177.89	12107.22	13369.26	12218.12
Cost B_1	11402.89	12544.72	13931.76	12626.46
Cost B_2	13602.89	14744.72	16131.76	14826.46
Cost C_1	15711.68	16782.34	17790.90	16761.64
Cost C_2	17911.68	18982.34	19990.90	18961.64
Cost C_3	19702.85	20880.58	21989.98	20857.81

Table 5. Return from cultivation of Chickpea on different land size holdings (Rs /ha)

Particulars	Size of holdings			Overall Average
	Small	Medium	Large	
Yield (qtls/ha.)	9.67	11.12	12.67	11.13
By product (qtls/ha)	14.83	17.12	17.54	16.50
Gross income	46241.67	53208.00	59892.31	53113.99
Farm business income	35063.78	41100.78	46523.05	40895.87
Family labour income	32638.78	38463.28	43760.55	38287.53
Net income	28329.98	34225.66	39901.41	34152.35
Return to management	26538.82	32327.42	37902.32	32256.19

Table 6. Regression coefficient of resources used in Chickpea production

Variables	Regression Coefficient	S.E	t-Value	R^2
Seed	0.82	0.21	0.39	0.665
FYM	0.37	0.11	0.35	
Nitrogen	-0.27	0.22	-0.13	
Phosphorous	.434*	0.15	2.94	
Human labour	-1.37	0.21	-0.64	
Machine labour	-0.31	0.63	-0.49	
Plant protection chemical	0.01	0.08	0.16	
Weeding	0.19	0.10	1.92	

** Significant at 1% level of significance*

Table 7. Marginal value productivity of resource used in Chickpea production

Input	G.M	MPP_{X1} (qtls.)	MVP_{X1}(Rs.)	P_{X1}(Rs.)	MVP_{x1}/P_{x1}
Yield	11.01	-	-	-	-
Phosphorous	20.96	0.23	1003.09	50	20.06

GM=Geometric mean, MPP= Marginal Physical Product, MVP_{X1}= Marginal Value Product, P_{X1}= Price of additional unit of input

3.5 Productivity and Profitability of Chickpea

The Table 5 reveals that on the overall basis, productivity of chickpea was 11.13 quintals per hectare. The yield was highest (12.62 quintals) on large farms, followed by medium farms (11.12 quintals) and small farmers (9.67 quintals) which indicated that as the size of holding increased, the productivity of chickpea also increased. The gross returns also increased with increase in the size of holding. Farm business income in small, medium and large size of farms group was Rs.35063.78/ha, Rs.41100.78/ha and Rs.46523.05/ha respectively. Sample average of Family labour income was Rs.38287.53/ha in different size of farms group. The net income varied from Rs. 28329.98 per hectare at small farms, Rs. 34225.66 per hectare at medium farms to Rs. 39901.41 per hectare at large farms net income increase with increase in size of holdings (similar trend was Bhupender and Amalendu Kumar [5] found in clusterbean crop) along with an average of Rs.34152.35 per hectare. Sample average of return to management income was Rs.32256.19/ha.

3.6 Resource use Efficiency in Chickpea Production in Rain-fed Area

Production function analysis was carried out to determine the efficiency of various resources used in the production process. Cobb Douglas production function turned out to be the best fit because of high R^2. The estimates are presented in Table 6.

The coefficient of multiple determination was 0.665 which indicated that independent variables included in the model explained 66 per cent variability in the dependent variable. Phosphorous contributed significantly to the yield of chickpea, where as seed, FYM, nitrogen, human labour, machine labour, plant protection chemical and weeding turned out to be non-significant.

3.7 Marginal Value Productivity of resource used in Chickpea Production in Rain-fed Micro Farming Situation

The marginal value productivity of inputs which made significant contribution to the yield on aggregate level are presented in Table 7.

The marginal value productivity for phosphorous was Rs. 1003.09, the ratio of MVP_{x1} to P_{x1} indicates that there is further scope to increase the use of these inputs till it equal to one [6].

4. CONCLUSIONS AND POLICY IMPLICATIONS

The study shows that the cost, return and resource use efficiency in chickpea production in Rain-fed area of Nohar tehsil. The main objective of the study is to analyze, economics of chickpea production and resource use efficiency in chickpea. The results reveal that economics of chickpea production is more profitable in large size farms as compared to medium size farms

and small size farms. Coefficient of multiple determinations (R^2) in the fitted Cobb-Douglas production was 0.66 indicating the included variables explained 66 per cent variations in dependent variable. Phosphorous contributed significantly to the yield of chickpea, where as seed, FYM, nitrogen, human labour, machine labour, plant protection chemical and weeding turned out to be non-significant. For rain-fed condition breeding program should be strengthened to develop nutri-rich and higher yielding, short duration tolerant hybrid with good quality of grain and fodder. In Rain-fed Farming Situation, major thrust should be given on developing short duration crop varieties and more emphasis on water storage facilites and mositure conservation activities. Adequate number of improved/high yielding verities must be evolved for rain-fed eco-system. In Rain-fed eco-system, farmers are using much less fertilizers per unit cropped area. Hence, awareness is required to be created among the farming community about balanced use of fertilizers to increase productivity of crops.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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