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 1b of Rajasthan. In zone Ib Sriganganagar district Suratgarh tehsil selected for Ghaggar river belt and in Hanumangarh district Rawatsar tehsil selected for Salt affected micro farming situation. Two villages from each tehsil were selected randomly. A sample of 50 farmers was selected for the present study for each tehsil. 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 ₹ 46110.02 and ₹ 37750.44 in Ghaggar river belt and Salt affected micro farming situations respectively. Gross return in Ghaggar river belt micro farming situation was ₹ 100852.50 and Salt affected micro farming situation was ₹ 79772.50 per hectare. Coefficient of multiple determinations (R^2) in Ghaggar river belt micro farming situations found 0.75 per cent and Salt affected micro farming situation 0.62 per cent.

Keywords- *Cost of cultivation, Gross return, R^2, Paddy*

1. 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 km^2 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 0.0^oC to as high as 49.0^o 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. 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 km^2 in Rajasthan. Ghaggar Basin falls in two Districts

Sriganganagar (60.62%) and Hanumangarh (39.38%). 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 [1]. 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.

2. MATERIALS AND METHODS:

This study undertaken in the Ghhagher River belt micro farming situations in Sriganganagar district and Salt affected micro farming situations in Hanumangarh district in zone Ib of Rajasthan state. In which one tehsil, two villages from each micro farming situations were selected. Suratgarh tehsil of Sriganganagar district two villages Manksar, and Brenka and in Hanumangarh district Rawatsar tehsil two villages Bheruwali and Kedasari selected. The Fifty farmers were selected randomly from selected tehsil. 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.

2.1 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 = 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

2.2 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 Farm yard manure (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 / Elasticities 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.

2.3 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, MFCxi is marginal factor cost

3. RESULTS AND DISCUSSION:

3.1.1 Cost and return in Ghhagher river belt Micro-Farming Situations

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 farm yard manure 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 Diammonium phosphate 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 of paddy crop in Ghhagher river belt Micro-Farming Situations

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. Farm yard manure (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) Diammonium phosphate	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 chemical (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

3.1.2 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	Size of holdings									Overall average		
	Small			Medium			Large					
	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

3.1.3 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. The total costs increased with increase in farm size. Srivastava and Agarwal (2017) similar trend of increasing in total cost on different land size holdings findings [2}. 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 and 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. Farm yard manure	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. Cost C_3 showed the role of household as a manager in cultivation of the crop.

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

3.1.4 Cost of production

The cost of production per quintal of paddy on different cost concepts basis is given in [Table-5]. Overall cost of production per quintal of paddy was ₹ 799.23 on C_2 basis. The cost of production per quintal was highest on large farms i.e. ₹ 859.35 followed by medium and small farms i.e. ₹ 795.20 and ₹

743.14, respectively. This indicates that small farms are more efficient as compared to medium and large farms because of optimum use of inputs.

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

3.1.5 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 farms but medium and large farms not significant difference yield in paddy crop.

Table-6 Gross income per hectare of paddy on different farm size holdings (₹/ha)

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

3.1.6 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 [3]. 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)

Cost	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

Cost	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

3.2 Cost and return in Salt affected Micro-Farming Situations

3.2.1 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 farm yard manure 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 Diammonium phosphate 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. Farm yard manure (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) Diammonium phosphate	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 chemical (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

3.2.2 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. Number of family labour use decreased with increase in farm size but hired human labour increased with increase in farm size.

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

Operations	Size of holdings									Overall average		
	Small			Medium			Large					
	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

3.2.3 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 size farm. 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 because frequency of

irrigation high in salt affected soil. 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. Farm yard manure	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. This cost showed the role of household as a manager in cultivation of the crop.

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

3.2.4 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. This indicates that small farms are more efficient as compared to medium and large farms because of optimum use of inputs.

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

3.2.5 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.. The gross returns also increased with increase in the size of holding.

Table 14 Gross income per hectare of paddy on different farm size holdings (₹/ha)

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

3.2.6 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. 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)

Cost	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.

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

Cost	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

In Table-17 reveals that Cobb-Douglass production function was estimated to analyze relationship between resource use and productivity of paddy using the data from sample farmers. The estimates of the production functions in both micros farming situation was presented in this table. The inputs included in model explained 75 per cent variation and 62 per cent variation for Ghaggar River Belt and Salt affected micro farming situation respectively coefficient of multiple determination [4].

The estimated parameter of Farm yard manure (0.06) and irrigation (0.21) was significant at five per cent, while plant protection chemical (-0.17) co-efficient was negative in Ghaggar River Belt micro

farming situation where seed, nitrogen, phosphorous, human labour, machine labour and weeding turned out to be non-significant.

The estimated parameters in Salt affected micro farming situation nitrogen (0.44) was significant at five per cent, while seed, farm yard manure, phosphorous, human labour, machine labour, irrigation, plant protection chemical, and weeding turned out to be non-significant. Similar results were obtained Nimoh *et al in* Irrigation Project in the Dangme West District of Ghana [5].

Table-17 Regression coefficient of resources used in paddy production in Ghaggar river belt and Salt affected Micro Farming Situation

Variables	Ghaggar river belt Micro Farming Situation		Salt affected Micro Farming Situation	
	Regression Coefficient	t-Value	Regression Coefficient	t-Value
Seed	-0.07 (0.05)	-1.49	-0.10 (0.08)	-1.28
Farm yard manure	0.06** (0.03)	2.17	0.02 (0.04)	0.39
Nitrogen	0.01 (0.17)	0.07	0.44** (0.23)	2.03
Phosphorous	-0.09 (0.12)	-0.81	-0.01 (0.18)	-0.08
Human labour	0.02 (0.07)	0.29	0.04 (0.09)	0.40
Machine labour	0.05 (0.10)	0.48	-0.12 (0.17)	-0.68
Irrigation	0.21** (0.09)	2.33	0.21 (0.44)	0.46
Plant protection chemical	-0.17** (0.08)	-2.28	-0.13 (0.11)	-1.25
Weeding	-0.06 (0.08)	-0.70	0.02 (0.11)	0.16
R^2	.754		.624	

Note: Figures in the parentheses indicate their respective standard errors

** Significant at five per cent probability level

In Table-18 revels that marginal value productivity of resource used in paddy production in Ghaggar river belt and Salt affected Micro Farming Situation. Marginal value productivity at geometric levels was calculated for both micro farming situation of significant inputs. In Ghaggar river belt Micro Farming Situation farm yard manure and irrigation was significant role of paddy crop production. Farm yard manure and irrigation marginal value productivity was ₹ 1472.53 and ₹ 1455.00 respectively. But in use of Plant protection chemical further not scope because negative significant. In Salt affected micro farming situation nitrogen was significant role of paddy crop production 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.

Table-18 Marginal value productivity of resource used in paddy production in Ghaggar river belt and Salt affected micro farming situations

Input	G.M	MPP_{X1} (qtls.)	MVP_{X1}(₹)	P_{X1}(₹)	MVP_{x1}/P_{x1}

Ghaggar river belt micro farming situation					
Yield	58.20	-	-	-	-
Farm yard manure	4.15	0.84	1472.53	220	6.69
Irrigation	14.70	0.83	1455.00	480	3.03
Plant protection chemical	2.31	- 4.28	-7495.45	1059.38	-7.08
Salt affected micro farming situation					
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

4. CONCLUSION AND POLICY IMPLICATIONS:

Paddy is not only a staple food, but a cash crop to farming households in study area. Profitability was found to be a function of both input and output costs indicating that the ability of farmers to limit their total cost and increase their level of total output, the better their chances of earning higher profits from paddy cultivation. Paddy production was found to be profitable in the study area. In study area overall cost of cultivation per hectare of paddy was higher in Ghaggar river belt (₹ 46110.02) compare to Salt affected (₹ 37750.44) micro farming situations. Main reason for high cost of cultivation in Ghaggar river belt was rental value of land. But in Salt affected micro farming situation main reason was cost of fertilizer because high quantity nitrogenous fertilizer was used by sample households. Gross return was higher in Ghaggar river belt (₹100852.50) compare to Salt affected (₹79772.50) micro farming situation because high yield of paddy crop in Ghaggar river belt compare to Salt affected micro farming situation. That indicates Ghaggar river belt more suitable for paddy production compare to Salt affected micro farming situation. 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. And in Salt affected micro farming situation farmers need to grow Salt tolerant variety and crop. And Salt-induced soil degradation is a serious threat to salt affected micro farming situations which is also responsible for diminished productivity of agro-ecosystems.

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