Original Research Article

Comparative study of Paddy cultivation in Ghaggar River Belt and Salt affected Micro Farming Situation in Zone 1b of Rajasthan

Abstract

The present study was conducted to analyze the comparative calculation of the cost and returns and resource use efficiency of Paddy crop in Ghaggar river belt and Salt affected micro farming situations in zone 1-B of Rajasthan. For study Multistage sampling framework was adopted for selection of sample respondents. Suratgarh tehsil representing Ghaggar river belt in Sriganganagar district and in Hanumangarh district representing Rawatsar tehsil salt affected micro farming situation was selected. Two villages from each tehsil were selected randomly. A sample of 50 farmers was selected for the present study. The farmers were divided into small, medium and large farms on basis of following criterion; Small (≤ 2ha), Medium (>2ha ≤4ha) and Large (>4ha). A sample of 25 farmers from each village was selected according to probability proportional to farm size. Primary data were collected on pre-structured schedules for agriculture year 2017-18. In study area overall cost of cultivation per hectare of paddy in Ghaggar river was reported highest on large farms (₹50310.09), followed by medium (₹46651.44) and small (₹41368.27) farms and in Salt affected micro farming situations Cost of cultivation was reported highest on large farms (₹40743.79), followed by medium (₹38791.41) and small (₹33716.14) farms.

Keywords- Cost, Return, Production, Resource use efficiency, Paddy

Introduction

India is a country of about 1.20 billion people. More than 65 percent of India's population lives in rural areas and their main occupation is agriculture. Agriculture is the backbone of the Indian economy because it contributes to the economic and social well-being of the entire nation through its influence on the gross domestic product and employment. Rajasthan is located on the northwestern side of India. The state covers an area of 342,239 square kilometers or 10.4 percent of the total geographical area of India (Agriculture Census 2015-16). Rajasthan was divided 10 agro climatic zone, in which zone 1b comprises Sriganganagar and Hanumangarh districts. The zone has extreme climatic conditions with scorching summer, cold winter and mild rainy season, dust storm during summer, frosty winter night and ground fog are some of the typical features of weather and rainfall is relatively low in western part as compared to eastern part of the zone. The average rainfall in zone-Ib is 32.6 cm of which 75 per cent is received in the month of July to September. The temperature of this zone fluctuates from as low as 0.0oC to as high as 49.0o C. January is the coldest and June is the hottest month of the year in this zone. The area is rich in agricultural production on account of a well-developed system of canal irrigation. Due to abundance of canal water irrigation, this region has today become the greenery of Rajasthan. The total Production as well as productivity levels of all crops is relatively much higher in this zone as compared to other zones of the state.

Sriganganagar belong to the lower Ghaggar Basin originating from Shivalik hills of Himachal Pradesh. It covers an area of 5,201.51 Km2 in Rajasthan. Ghaggar Basin falls in two Districts Sriganganagar (60.62%) and Hanumangarh (39.38%).The area of Ghaggar Basin with in Rajasthan predominantly comprises agriculture land with canal irrigation through extensive canal systems. Salt affected soils occur to a lesser or greater extent in practically all the districts of Rajasthan, however, their nature is location specific. Such soils cover an area of nearly 14.62 million in the country and 0.50 million in Rajasthan according to Rajasthan agriculture department. Indira Gandhi Nahar Pariyojna is the largest irrigation project in the world. It promised to make the desert green but has also waterlogged vast tracts of land and more stands in danger of being turned saline through this process. A number of factors viz. large percolation losses, natural inter-dunal depressions located in the Rawatsar tehsil are used to store excess floodwaters of Ghaggar River. As the depressions are filled with water, the area around depression experiences a sudden rise in ground water level causing wide spread water logging condition. Impounding of Ghaggar flood water in natural depression is the main cause of water logging. The physiographic situation of these villages is such that villages in this belt are located at lower altitude than the depression, which creates a steep gradient and sand dunes being

pervious, cause heavy seepage which results in water logging conditions in surrounding areas. The unlined canals from the saddles have further added to the problem.

Methodology

In Sriganganagar district Paddy crop was selected the basis of major crop Ghhagher river belt micro farming situations, from Suratgarh tehsil of Sriganganagar district two villages selected Manksar, and Brenka. In Hanumangarh district Paddy crop was selected the basis of major crop in Salt affected micro farming situations, In Rawatsar tehsil of Hanumangarh district two villages selected Bheruwali and Kedasari. The Fifty farmers were selected randomly from selected tehsil. Both primary as well as secondary data were used for the present study. Information regarding various cost components in production of Paddy crop viz., costs of various inputs, quantity through personal interview method on pre-structured data schedule. The study For estimating the cost of cultivation and returns from this crop, various cost concepts (cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3) and income measures (gross income and net income) were used.

Analytical framework

Cost of cultivation: The cost of cultivation of Paddy crop was worked out by using various cost concepts defined below

Cost A_1: It includes:
Value of hired human labour, value of hired and owned animal labour, value of hired and owned machine labour, value of seed (both farm seed and purchased), value of manures (owned and purchased) and fertilizers, depreciation on fixed assets, irrigation charges, land revenue, interest on working capital and miscellaneous expenses.
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 = Goss income – Cost A_1
Family labour income = Goss income – Cost B_2
Net income = Goss income – Cost C_2
Returns to management = Goss income – Cost C_3

Resource use efficiency:

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

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

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

b1, b2, ….bn = Regression coefficients / elasticises of production.

Ui = 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.

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;

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

The MVP was worked out as follows: **MVP = MPP x Price/quintal**

Where:

bi = Elasticity of production of ith input.

Y= Geometric mean of output per hectare. X= Geometric mean of input per hectare. MPP = Marginal physical product of ith input. MVP = Marginal value productivity of ith input.

Resource use efficiency =

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

Where, MFCx1 is marginal factor cost

Results and Discussion

Ghhagher River Belt Micro-Farming Situations

Resource use pattern

The use of inputs and the adoption of various cultural practices in the cultivation of Paddy crop on the sample farms in the study area were presented in the [Table-1]. On an average, 2.00 preparatory tillage operations were done to prepare the fields. The farmers prepared their fields with the help of tractor. The average quantity of seed used was 8.94 kg per hectare by the sample farms, average quantity of FYM used was 4.40 tonnes per hectare by the sample farms. Average quantity of chemical fertilizer Urea used was 278.65 kg per hectare, average quantity of D.A.P fertilizer used was 77.33 kg per hectare, average quantity of Sulphur fertilizer used was 13.30 kg per hectare and average quantity of Zinc fertilizer used was 8.89 kg per hectare. On an average, plant protection chemical was used 2.39 times during growing season of Paddy crop by the sample farmers. On an average, 2.14 time weeding was done manually during growing season of Paddy crop by the sample farmers. On an average, 14.90 irrigations were given to the Paddy crop by sample farmers using canal and tubewell.

Table-1 Resource use pattern in Paddy on different land size holdings (per hectare)

Input	Size of Holdings			Overall Average
	Small	Medium	Large	
1. Seed (kg)	9.93	8.89	8.00	8.94
2. Prepatory tillage	2	2	2	2.00
3. FYM (tonnes/ha)	3.83	4.81	4.55	4.40
4. Fertilizer (kg/ha)				
(a) Urea	263.33	278.07	294.55	278.65
(b) D.AP	66.33	79.85	85.82	77.33
(c) Sulphur	9.50	13.60	16.80	13.30
(d) Zinc	6.00	10.67	10.00	8.89
5. Plant protection (No)	2.33	2.30	2.55	2.39
6.Hoeing/Weeding (No)	1.92	2.22	2.27	2.14
7. Irrigation (No)	13.75	15.67	15.27	14.90

Labour use pattern

The various operations performed by family labour, hired labour and machine labour are given in [Table-2]. The overall operations, 169.36, 136.18 and 118.62 man hours per hectare of family labour, 144.64, 234.44 and 305.25 man hours per hectare of hired labour and 57.63, 61.85 and 66.03 hours per hectare of machine labour was used by the small, medium and large farmers, respectively. On an average for various operations about 141.39 man hours' family labour, 228.11 man hour's causal hired labour and 61.84 hours machine labour was used in the Ghhagher River belt micro-farming situations in Paddy cultivation.

Table-2 Operation-wise labour use pattern on different size holdings (hours/ ha)

Operations	Small			Medium			Large			Overall Average		
	FL	HL	ML	FL	HL	ML	FL	HL	ML	FL	HL	ML
Preparatory tillage	2.03	1.08	4.69	1.84	2.33	5.38	1.44	2.47	5.50	1.77	1.96	5.19
Sowing	0.00	114.42	0.00	0.00	118.96	0.00	0.00	119.45	0.00	0.00	117.61	0.00
Irrigation	55.00	0.00	49.94	53.38	9.28	53.05	44.43	16.66	56.43	50.94	8.65	53.14
Fertilizer	8.19	2.67	0.00	7.32	5.43	0.00	8.73	5.94	0.00	8.08	4.68	0.00
Intraculture operation	97.11	25.56	0.00	68.48	94.81	0.00	59.50	157.85	0.00	75.03	92.74	0.00
Plant protection	4.28	0.67	0.00	3.06	2.69	0.42	2.48	1.91	1.09	3.27	1.76	0.50
Harvesting & Picking	0.97	0.11	1.00	0.74	0.40	1.00	0.82	0.36	1.00	0.84	0.29	1.00
Transportation	1.78	0.14	2.00	1.36	0.53	2.00	1.21	0.61	2.00	1.45	0.43	2.00
Total	**169.36**	**144.64**	**57.63**	**136.18**	**234.44**	**61.85**	**118.62**	**305.25**	**66.03**	**141.39**	**228.11**	**61.84**

FL = Family labour; HL = Hired labour and ML = Machine labour

Cost of cultivation

Various costs incurred in the cultivation of Paddy on sample farms on different size holdings are presented in [Table-3]. On an average, the total cost per hectare of Paddy cultivation was ₹ 46110.21 in the Ghhagher River belt micro-farming situations. It was ₹ 41368.28 on small, ₹ 46651.45 on medium and ₹ 50310.90 on large holdings farmers. Rental value of land was the most important component of the cost in all the categories. Out of the total cost, On a average it accounted for 26.02 per cent. Hired labour was the second most important component in all the categories. It accounted for 17.31 per cent of the total cost on a average.

Table-3 Cost of cultivation of Paddy (₹/ ha)

Cost components	Size of holdings			Overall Average
	Small	Medium	Large	
1. Machine labour	3741.11 (9.04)	4045.18 (8.67)	4189.69 (8.32)	3991.99 (8.65)
2. Casually hired labour	5062.36 (12.23)	8205.55 (17.58)	10683.81 (21.23)	7983.9 (17.31)
3. Imputed value of family labour	4657.27 (11.25)	3745.06 (8.02)	3261.99 (6.48)	3888.11 (8.43)
4. Seed	1192 (2.88)	1066.66 (2.28)	960 (1.9)	1072.88 (2.32)
5. FYM	843.33 (2.03)	1059.25 (2.27)	1000 (1.98)	967.53 (2.09)
6. Fertilizer	3563.6 (8.61)	4280.21 (9.17)	4575.92 (9.09)	4139.91 (8.97)
7. Plant protection chemical	2158.33 (5.21)	2514.07 (5.38)	2669.09 (5.3)	2447.16 (5.3)
8. Irrigation charge	5993.33 (14.48)	6365.81 (13.64)	6771.9 (13.46)	6377.01 (13.82)

9. Depreciation	1150 (2.77)	1800.4 (3.85)	2200.35 (4.37)	1716.91 (3.72)
10. Land revenue	100 (0.24)	100 (0.21)	100 (0.19)	100 (0.21)
11. Interest on working capital	281.92 (0.68)	344.2 (0.73)	385.63 (0.76)	337.25 (0.73)
12. Interest on fixed capital	625 (1.51)	1125 (2.41)	1512.5 (3)	1087.5 (2.35)
13. Rental value	12000 (29)	12000 (25.72)	12000 (23.85)	12000 (26.02)
TOTAL	41368.27 (100)	46651.44 (100)	50310.9 (100)	46110.2 (100)

The comparative estimates of different costs incurred in Paddy cultivation for different size groups are given in [Table-4] and its revealed that cost A_1, on an overall basis, was ₹ 29134.60. It increased with the increase in size of holding because of better resource endowment and higher use of hired labour on medium and large farms. Cost A_2 was same as cost A_1 because no farmer had leased-in land. Cost B_1 and B_2 were worked out to be ₹ 30222.10 and ₹ 42222.10 respectively. The costs C_1 and C_2, on overall basis, were worked out to be ₹ 34110.21 and ₹ 46110.21 respectively. Cost C_3, which also includes managerial cost, was worked out to be ₹ 50721.23 per hectare.

Table-4 Cost of cultivation per hectare of Paddy on different cost concepts basis (₹/ ha)

Cost	**Size of holdings**			**Overall Average**
	Small	**Medium**	**Large**	
Cost A_1	24086.00	29781.38	33536.41	29134.60
Cost A_2	24086.00	29781.38	33536.41	29134.60
Cost B_1	24711.00	30906.38	35048.91	30222.10
Cost B_2	36711.00	42906.38	47048.91	42222.10
Cost C_1	29368.28	34651.45	38310.90	34110.21
Cost C_2	41368.28	46651.45	50310.90	46110.21
Cost C_3	45505.10	51316.59	55341.99	50721.23

Cost of production

The cost of production per quintal of Paddy on different cost concepts basis is given in [Table-5]. It is evident from the table that the overall cost of production per quintal of Paddy was ₹ 799.23 on cost C_2 basis. The cost of production per quintal was highest on small farms i.e. ₹ 743.14 followed by medium and large farmer i.e., ₹ 795.20 and ₹ 859.35 respectively because of the two productions in comparison to medium and large farms.

Table-5 Cost of production of Paddy on different farm size holdings (₹/qt)

Cost	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	432.68	507.64	572.83	504.38
CostA_2	432.68	507.64	572.83	504.38
Cost B_1	443.91	526.81	598.66	523.13
Cost B_2	659.48	731.36	803.63	731.49
Cost C_1	527.57	590.65	654.38	590.87
Cost C_2	743.14	795.20	859.35	799.23
Cost C_3	817.46	874.71	945.28	879.15

Productivity and profitability of Paddy

The productivity of Paddy and gross returns on sample farms are given in [Table-6]. The table revealed that on an overall basis, yield of Paddy was 57.63 quintals per hectare. The yield was highest (58.67 quintals) on medium farms, followed by large farms (58.55 quintals) and small farms (55.67 quintals) which indicated yield is low in small farmer but medium and large farmer not much difference the yield of Paddy.

Table-6 Gross income per hectare of Paddy on different farm size holdings (₹/Hec.)

Size of holdings	Yield(qtls/ha)	Price/qtl	Gross income (₹)
Small	55.67	1750	97422.50
Medium	58.67	1750	102672.50
Large	58.55	1750	102462.50
Overall average	57.63	1750	100852.50

Income measures:

It is evident from the [Table-7] that on overall basis net returns from cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3 were ₹ 71717.90, ₹ 71717.90, ₹ 70630.40, ₹ 58630.40, ₹ 66742.29, ₹ 100053.27 and ₹ 50131.27 per hectare of Paddy cultivation, respectively. The net returns increased with increase in the size of the holding. Similar results were obtained while studying the Sesame Cultivation in Punjab [2]. Returns per rupee of investment from Paddy cultivation on the basis of different cost concepts are given in [Table-8].

Table-7 Net returns per hectare of Paddy on different cost concepts basis (₹/ha)

Particulars	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	73336.50	72891.12	68926.09	71717.90
CostA_2	73336.50	72891.12	68926.09	71717.90
Cost B_1	72711.50	71766.12	67413.59	70630.40

Cost B_2	60711.50	59766.12	55413.59	58630.40
Cost C_1	68054.22	68021.05	64151.60	66742.29
Cost C_2	96679.36	101877.30	101603.15	100053.27
Cost C_3	51917.40	51355.91	47120.51	50131.27

It is evident from the table that on an average, the returns per rupee of investment on cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3 were ₹ 3.52, ₹ 3.52, ₹ 3.40, ₹ 2.41, ₹ 2.98, ₹ 2.20 and ₹ 2.00, respectively. No major difference was observed in returns per rupees among different size groups.

Table-8 Returns per rupee of investment in Paddy cultivation in Ghhagher River belt

Particulars	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	4.04	3.45	3.06	3.52
CostA_2	4.04	3.45	3.06	3.52
Cost B_1	3.94	3.32	2.92	3.40
Cost B_2	2.65	2.39	2.18	2.41
Cost C_1	3.32	2.96	2.67	2.98
Cost C_2	2.35	2.20	2.04	2.20
Cost C_3	2.14	2.00	1.85	2.00

Salt affected Micro farming Situations

Resource use pattern

The use of inputs and the adoption of various cultural practices in the cultivation of Paddy crop on the sample farms in the study area were presented in the [Table-9]. On an average, 2.00 preparatory tillage operations were done to prepare the fields. The farmers prepared their fields with the help of tractor. The average quantity of seed used was 11.49 kg per hectare by the sample farms. The average quantity of FYM used was 4.67 tonnes per hectare by the sample farms. The average quantity of Urea fertilizer used was 339.83 kg per hectare, average quantity of D.A.P fertilizer used was 95.16 kg per hectare, average quantity of Sulphur fertilizer used was 18.26 kg per hectare and average quantity of Zinc fertilizer used was 8.49 kg per hectare. On an average, plant protection chemical was used 3.01 times during growing season of Paddy crop by the sample farmers. On an average, 2.30 time weeding was done manually during growing season of Paddy crop by the sample farmers. On an average, 15.32 irrigations were given to the Paddy crop by sample farmers using canal and tubewell.

Table-9 Resource use pattern in Paddy on different land size holdings (per hectare)

Input	Size of Holdings			Overall Average
	Small	Medium	Large	
1. Seed (kg)	12.67	11.13	10.67	11.49
2. Prepatory tillage	2	2	2	2.00

3. FYM (tonnes/ha)	4.67	4.52	4.83	4.67
4. Fertilizer (kg/ha)				
(a) Urea	310.93	345.22	363.33	339.83
(b) D.AP	75.73	98.09	111.67	95.16
(c) Sulphur	14.67	17.45	22.67	18.26
(d) Zinc	6.93	8.87	9.67	8.49
5. Plant protection (No.)	2.93	3.00	3.08	3.01
6.Hoeing/Weeding (No.)	2.40	2.26	2.25	2.30
7. Irrigation (No.)	14.53	15.35	16.08	15.32

Labour use pattern

The various operations performed by family labour, hired labour and machine labour are given in [Table-10]. The overall operations, 151.67, 123.87 and 108.91 man hours per hectare of family labour, 138.66, 216.27 and 239.88 man hours per hectare of hired labour and 55.25, 61.94 and 61.58 hours per hectare of machine labour was used by the small, medium and large farmers, respectively. On an average for various operations about 128.15 man hours' family labour, 198.27 man hour's hired labour and 59.59 hours machine labour was used in the Salt affected micro-farming situations in Paddy cultivation.

Table-10 Operation-wise labour use pattern on different size holdings (hours/ ha)

Operations	Small			Medium			Large			Overall Average		
	FL	HL	ML	FL	HL	ML	FL	HL	ML	FL	HL	ML
Preparatory tillage	2.11	0.62	4.46	1.93	2.09	4.86	1.28	2.69	4.64	1.77	1.80	4.66
Sowing	0.00	113.47	0.00	0.00	119.91	0.00	0.00	120.92	0.00	0.00	118.10	0.00
Irrigation	58.13	0.00	45.80	53.38	8.01	52.08	48.25	16.08	51.94	53.26	8.03	49.94
Fertilizer	8.82	1.27	0.00	6.07	5.03	0.00	6.08	7.58	0.00	6.99	4.63	0.00
Intraculture operation	76.80	20.48	0.00	56.62	77.85	0.00	48.00	88.50	0.00	60.47	62.28	0.00
Plant protection	3.00	1.73	1.00	3.70	1.79	1.00	3.11	2.00	1.00	3.27	1.84	1.00
Harvesting & Threshing	1.60	0.42	1.00	1.43	0.54	1.00	1.35	0.74	1.00	1.46	0.57	1.00
Transportation	1.20	0.67	3.00	0.74	1.06	3.00	0.83	1.36	3.00	0.92	1.03	3.00
Total	**151.67**	**138.66**	**55.25**	**123.87**	**216.27**	**61.94**	**108.91**	**239.88**	**61.58**	**128.15**	**198.27**	**59.59**

Cost of cultivation

Various costs incurred in the cultivation of Paddy on sample farms on different size holdings are presented in [Table-11]. On an average, the total cost per hectare of Paddy cultivation was ₹ 37750.44 in the Salt affected micro-farming situations. It was ₹ 33716.14 on small, ₹ 38791.41 on medium and ₹ 40743.79 on large holdings farmers. Irrigation charge was the most important component of the cost in all the categories. Out of the total cost, On a average it accounted for 15.87 per cent. Fertilizer cost was the second most important component in all the categories. It accounted for 13.31 per cent of the total cost on a average.

Table-11 Cost of cultivation of Paddy (₹/ ha)

Cost components	Size of holdings			Overall Average
	Small	Medium	Large	
1. Machine labour	3953.77 (11.72)	4100.9 (10.57)	4025.55 (9.88)	4026.74 (10.66)
2. Casually hired labour	4853.02 (14.39)	7569.49 (19.51)	8395.72 (20.6)	6939.41 (18.38)
3. Imputed value of family labour	4170.83 (12.37)	3406.51 (8.78)	2994.9 (7.35)	3524.08 (9.33)
4. Seed	1520 (4.5)	1335.65 (3.44)	1280 (3.14)	1378.55 (3.65)
5. FYM	1026.66 (3.04)	994.78 (2.56)	1063.33 (2.6)	1028.26 (2.72)
6. Fertilizer	4235.81 (12.56)	5120.93 (13.2)	5726.26 (14.05)	5027.67 (13.31)
7. Plant protection chemical	2626.66 (7.79)	2873.04 (7.4)	2966.66 (7.28)	2822.12 (7.47)
8. Irrigation charge	5495.46 (16.29)	6249.52 (16.11)	6232.22 (15.29)	5992.4 (15.87)
9. Depreciation	1000 (2.96)	1750 (4.51)	2088 (5.12)	1612.66 (4.27)
10. Land revenue	100 (0.29)	100 (0.25)	100 (0.24)	100 (0.26)
11. Interest on working capital	296.39 (0.87)	353.05 (0.91)	371.12 (0.91)	340.18 (0.9)
12. Interest on fixed capital	437.5 (1.29)	937.5 (2.41)	1500 (3.68)	958.33 (2.53)
13. Rental value	4000 (11.86)	4000 (10.31)	4000 (9.81)	4000 (10.59)
TOTAL	33716.14 (100)	38791.41 (100)	40743.79 (100)	37750.44 (100)

The comparative estimates of different costs incurred in Paddy cultivation for different size groups are given in [Table-12] and its revealed that cost A_1, on an overall basis, was ₹ 29268.03. It increased with the increase in size of holding because of better resource endowment

and higher use of hired labour on medium and large farms. Cost A_2 was same as cost A_1 because no farmer had leased-in land. Cost B_1 and B_2 were worked out to be ₹ 30226.36 and ₹ 34226.36 respectively. The costs C_1 and C_2, on overall basis, were worked out to be ₹ 33750.45 and ₹ 37750.45 respectively. Cost C_3, which also includes managerial cost, was worked out to be ₹ 41525.49 per hectare.

Table-12 Cost of cultivation per hectare of Paddy on different cost concepts basis (₹/ ha)

Cost	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	25107.81	30447.39	32248.89	29268.03
CostA_2	25107.81	30447.39	32248.89	29268.03
Cost B_1	25545.31	31384.89	33748.89	30226.36
Cost B_2	29545.31	35384.89	37748.89	34226.36
Cost C_1	29716.14	34791.41	36743.79	33750.45
Cost C_2	33716.14	38791.41	40743.79	37750.45
Cost C_3	37087.76	42670.55	44818.17	41525.49

Cost of production

The cost of production per quintal of Paddy on different cost concepts basis is given in [Table-13]. It is evident from the table that the overall cost of production per quintal of Paddy was ₹ 828.97 on cost C_2 basis. The cost of production per quintal was highest on Medium farms i.e. ₹ 861.20 followed by Large and Small farmer i.e., ₹ 854.76 and ₹ 770.95 respectively.

Table-13 Cost of production of Paddy on different farm size holdings (₹/qt)

Cost	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	574.11	675.96	676.55	642.21
CostA_2	574.11	675.96	676.55	642.21
Cost B_1	584.12	696.77	708.02	662.97
Cost B_2	675.58	785.57	791.93	751.03
Cost C_1	679.49	772.40	770.85	740.91
Cost C_2	770.95	861.20	854.76	828.97
Cost C_3	848.04	947.32	940.24	911.87

Productivity and profitability of Paddy

The productivity of Paddy and gross returns on sample farms are given in [Table-14]. The table revealed that on an overall basis, yield of Paddy was 45.47 quintals per hectare. The yield was highest (47.64 quintals) on large farms, followed by medium farms (45.04 quintals) and small farms (43.73 quintals) which indicated that as the size of holding increased, the yield

of Paddy also increased. Srivastava *et al*. 2017 also found similar findings. The gross returns also increased with increase in the size of holding [1].

Table-14 Gross income per hectare of Paddy on different farm size holdings (₹/Hec.)

Size of holdings	Yield(qtls/ha)	Price/qtl	Gross income (₹)
Small	43.73	1750	76527.50
Medium	45.04	1750	78820.00
Large	47.64	1750	83370.00
Overall average	45.47	1750	79572.50

Income measures:

It is evident from the [Table-15] that on overall basis net returns from cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3 were ₹50304.47, ₹50304.47, ₹49346.14, ₹45346.14, ₹45822.05, ₹78743.53 and ₹38047.01 per hectare of Paddy cultivation, respectively. The net returns increased with increase in the size of the holding. Similar results were obtained while studying the Sesame Cultivation in Punjab [2]. Returns per rupee of investment from Paddy cultivation on the basis of different cost concepts are given in [Table-16].

Table-15 Net returns per hectare of Paddy on different cost concepts basis (₹/ha)

Particulars	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	51419.69	48372.61	51121.11	50304.47
CostA_2	51419.69	48372.61	51121.11	50304.47
Cost B_1	50982.19	47435.11	49621.11	49346.14
Cost B_2	46982.19	43435.11	45621.11	45346.14
Cost C_1	46811.36	44028.59	46626.21	45822.05
Cost C_2	75756.55	77958.80	82515.24	78743.53
Cost C_3	39439.74	36149.45	38551.83	38047.01

It is evident from the table that on an average, the returns per rupee of investment on cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3 were ₹2.74, ₹2.74, ₹2.66, ₹2.34, ₹2.37, ₹2.12 and ₹1.92, respectively. No major difference was observed in returns per rupees among different size groups [2].

Table-16 Returns per rupee of investment in Paddy cultivation Salt affected Micro farming Situations

Particulars	Size of holdings			Overall Average
	Small	Medium	Large	
Cost A_1	3.05	2.59	2.59	2.74
CostA_2	3.05	2.59	2.59	2.74
Cost B_1	3.00	2.51	2.47	2.66

Cost B_2	2.59	2.23	2.21	2.34
Cost C_1	2.58	2.27	2.27	2.37
Cost C_2	2.27	2.03	2.05	2.12
Cost C_3	2.06	1.85	1.86	1.92

Resource use efficiency in Paddy production in Ghaggar River Belt Micro Farming Situation (Suratgarh tehsil)

Table-17 Regression coefficient of resources used in Paddy production in Ghaggar River Belt Micro Farming Situation

Variables	Regression Coefficient	S.E	t-Value	R^2
Seed	-0.07	0.05	-1.49	.754
FYM	0.06**	0.03	2.17	
Nitrogen	0.01	0.17	0.07	
Phosphorous	-0.09	0.12	-0.81	
Human labour	0.02	0.07	0.29	
Machine labour	0.05	0.10	0.48	
Irrigation	0.21**	0.09	2.33	
PPC	-0.17**	0.08	-2.28	
Weeding	-0.06	0.08	-0.70	

** Significant at 5% level of significance

In [Table-17] the coefficient of multiple determinations was 0.754 which indicated that independent variables included in the model explained 75 per cent variability in the dependent variable. FYM and irrigation contributed positively significantly to the yield of paddy and PPC was negatively significant where seed, nitrogen, phosphorous, human labour, machine labour and weeding turned out to be non-significant.

Table-18 Marginal value productivity of resource used in Paddy production in Ghaggar River Belt Micro Farming Situation

Input	G.M	MPP_{X1} (qtls.)	MVP_{X1}(₹)	P_{X1}(₹)	MVP_{x1}/P_{x1}
Yield	58.20	-	-	-	-
FYM	4.15	0.84	1472.53	220	6.69
Irrigation	14.70	0.83	1455.00	480	3.03
PPC	2.31	- 4.28	-7495.45	1059.38	-7.08

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

In [Table-18] the marginal value productivity for FYM and irrigation was ₹1472.53 and ₹ 1455.00 respectively. The ratio of MVP to P x_1 indicates that there is further scope to increase the use of these inputs till it equal to one. But in use of PPC further not scope because negatively.

Resource use efficiency in Paddy production in Salt affected Micro Farming Situation (Rawatsar tehsil)

Table-19 Regression coefficient of resources used in Paddy production in Salt affected Micro Farming Situation

Variables	Regression Coefficient	S.E	t-Value	R^2
Seed	-0.10	0.08	-1.28	.624
FYM	0.02	0.04	0.39	
Nitrogen	0.44**	0.23	2.03	
Phosphorous	-0.01	0.18	-0.08	
Human labour	0.04	0.09	0.40	
Machine labour	-0.12	0.17	-0.68	
Irrigation	0.21	0.44	0.46	
PPC	-0.13	0.11	-1.25	
Weeding	0.02	0.11	0.16	

** Significant at 5% level of significance

In [Table-19] the coefficient of multiple determinations was 0.624 which indicated that independent variables included in the model explained 62 per cent variability in the dependent variable Similar results were obtained Nimoh *et al in* Irrigation Project in the Dangme West District of Ghana [3]. Nitrogen contributed positively significantly to the yield of paddy Similar results were obtained while studying the wheat Cultivation by Ghaderzadeh *et al*. [4], where seed, FYM, phosphorous, human labour, machine labour, irrigation, PPC, and weeding turned out to be non-significant.

Table-20 Marginal value productivity of resource used in Paddy production in Salt affected Micro Farming Situation

Input	G.M	MPP_{X1} (qtls)	MVP_{X1}(₹)	P_{X1}(₹)	MVP_{x1}/P_{x1}
Yield	44.99	-	-	-	-
Nitrogen	193.54	0.10	178.99	12.00	14.92

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

In [Table-20] the marginal value productivity for nitrogen was ₹178.99. The ratio of MVP to P x_1 indicates that there is further scope to increase the use of these inputs till it equal to one.

Conclusions

1. In resource use pattern average seed rate 8.94 kg per hectare use in ghaggar river belt micro farming situation compare 11.49 kg per hectare use in salt affected micro farming situation in Paddy crop.

2. Resource use pattern quantity of fertilizer Urea (278.65 kg) and D.A.P (77.33kg) per hectare use in ghaggar river belt micro farming situation compare Urea (339.83kg) and D.A.P (95.16kg) per hectare use in salt affected micro farming situation in Paddy crop.

3. Average cost of cultivation of Paddy in ghaggar river belt micro farming situation was ₹ 46110.02 and average cost of cultivation in salt affected micro farming situation was ₹ 37750.44 Per hectare. Reason of high cost of cultivation in ghaggar river belt micro farming situation compare to salt affected micro farming situation due to high rental value of land in ghaggar river belt micro farming situation.

4. Average yield of paddy crop in ghaggar river belt micro farming situation was high 57.63 quintal per hectare compare to salt affected micro farming situation was 45.47 quintal per hectare.

5. Ghaggar river belt micro farming situation coefficient of multiple determinations was 0.754 which indicated that independent variables included in the model explained 75 per cent variability in the dependent variable. FYM and irrigation contributed positive significant to the yield of paddy and PPC was negative significant that mean further scope of use irrigation and FYM and in salt affected micro farming situation coefficient of multiple determinations was 0.64.4 which indicated that independent variables included in the model explained 64 per cent variability in the dependent variable. Nitrogen contributed positive significant to the yield of paddy crop that mean these micro farming situations further scope of use Nitrogen increase in yield.

Suggestions

- The economies of scale are not in favor of small farms mainly due to high cost per unit of output. Therefore, the small farms should use their resources (capital and labour) optimally so that the scale economies tilt in their favor.
- Paddy crop cropping system in ghaggar belt micro farming situation is labour, water, capital and energy-intensive, and becomes less profitable as the availability of these resources diminished. This situation could further aggravate with deterioration of soil structure, declining underground water table and lesser land and water productivity which

ultimately are threat in front of sustainable and profitable Paddy-Wheat rotation in the region. Therefore policy makers need to employ new and improved set of practices needed to make the system sustainable, and employ resource conservations technologies and crop diversification so as to improve profit, productivity and sustainability of the system.

- Salt-induced soil degradation is a serious threat to salt affected micro farming situations which is also responsible for diminished productivity of agro-ecosystems. There is need for developing variety which are salt tolerant.
- Analysis of resource use efficiency revealed that some inputs are in excess use while others are underutilized having $MVP_{x1>} P_{x1}$ Hence, awareness should be created for balanced use of fertilizers.

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