Effect of Crop Rotation on profitability of Paddy Production in Odisha: An Empirical Analysis

Abstract: The returns from crop cultivation are essential not only for the survival of farmers but also to facilitate reinvestment in agriculture. An attempt has been made to evaluate profitability in paddy production with respect to crop rotation. Primary data from 455 farmers through a multistage purposive sampling technique were used in the study. Descriptive statistics and independent sample t-test were used in the study. The study found that profitability in paddy production varies at moderate level with respect to crop rotation. In total farmers were getting anet profit of 5324 rupees per acre. But per acre profit of paddy varies significantly considering point of product sold by farmers and share cropping characteristics of the farmer. On average farmer selling paddy at mandi were getting 11388 rupees of profit per acre while farmer selling at local markets were getting per acre 3103 rupees of profit.

Keywords: paddy production, crop rotation, net profit, selling point, share cropping

Introduction

The Indian history of economic activities endorses that, agriculture has remained the largest sector of economic activities in India. Although share of agriculture in GDP is declining, still its importance is intact as it is providing sustenance to a major group of people. Agricultural development is obstructed by levels of productivity and higher dependency. Unfortunately productivity level in Indian agriculture is very low in comparison to other countries. Low level of productivity and technical efficiency in agricultural sector of India is a matter of concern for all-round development of the economy. Food is a basic requirement for people of underdeveloped regions of the world. This is very much important to feed the growing population of the country. In order to fulfill increasing demand for food heavy pressure has been given to land. Economic development to be balanced it indispensableble to produce enough food along with balanced and sustainable use of resources.

In the pre-green revolution era, Odisha was a leading paddy-producing state in the country. The share of paddy production was 11 percentage of total production in the country before green revolution, which gradually declined to 7.9 percent in 2008-09. Paddy in Odisha is now grown in an area of 4.4 million hectars, which accounts for 91 percentages of the area under

cereals and 94 percent of production of cereals in the state (Das, 2012). Paddy covers about 69 percent of the total cultivated area and covers about 63 percentages of total area under food grains in the state (Das, 2012). It is the staple food of almost entire population of Odisha; therefore, the state economy is directly linked with improvements in production and productivity of rice in the state. But the returns from cultivation are not assures and largely fluctuating. At the same time cost of cultivation is increasing at a higher rate. So the profit earning from cultivation is often questioned. Now a days many times it is claimed that agriculture seems to have been reduced to a traditional compulsion rather than an economic option in Odisha. Thus strategies to be taken by which simultaneously input cost could be reduced and at the same time production could be enhanced.

Crop rotation strategy can be used to reduce inputs used and output increment in agricultural production by preserving or enhancing soil quality and productivity, and reducing nitrogen fertilizer requirements. Traditionally crop rotation has also been viewed as one of the simplest and most effective methods of managing weeds (Shahzad, Farooq, Jabran, & Hussain, 2016). Crop rotation promotes diversity by increasing nutrient components and reducing pH concentration in the soil (NASCENTE & STONE, 2018). The stock of soil organic carbon is induced and also nitrogen (N) concentration in the soil is developed by crop rotation (McDaniel, Tiemann, & Grandy, 2014), (Chen, et al., 2018), (Witt, et al., 2000). But rotation in specified crops enhanced the soil quality, while rotation in many other crops did not improve the soil quality (Oliveira, Barré, Trindade, & Virto, 2019). Crop rotation has an impact on weed management and density as well as the production of subsequent crops, but the effect is not consistent across the different cycles of study and different crop rotations (Brainard, Bellinde, Hahn, & Shah, 2008).

Production process occurs with the important aim to get some amount of profit. Producers are motivated towards production through the incentive of profit. But many times it claimed that profit from agriculture is substantial. There are two components of profit namely cost and return. The cost of production is influenced by the inefficiency of farmers (Burki & Shah, 1998). And it is observed that costs of medium and small farmers are comparatively higher than large farms (Sharma, 1996). So large farms earn more profit than medium and small farms. There many factors like education, non-agricultural employment, and credit constraints that affect profit of the farmer (Ali & Flinn, 1989). Profit also varies from crop to crop. The net return from sugar cane was found to becomparativelye higher than paddy

(Pushpa, Srivastava, & Agarwal, 2017). In some places, paddy is more profitable and promoted for production like Nigeria (Bwala & John, 2018) and in other places it earns marginal profit (Muazu, Yahya, Ishak, & Khairunniza-Bejo, 2014). According to OUAT (Odisha University of Agriculture and Technology), in 2011-12 farmers used to get approximately rupees 2000 as net profit per acre of land in Odisha. So there is a need to look into the matter concern.

With importance of crop rotation on soil organic carbon, N concentration, weed management, and larger productivity, relatively few studies have examined effect of crop rotation on profitability of paddy production, and rarely study has been made in India. In measurement of cost to derive profit from agriculture, often opportunity cost of own capital, rent for share croppers, and selling cost are ignored. And paddy being the major crop production in India as well as in Odisha, the present study is an attempt to evaluate profitability in paddy production with respect to crop rotation.

Material and method

The data used in the study were from framing household practicing paddy based crop rotation conducted between February and March 2021 in Odisha, a state of India through multi stage purposive sampling method. The first stage involves the selection of 2 top districts of Odisha as per the land under paddy cultivation and in the second stage 2 blocks were selected from each district with thesame criteria. Thirdly two Gram panchayats were chosen from each block and comprised 455 farmers as a sample unit. To examine profitability of farmers, descriptive statistics were employed in the study. Profitability is also examined with respect to other parameters (point of sell, share cropping). In that case, the study used an independent sample t-test for testing the significance of a mean difference between two categories.

Profit (P) = total revenue (TR) – total cost (TC)

Total revenue (TR) = revenue from main products (R1) + revenue from bi-products (R2)

Total cost = total production cost (C1) + financial cost (C2) + selling cost (C3)

Total production cost (C1) = cost of seed + hired labour + machinery + fertilizer + pesticide + manures + irrigation cost + land tax + rent for shared land

Total financial cost = interest paid on agricultural loan + opportunity cost of own capital

Total selling cost = packaging cost + transportation cost + brokerage fee

Profit in this study is estimated in 3 steps. The estimation of profit is explained below.

$$\text{Profit (P3)} = TR - (C1 + C2 + C3)$$

Total return is the summation of returns from the main products and bi-products. In paddy production, the study considered production of paddy as main product and return from other sources like straw as bi-products. Total cost involved in the process from cultivation to sell is summation of total production cost, financial cost and selling cost. Selling cost involves a cost of packaging, transportation to sell point and brokerage fee. Total production includes cost of seed, machinery, fertilizer, pesticide, hired labour, cost of irrigation, and other operational costs. By deducting total cost from total revenue the study found profit earned by the farmers.

Results and discussion

To determine profit level, attempts were made to evaluate the cost and return from paddy farming. Different crop rotation adopted by farmers is primarily addressed and per acre, gross profit, and net profit from paddy production are evaluated.

Table 1: Crop rotation and types of farmer

Crop rotation / Farmers type	K-Pa, R-Pa[1]	K-Pa, R-Pu	K-Pa, R-No crop	Total
Marginal (0-2.5 acres)	82 (56.16)[2]	128 (82.58)	95 (61.69)	305 (67.03)
Small (2.5-5 acres)	20 (13.69)	23 (14.84)	44 (28.57)	87 (19.12)
Large (more than 5 acres)	44 (30.13)	4 (2.58)	15 (9.74)	63 (13.85)
Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

The study observed 3 groups of farmers shown in table 1. As the objective of study is to find out profitability of paddy production, the study kept all farmers producing paddy in the

[1]K-Pa, R-Pa indicates kharif- paddy and rabi- paddy crop rotation, K-Pa, R-Pu indicates kharif- paddy & rabi- pulses crop rotation and K-Pa, R- no crop indicates kharif- paddy and rabi- no crop rotation.

[2] Values in the parentheses in this table and subsequent tables are presented in percentages.

Kharif season. But in case of rabi season, we found 3 types of farmers. There were 32.1 percent of farmers producing paddy both in kharif and rabi seasons. Another group of a farmer producing paddy in Kharif season and pulses in rabi season was 34.1 percent present in the study. The third group of farmers was those who produce paddy in Kharif season but do not practice any cultivation in rabi season having 33.8 percentages present in the study. Table 1 depicts that there were 67 percentages of marginal farmers presented in the study. And there were 19 and 14 percentages of small and large farmers presented in the study respectively. Here we can notice that most of large farmers were practicing paddy in rabi season. The large land size helps these farmers to reap the benefit of scale in irrigation cost in form of bore well, lift irrigation, and other forms. Likewise, most of the marginal farmers were practicing pulses in rabi season. There were a group of farmers not practicing any crop during rabi season for different reasons like saline land, irrigation problem, etc.

Table 2: Per acre production cost for different crop rotation

Per acre production cost (in rupees)	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
0-5000	1 (0.7)	6 (3.9)	1 (0.6)	8 (1.8)
5000-10000	49 (33.6)	58 (37.4)	62 (40.3)	169 (37.1)
10000-15000	73 (50)	53 (34.2)	60 (39)	186 (40.9)
15000-20000	23 (15.8)	30 (19.4)	28 (18.2)	81 (17.8)
20000 & above		8 (5.2)	3 (1.9)	11 (2.4)
Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

Production cost is an important part of total cost incurred by the producer. The per acre production cost for different crop rotation is presented in the table 2. The per acre production cost includes cash cost (cost of seed, hired labour, fertilizer, machinery, pesticide, and other operation). Non-cash cost (family labour) is not included in the analysis under the assumption that family labour is surplus in the area and has no opportunity cost. The study found that in total only 1.8 percentages of farmers had per acre production cost below 5000 rupees and varies in different crop rotation. In particular kharif-paddy and rabi-pulses crop rotation there were 3.9 percentages of farmers having production cost below 5000 rupees per acre. As we can observed from the table most of the farmers had production cost either 5000-10000 or 10000-15000 rupees per acre. In the total study 17.8 percentages of farmers were there who

had incurred 15000 to 20000 rupees per acre as production cost. There were also some farmers incurring more than 20000 rupees per acre production cost.

Table 3: Per acre financial cost for different crop rotation

Per acre financial cost (in rupees)	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
0-500	93 (63.7)	83 (53.5)	74 (48.1)	250 (54.9)
500-1000	47 (32.2)	46 (29.7)	50 (32.5)	143 (31.4)
1000-1500	3 (2.1)	14 (9.0)	16 (10.4)	33 (7.3)
1500-2000	1 (0.7)	2 (1.3)	8 (5.2)	11 (2.4)
2000 & above	2 (1.4)	10 (6.5)	6 (3.9)	18 (4)
Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

Financial cost is another part of cost which is borne by the farmer but often ignored. The description of financial cost is presented in table 3. In our study financial cost represents interest payment of a loan for agricultural purposes and also opportunity cost of own capital invested in agriculture. The interest rate varies differently as per the source of finance. Accordingly, farmers incur different interest amounts depending upon the quantum and source from which they borrowed. Similarly, some farmers incur financial expenses out of pocket. But that capital has an opportunity cost. The opportunity cost of own capital is estimated by taking an average of interest rate from all sources made by the borrowed farmers in the study. The study found that nearly 55 percentages of farmers had financial costs below 500 rupees per acre. Likewise, 31.4 percentages of farmers had financial costs in between 500 to 1000 rupees per acre. Till now product is not being sold. And there involves some cost for sell of the product known as selling cost is presented in table 4.

Table 4: Per acre selling cost for different crop rotation

Per acre selling cost (in rupees)	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
0-500	86 (58.9)	83 (53.5)	113 (73.4)	282 (62)
500-1000	21 (14.4)	20 (12.9)	18 (11.7)	59 (13)
1000-1500	17 (11.6)	25 (16.1)	10 (6.5)	52 (11.4)
1500-2000	14 (9.6)	15 (9.7)	6 (3.9)	35 (7.7)
2000 & above	8 (5.5)	12 (7.7)	7 (4.5)	27 (5.9)

Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

Selling cost in this study involves packaging cost, transportation cost and brokerage fee. The study found brokerage fee as an important part of the selling cost, which differs according the point of sell by the farmer. At selling time, farmer bears a brokerage fee in form of the output differing according to the point of sell. The brokerage fee was quite high at mandies than the local market. In this study, there were 62 percentages of farmers incurring selling costs between 0 to 500 rupees per acre. Likewise, 13 percentages of farmers were incurring 500 to 1000 rupees per acre selling cost. In particular, farmers practicing Kharif-paddy and rabi-pulses crop rotation were incurring comparatively higher amount of selling costs. The study has found that return from bi-product is minimal, thus total revenue is nearly same as revenue from main product.

Table 5: Per acre total revenue for different crop rotation

Per acre total revenue (in rupees)	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
5000-10000	8 (5.5)	6 (3.9)	7 (4.5)	21 (4.6)
10000-15000	26 (17.8)	33 (21.3)	45 (29.2)	104 (22.9)
15000-20000	51 (34.9)	54 (34.8)	71 (46.1)	176 (38.7)
20000-25000	44 (30.1)	30 (19.4)	18 (11.7)	92 (20.2)
25000-30000	15 (10.3)	21 (13.5)	7 (4.5)	43 (9.5)
30000 & above	2 (1.4)	11 (7.1)	6 (3.9)	19 (4.2)
Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

Total revenue is the summation of main product revenue and bi-product revenue. Per acre total revenue for different crop rotations is presented in table 5. In total there were 4.6 percentages of farmers received 5000 to 10000 rupees per acre total revenue. Likewise, 22.9 percentages of farmers were getting 10000 to 15000 rupees per acre total revenue. Similarly, 15000 to 20000 rupees per acre revenue were received by 38.7 percent of farmers. As a comparative observation, the study found that in case of kharif-paddy, and rabi-no crop rotation approximately 80 percentages of farmers were earning lower than 20000 rupees per acre revenue which is comparatively higher than from other two crop rotations.

Table 6: Per acre profit for different crop rotation

Per acre profit (in rupees)	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
-15000- -10000	2 (1.4)	3 (1.9)	2 (1.3)	7 (1.5)
-10000- -5000	5 (3.4)	8 (5.2)	4 (2.6)	17 (3.7)
-5000- 0	13 (8.9)	25 (16.1)	30 (19.5)	68 (14.9)
0- 5000	48 (32.9)	37 (23.9)	47 (30.5)	132 (29)
5000- 10000	47 (32.2)	39 (25.2)	48 (31.2)	134 (29.5)
10000-15000	24 (16.4)	18 (11.6)	14 (9.1)	56 (12.3)
15000-20000	7 (4.8)	17 (11)	7 (4.5)	31 (6.8)
20000 & above		8 (5.2)	2 (1.3)	10 (2.2)
Total	146 (100)	155 (100)	154 (100)	455 (100)

Source: Field survey 2021

Per acre profit for different crop rotation is presented in table 6. The study found that approximately 20 percentages of farmers were bearing losses in paddy production. Out of rest 80 percentage farmers, 29 percentages were getting 0 to 5000 rupees profit per acre and 29.5 percentages farmers getting 5000 to 10000 rupees profit per acre. Very few farmers were earning higher amounts of profit i.e. above 20000 rupees per acre. The Clear picture of profit is presented in table 7.

Table 7: Per acre average cost, revenue and profit for different crop rotation

Particulars	K-Pa, R-Pa	K-Pa, R-Pu	K-Pa, R-No crop	Pooled data
Per acre production cost (C1)	11649.93	11872.74	11863.51	11798.12
Per acre financial cost (C2)	512.63	732.32	715.36	656.08
Per acre selling cost (C3)	656.95	757.63	440.74	618.07
Per acre total cost (C1+C2+C3)	12819.51	13362.69	13019.61	13072.27
Per acre Main product revenue (R1)	18321.80	18954.32	17043.95	18104.77
Per acre Bi-product revenue (R2)	260.96	343.12	270.56	292.20
Per acre total revenue (TR= R1+ R2)	18582.74	19297.41	17314.49	18396.95
Per acre profit (TR-C1-C2-C3)	5763.23	5934.74	4294.88	5324.67

Source: field survey 2021

Per acre average production cost for all farmers was 11798 rupees, while farmers practicing kharif-paddy & rabi- paddy, kharif-paddy & rabi- pulses and kharif- paddy & rabi- no crop rotation had average per acre production cost of 11649, 11872 and 11863 rupees respectively. It is been noticed that production cost is not significantly different between crop rotations. The average per acre financial cost for all farmers stands at 656 rupees and lower in Kharif-paddy & rabi- paddy crop rotation. Likewise average per acre selling cost for all farmers was 618 rupees. Average per acre selling cost was lower in the case of kharif- paddy & rabi- no crop rotation and highest in kharif- paddy & rabi- pulses crop rotation. Average per acre main product revenue for all farmers was 18104 rupees and particularly in case of kharif- paddy & rabi- pulses crop rotation it was highest i.e. 18954 rupees. The average per acre main product revenue for kharif- paddy & rabi- paddy and kharif- paddy & rabi- no crop rotation was 18321 and 17043 rupees respectively. Price mechanism and productivity are the important reasons for main product revenue differential among different crop rotations. The study found no significant contribution of bi-product to the total revenue. The average per acre bi-product revenue for all farmers was 292 rupees. Then total revenue is estimated by adding both main product and bi-product revenue. Average per acre total revenue for all farmers was 18396 rupees. The pattern of average per acre total revenue is nearly similar to average per acre main product revenue.

The study found that average per acre profit for all farmers was 5324 rupees. The average per acre profit for kharif- paddy & rabi- paddy crop rotation was 5763 rupees and for kharif-paddy & rabi- pulses crop rotation was 5934 rupees. It was lowest for kharif- paddy & rabi-no crop rotation i.e. 4295 rupees. Average per acre profit is varying across different crop rotations, but is always profitable. Supporting the result of (Bwala & John, 2018) rice production is also profitable in Odisha. As the intensity of factor use and investment in agriculture varies, a clear picture of profit can be visualized from Net Return Per Rupee invested (NRPRI). NRPRI is estimated by dividing profit by total cost.

Table 8: Net Return Per Rupee Invested (NRPRI) for different crop rotation

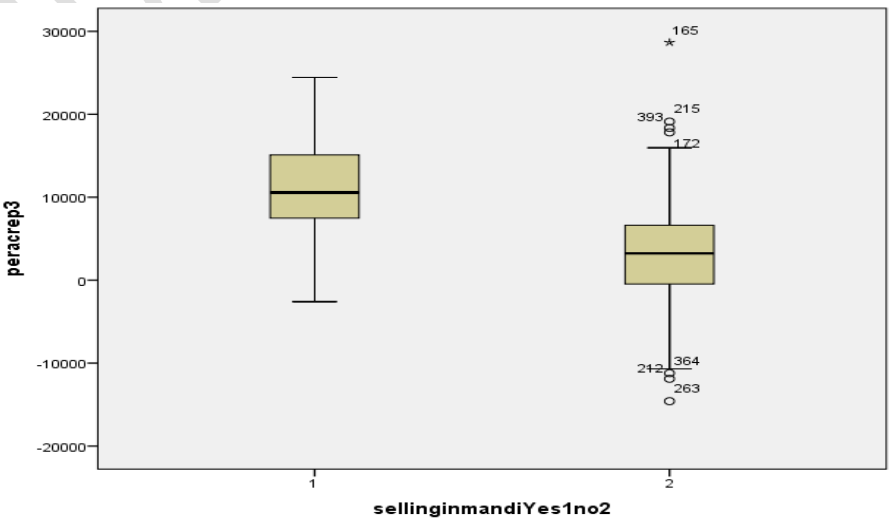
Crop rotation	N	Minimum	Maximum	Mean	Std. Deviation
K-Pa, R-Pa	146	-.6045	2.3397	.534185	.5578873
K-Pa, R-Pu	155	-.6118	9.9228	.720825	1.1802488
K-Pa, R-No crop	154	-.5426	3.0262	.440847	.5929591
Pooled data	455	-.6118	9.9228	.566174	.8391833

Source: Estimated from field survey 2021

Table 8 depicts that mean NRPRI for all farmers was 0.56 while it was 0.53 for farmers practicing kharif- paddy & rabi- paddy crop rotation. Highest NRPRI was observed in case of kharif- paddy & rabi- pulses crop rotation i.e. 0.72. Likewise, least NRPRI was estimated in case of kharif- paddy & rabi- no crop rotation i.e. .44 with a minimum score of -0.5426 and a maximum score of 3.02. The study found that NRPRI was highest for kharif- paddy & rabi- pulses crop rotation and lowest for kharif-paddy & rabi- no crop rotation.

The study has observed that besides crop rotation there were other factors responsible for variation in profitability among farmers. Some particular aspects like a point of sell, share cropping in this regard were analyzed. Farmers had two options to sell their product either in the local market or at mandies. Selling at mandies is made according to the registration in co-operative society and sold at MSP (Minimum Support Price) decided by government. In general price in mandi is quite higher than in the local market. But due to complexity in registration process, all farmers could not able to sell their products at mandies. There are also some farmers who could able to sell a part of their output at mandies. Taking account of that the study has considered those farmers selling more than 50 percent of their marketed surplus at any of two selling points of that category. The study found that only 1.64 percentages of farmers selling at mandies were incurring losses. At the same time, approximately 27 percentages of farmers were incurring losses by selling their products in local market.

Figure 1: Selling in mandi and per acre profit



Source: Field survey 2021

The pattern of profit as per the selling point is shown in above figure 1. The study found that median value of profit selling at mandi was quite higher than selling at local market. The ranges of profit in two scenarios were also quite different. The significant differential of profit as per the selling point was tested by independent t test.

Table 9: Independent sample t test for profit differential with respect to selling point

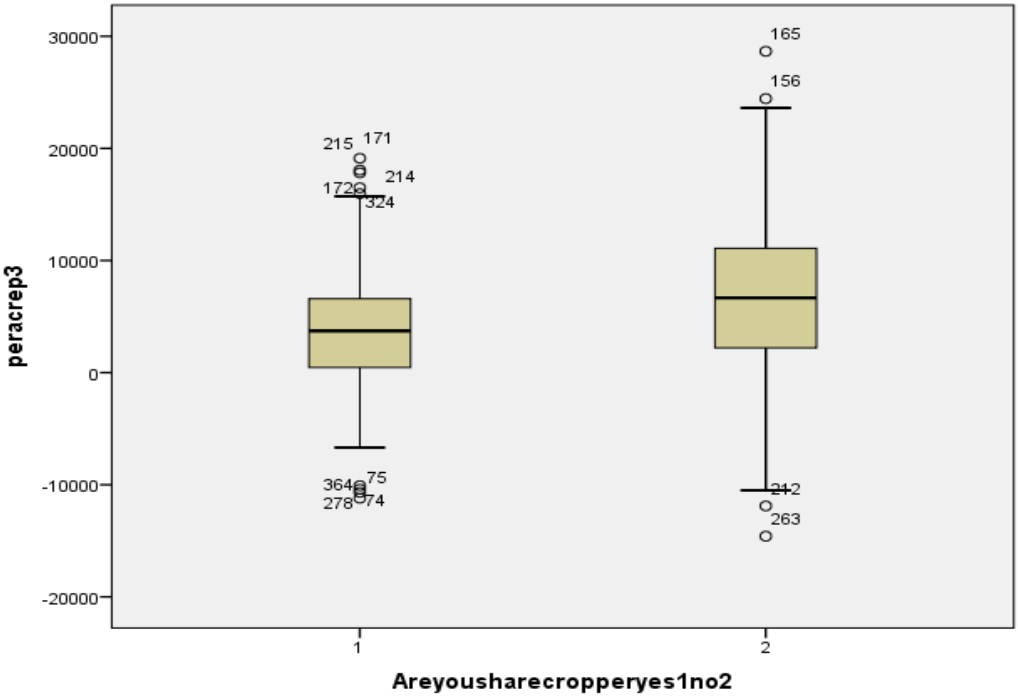
Selling point	Observation	Mean	Standard deviation	Standard error mean
Mandi	122	11388.3	5773.66	522.72
Local market	333	3103.17	5760.87	315.69
H0: $\mu_{mandi} = \mu_{local\ market}$ H1: $\mu_{mandi} \neq \mu_{local\ market}$ $\mu_{mandi} - \mu_{local\ market}$ = 8285.12 (sig= 0.000) t value- 13.582 (453)				

Source: Estimated from field survey 2021

The table 9 depicts that mean per acre profitability for farmers selling at mandi was 11388 rupees and mean per acre profit for farmers selling at local markets was 3103 rupees. The study found that the mean profit differential of 8285 rupees was significant at 1 percent level of significance. The high 't' value of 13.582 indicates significance of mean difference. So farmers selling output at mandies were receiving significantly higher profit than selling at a local market. Along with a point of sell another important variable that determined profit of farmers was share cropping.

Share cropping is observed to be an important factor affecting profitability of farmers. Some farmers were practicing both their own cultivation and share cropping. In that case, more than 50 percent of land cultivated as share cropping is considered as share cropper otherwise own cultivator. Share cropping put an extra cost burden on farmers in the form of rent. Usually, the share cultivator pays a share of output produced to the land owner as we have found in the study. As a result of this cost of a share cropper increases to a higher level ultimately affecting profitability. On the other hand procedural complexity is faced by a share cropper to sell the output at mandies. Consequently, share croppers were enforced to sell their product at a local markets at lower prices. From both cost and revenue points of view, a share cropper suffers.

Figure 2: Share cropping and per acre profit



Source: Field survey 2021

The distribution of per acre profit in two different scenarios of share cropping and non-share cropping is shown in figure 2. It is visualized from the figure that median per acre profit in case of share cropper is lower than non-share cropper. And also the range of per profit in case of share cropper is quite smaller than non-share cropper.

Table 10: Independent sample t test for profit differential with respect to share cropping

Share cropping	Observation	Mean	Standard deviation	Standard error mean
Yes	200	3443.81	5617.18	397.19
No	255	6799.87	7327.92	418.89
H0: $\mu 1 = \mu 2$ H1: $\mu 1 \neq \mu 2$ Mean (share cropper) – mean (non-share cropper) = -3356.06 (sig= 0.000) t value- -5.358 (453)				

Source: Estimated from field survey 2021

Independent sample t test for per acre profit with respect to share cropping is shown in table 10. The mean per acre profit for share cropper was 3443 rupees, while it was 6799 rupees for non-share croppers. The mean difference of 3356 rupees was statistically significant at 1 percent level of significance. The study found that farmers practicing share cropping were getting a significantly lower amounts of per acre profit than non-share croppers due to higher cost borne by them in form of rent (Das, 2012).

Conclusion

The study aimed to evaluate profitability of paddy production with respect to crop rotation and other parameters. With respect to cost of production, the study found that crop rotation affects input requirement and ultimately payment incurred for it. The revenue from production also varies with different crop rotations. Accordingly, profit per acre varies with crop rotation. The study has found that kharif- paddy rabi- pulses crop rotation is more profitable and kharif- paddy rabi- no crop rotation is least profitable. Overall the NRPRI is found to be 0.56 indicating a farmer is getting 0.56 rupees profit for every rupee invested in production. Along with crop rotation share cropping and selling point significantly affect profit from paddy production. Longer period of time comprising more crop rotations may provide a greater understanding and a clear picture of the concept. Share croppers should enjoy the freedom to sell their marketable surplus without restriction in procurement at mandie. Hassle-free and larger procurement at mandies from share croppers could enhance profitability of farmers.

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