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Research Article

Resource Utilization and Profitability of Rice Production in The Terai Region of Nepal

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Abstract

Rice is the most important staple food crops in Nepal; however, the national yield of rice is low which has led in insufficient supply and heavy annual import. So, this study assessed the profitability and resource utilization of main and spring season rice production. A Semi-structured interview schedule was administered in 2022 among 360 randomly selected main-season rice-producing farmers across three major rice producing districts of Terai region of Nepal. Similarly, it conducted four Focus Group Discussions (FGDs) to collect necessary data for spring season rice from two Terai districts within similar agro-ecological regions. Cobb-Douglas production function was used to assess the resource utilization in main season rice production. Result revealed that per hectare total cost and revenue of spring season rice production was higher with benefit-cost ratio of 1.63 as compared to main season. It is found that major resources such as the cost of seed, farm yard manure (FYM), chemical fertilizer, micronutrient and pesticides were found underused. On the other hand, the cost of labor, tillage and harvesting were found overused in the main season rice production. The proportion of the increase in rice income to the increase in costs of inputs for main season rice production was less, as indicated by the return to scale being less than unity. Hence, the study recommends to focus on addressing on prioritization to increase the cropping area under spring season rice and optimization in the use of resources supported by improved technologies to improve profitability and increase farmers' income from rice this can eases the constraints in the domestic supply of rice and thereby contribute to lowering the annual volume of rice import.

Keywords: Benefit-cost ratio, Main season rice, Profitability, Resource utilization, Spring season rice.

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Introduction

Rice (*Oryza sativa* L.) is the most widely grown crop with annual production of 513.68 million Metric Tons (MT) in the World in 2022/23 (FAO, 2023). So, it is a staple food crop for more than 50% of the world's population (Birla et al., 2017). However, the growth in the yield of rice is low to meet the increase in its global market demands These calls for a higher increment in the yield of rice to meet future food requirements or demands (Hashim et al., 2024). In Nepal, rice is the most important staple food crop contributing significantly to the national food and nutritional security. It is grown in all the three agro-ecological zones viz. Terai, Hill and Mountain. Rice was found cultivated in 1.47 million hectares (ha) with production of 5.48 million MT and a yield of 3.79 MT/ha in 2022/23 (MoALD, 2023). The contribution of rice to the national Gross Domestic Product (GDP) is 3.25% and 13.6% to the Agricultural GDP in 2022/23 (MoALD, 2023). The Terai region is termed as the ‘granary of Nepal’ as it accounts for over two-third of the country’s rice production. The main rice is cultivated from June-November and the spring season rice March - June in Nepal. The Ministry of Agriculture and Livestock Development (MoALD) / Prime Minister Agriculture Modernization Project (PMAMP) has prioritized the production of rice by creating its superzone and zone. The study selected three Terai districts viz. Jhapa, Rupandehi and Kailali where the area under rice as 92,915 ha; 63,873 ha and 72,377 ha along with production of 406,738 MT; 249,151 MT and 181,859 MT in 2021/22, respectively (MoALD, 2024). Districts are purposively selected based on their highest importance in rice production. The yield of rice in Nepal is low (3.79 MT/ha) as compared to the world’s average yield (4 MT/ha) and neighboring countries Bangladesh (4.4 MT/ha) and China (6.7 MT/ha) and similar to the yield of India (3.7 MT/ha) and Pakistan (3.5 MT/ha). The low yield of rice is mainly due to the lack of adoption of high yielding and hybrid rice varieties. Nepal is ranked at 17^{th} in production and 64^{th} in terms of yield in the world (Choudhary et al., 2022). The current rice production level is insufficient to fulfill the growing demand for rice for ensuring the food security (Gairhe et al., 2021). It has been argued that by integrating the population growth rate of the last decade (0.57% per annum) with two productivity growth rate scenarios, the country can be self- sufficient by 2040 (Timsina et al., 2023). From the period 1960 to 2017, the annual growth rate of rice yield of Nepal was low (1.14%) as compared to the neighboring countries India (2.5%), Bangladesh (3%) and China (4.2%), and the World (4.5%) (FAO, 2019). Nepal exported rice till 1982 (equivalent of US$ 16.54 million in 1982) but after that it has been importing huge amount of rice annually. Nepal’s imported of rice was US$ 625.68 million in 2022 (FAO, 2023).

The cost of production of rice in Nepal is high because of high labor-intensive nature of production and higher cost of inputs. The low profitability and lack of knowledge on using the resources optimally are the major hindrances for its wider expansion which has threatened the food security situation of the country. There is potentiality of production of rice twice in a year as main and spring season specially in lower hills and Terai region of Nepal. The yield of spring season rice is high as compared to main season due to its high photosynthetic efficiency, disease and pest free condition and cultivation in fully irrigated condition. Thus, double cropping of rice will help in increasing the annual production of rice for easing in the supply constraints to meet its the domestic demand. The optimum used of resources would help in decreasing the cost of production and increasing profitability. In this context, this study aimed to assess the resource utilization and profitability of rice production in major rice producing districts of Terai region of Nepal; the latter being the granary of Nepal.

Materials and Methods

Research Design

Study employed multistage sampling, where provinces, districts and selected major growing municipality were selected purposively, while rice growing households were selected randomly from each of the selected major rice growing municipality in the selected districts. We selected three major rice producing provinces namely Koshi, Lumbini and Sudurpaschim out of seven provinces in Nepal (Figure 1). One largest rice producing district from each of these three provinces namely, Jhapa, Rupandehi and Kailali were further purposively selected Those districts are also MoALD priority rice promotion program where PMAMP have implemented rice zone and superzone programs to increase the production and productivity. Furthermore, for primary data collection, one major rice growing municipality from each district was selected viz, Kachanakawal rural municipality of Jhapa, Suddhodhan rural municipality from Rupandehi and Joshipur rural municipality from Kailali district consultation with the agricultural officials of PMAMP, Agriculture Knowledge Center (AKC) representing provincial governments and the local government. The pretested semi-structured interview schedule was administered to 120 randomly selected main season rice producing farmers in each district due to similar population size to represent. The three study districts (Jhapa in East, Rupandehi in Central and Kailali in West) of Terai region which is considered as the repository of Nepal for rice production. Altogether, the total of 360 samples were selected from three districts for the collection of primary data during the period of February - May 2022 through face-face interview. It employed a pre-tested semi-structure interview schedule to collect the primary data for main season rice production. The two key informant interview (KII) per district were conducted to validate information obtained from the respondents during primary data collection. Likewise, four FGD in Chitwan and Bardiya districts (2 in each district), with the participation of government officers, committee members, lead farmers including small, medium and large size farmers, women farmers in 2022. Two districts were selected because of the larger cultivated area under spring season rice and similar agro-ecological regions for primary data collection. The data were analyzed using the software Statistical

Packages for Social Sciences (SPSS) for coding, then Stata for regression analysis and Microsoft Excel for benefit-cost analysis and tabulations.

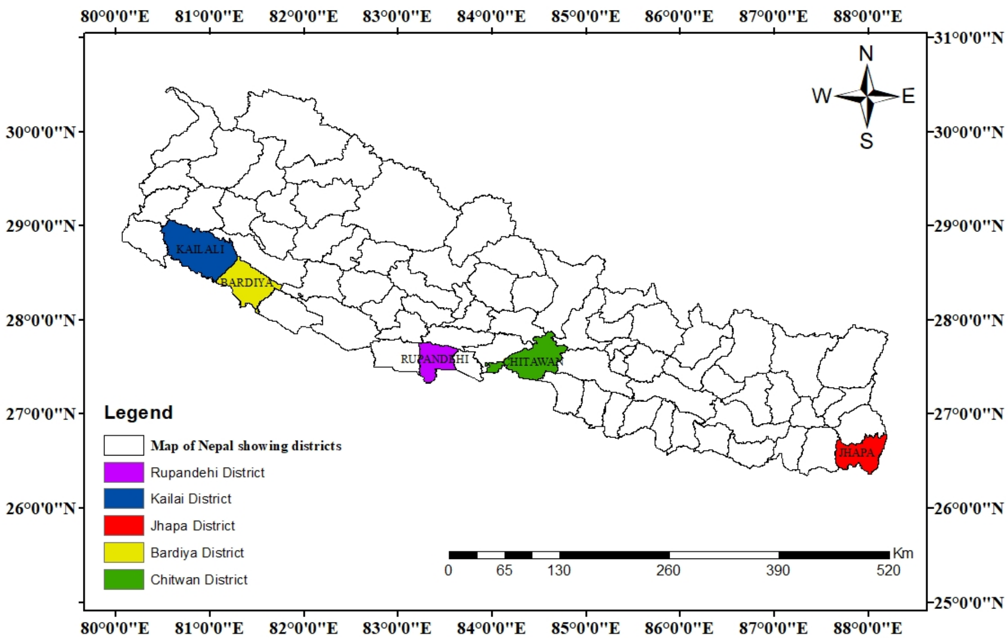

Fig. 1. Map of Nepal showing study sites

Profitability Assessment

The Benefit-Cost Analysis (BCA) is a widely used tool in the economic analysis of agricultural projects internationally (Gittinger, 1982), and rice production in Nepal (Acharya et al. 2020). Accordingly, the study employs the BCA to assess the profitability of rice production in Nepal.

Profitability assessment is done by the benefit-cost ratio (BCR) as follows:

$$Benefit - Cost\ Ratio = \frac{Gross\ Return}{Total\ Variable\ Cost}$$

Where,

Total Variable Cost (NPR) = sum of variable costs of tillage, seed, labor, FYM, chemical fertilizer and micronutrient and pesticide.

The above formula to calculate the BCR was also used in the studies by Subedi et al. 2019 and Sapkota et al. 2021.

Gross Return (NPR) = Quantity of rice produced*Price + Quantity of by-products*Price

Production Function Analysis

Cobb–Douglas (C-D) production function is one the most common and frequently used (Dhakal, 2015) technique in economics to represent the technological relationship between the various inputs used and output produced. In the CD function the coefficients represent the elasticity of respective inputs, and the summation of these coefficients provides the return to scale. The CD production function model was used to compute the efficiency ratios of inputs used in main season rice production. Natural logarithm transformation of the equation of Cobb-Douglas production function is represented as follows:

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7$$

Where, the values are in NPR on per hectare basis.

Y = Gross income from rice production

X_1 = Tillage cost

X_2 = Seed cost

X_3 = Labor cost

X_4 = FYM cost

X_5 = Chemical Fertilizer cost

X_6 = Micronutrient and pesticide cost

X_7 = Harvesting cost and

a = Intercept

The efficiency of a resource used was determined by the ratio of the Marginal Value Product (MVP) of variable input and the Marginal Factor Cost (MFC) for the input and tested for its equality to one i.e. (MVP/MFC) =1. Taking reference of Goni et al. (2007), the resource use efficiency was calculated using the formula;

r = MVP/MFC

Where,

r = Efficiency ratio,

MVP = Marginal Value Product of a variable input; MFC = Marginal Factor Cost

$MVP_i = b_i * Y/X_i$

b_i – regression coefficients

Y = Geometric mean of gross revenue of rice production

X_i = Geometric mean of i^{th} inputs

Efficiency ratio is analyzed as:

r = 1, efficient use of resource

r>1, underused of the resource

r<1, overused of the resource

Again, following (Mijindadi, 1980), the relative percentage change in MVP of each resource required to obtain optimal resource allocation, i.e. r = 1 was estimated using the equation below;

D = (1-MFC/MVP) × 100

Or D = (1-1/r) × 100

Where,

D is the absolute value of percentage change in MVP of each resource

Return to Scale Analysis

The return to scale measures the proportional response of output due to overall changes in the inputs. The sum of the coefficients (b_i) estimated from the Cobb-Douglas production function regression model provides the value of return to scale.

Return to scale (RTS) = Sum of the coefficients ($b_1 + b_2 + \cdots + b_7$)

Decision rule:

RTS > 1: Increasing return to scale

RTS = 1: Constant return to scale

RTS < 1: Decreasing return to scale.

Results and Discussion

Profitability Assessment of Spring Season Rice

Table 1 shows that the total cost of spring season improved variety as chaite 5 of rice production of two districts (Chitwan and Bardiya) was NPR 106,037 and revenue was NPR 172,500 per hectare with benefit-cost ratio 1.63. In Bardiya, the per hectare cost of spring season rice production (NPR 90,244) was found low as compared to Chitwan (NPR 121,830) district which resulted in the higher profit in Chitwan (NPR. 67,170) in comparison to Bardiya (NPR 65,755) district due to premium price of rice. The benefit-cost ratio of spring season rice production of Bardiya and Chitwan was 1.73 and 1.55 respectively. The benefit-cost ratio is a measure of the profitability of rice production, indicating that for every unit of cost incurred, there is a certain multiple of benefit (revenue).

Table 1. Cost and revenue associated with spring season rice production (NPR/ha)

Variables	Overall	Location 1	Location 2
		Bardiya	Chitwan
A. Fixed costs (FC)			
Cost on land rent, water, electricity	17,680	10,900	24,460
Depreciation cost of assets	4,390	4,150	4,630
Sub-total (A)	22,070	15,050	29,090
B. Variable costs (VC)			
Seed	2,145	2,925	1,365
Labor	16,750	12,600	20,900
Tillage	20,325	19,200	21,450
Fertilizer (FYM & Chemical Fertilizer)	25,778	19,027	32,529
Plant protection (micronutrients, pesticides)	2,175	2,300	2,050
Harvesting cost	12,773	14,900	10,646
Interest on the amount invested to cover VC	4,021	4,243	3,800
Sub-total (B)	83,968	75,195	92,740
Total Costs (A+B)	106,037	90,245	121,830
Rice production (kg)	6,125	5,500	6,750
Revenue (NPR)	172,500	156,000	189,000
Profit (NPR)	66,462	65,755	67,170
B/C ratio	1.63	1.73	1.55

Source: FGDs, 2022

Profitability Assessment of Main Season Rice Production

Table 2 presents information on the cost of main season improved variety (like sawa mansuli, ranjit, sarju 52) of rice production across three districts (n=360). The per hectare cost of tillage, seed, labor, FYM, chemical fertilizer, micronutrients and harvesting cost incurred in rice were found to be NPR 11466, 5232, 27977, 5364 10837, 1790 and 17393 respectively and the difference across district was found statistically significant at 1% level. The per hectare average total cost incurred in rice production was NPR 80,059 per hectare (Table 3). The total per hectare cost of production in Jhapa was significantly low (NPR 73,891) as compared to Kailali (NPR 76,957) and Rupandehi districts (NPR 89,330), and the difference across the district was found statistically significant at 1% level.

Table 2. The costs of main season rice production in Jhapa, Rupandehi, Kailaki Districts (NPR/ ha)

Variables	Overall (n=360)	District			f-value
		Jhapa (n=120)	Rupandehi (n=120)	Kailali (n=120)	
Tillage cost	11466 (3847.15)	12557 (3025.19)	11783 (3542.76)	10060 (4433.06)	14.224***
Seed cost	5232 (3203.75)	5414 (2020.81)	6623 (3803.67)	3660 (2817.17)	30.167***
Labor cost	27977 (5872.85)	25321 (4209.49)	28971 (5284.86)	29639 (6892.46)	20.876***
FYM cost	5364 (6531.49)	6512 (6295.17)	6772 (6837.02)	2807 (5692.06)	14.915***
Chemical fertilizer	10837 (4832.32)	7960 (3160.87)	12819 (6073.56)	11732 (3233.47)	40.821***
Micronutrient and pesticide cost	1790 (1940.31)	803 (1325.44)	2010 (2115.36)	2557 (1871.21)	29.796***
Harvesting cost	17393 (6531.63)	15324 (4909.10)	20352 (7397.12)	16503 (5994.93)	21.696***
Total Cost	80059 (15596)	73891 (11244)	89330 (16643)	76957 (13987)	40.15***

Notes: Figures in parentheses indicate standard deviation. *** indicate significant at 1 percent level.

On the relative shares of different inputs in the production of main season rice as shown in Fig.2, the total cost of labor used was maximum (35%), which is followed by harvesting (22%) and tillage cost (14%). Custom hiring centers and use of machineries were promoted in the study areas through rice superzone and zone for the reduction of labor cost. These findings were found in line with Subedi et al. (2020), who reported that the share of the cost of human labor (63.44 %) was highest in rice production in the Jhapa district. Sapkota et al. (2021) also reported high cost of labor (NPR 56,827) in rice production in the Rautahat district. Ghimire et al. (2024) reported agriculture production cost in Nepal is highly shared by labor and need to be optimized.

In line with this finding, Basnet et al. (2022) revealed that the labor cost of paddy has contributed most to the variable cost with 45.48% share in Morang, Nepal. Here, independent variables such as seed, labor and mechanical power had contributed significantly to the yield.

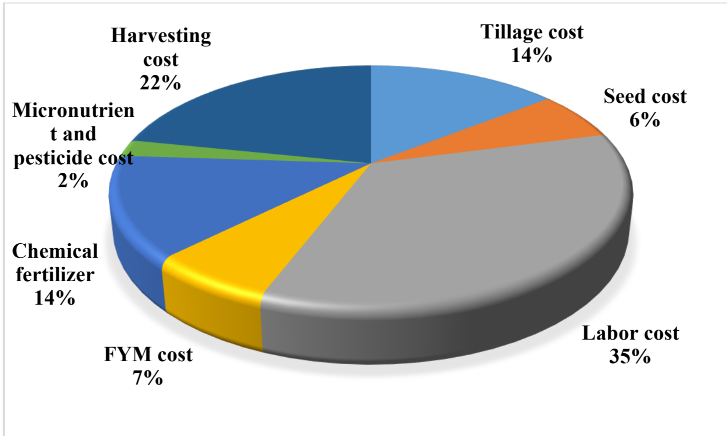

Fig. 2. Percentage share of various inputs to total cost of main season rice production

Cost, Revenue and Profitability of Main Season Rice

Table 3 provides information on the per hectare cost, revenue, and profitability of main season rice production, across three different districts. The average production of rice was 4.09 MT per hectare in the study area. The average production of rice per hectare was found low in Kailali (4.02 MT) as compared to Jhapa (4.04 MT) and Rupandehi (4.21 MT).

The total revenue of rice production was found NPR 106,660 per hectare in the study area. Rice straw was used in mushroom farming as well as animals feed in the study areas. The revenue of rice production per hectare was found low in Jhapa (NPR 96,016) as compared to Kailali (NPR 108,503) and Rupandehi (NPR 115,459). Higher revenue in Rupandehi was due to the adoption of high yielding varieties and more price received by the farmers. Adhikari (2011) reported that the average total gross returns from rice production in Chitwan was NPR 66,597 per ha. Similarly, Subedi et al. (2020) reported that the average total returns from rice production per hectare as NPR 1,04,432in Jhapa.

The per hectare profit from rice production was NPR 26,600 in the study area, which was found higher in Kailali (NPR 31,546) as compared to Jhapa and Rupandehi. Subedi et al. (2020) also revealed that the rice production was profitable in the Jhapa.

Table 3. Assessment of profitability of main season rice production (NPR, hectare)

Variables	Overall	District			F-value
		Jhapa	Rupandehi	Kailali	
Total cost	80059 (15596)	73891 (11244)	89330 (16643)	76957 (13987)	40.15***
Paddy production (MT)	4.09 (0.58)	4.04 (0.59)	4.21 (0.56)	4.02 (0.56)	4.34**
Straw production (kg)	5897 (5264)	6341 (4026)	4599 (3681)	6750 (7155)	5.81***
Total revenue (NPR)	106660 (18024)	96016 (13664)	115459 (17494)	108503 (17073)	44.56***
Profit (NPR)	26600 (15005)	22126 (11034)	26129 (13855)	31546 (17902)	12.69***
BC ratio	1.36 (0.23)	1.31 (0.17)	1.32 (0.20)	1.44 (0.28)	13.54***

Notes: Figures in parentheses indicate standard deviation. *** and ** indicate significant at 1 and 5 percent level of significance respectively.

The per kg cost of rice production was found NPR 19.57 and the price was NPR 24.63 which resulted in the B/C ratio of 1.36 in the study area (Table 3). This indicated that one rupee spent on rice production yields 36 paisa as net-benefits from rice production and, thus, the rice production has been profitable in the study area. The B/C ratio in Kailali district is higher (1.44) than Jhapa (1.31) and Rupandehi district (1.32). It is also found that the B/C ratio of main season rice (1.36) is very low as compared to the spring season (1.62) rice in the study areas. The reason for the lower B/C ratio is due to increase in costs of labor, lack of high-yielding varieties and improved technologies. In line with this finding, the benefit-cost ratio of rice production has been reported as 1.9 in the eastern region and as 1.8 in the country (Joshi et al., 2011). Sapkota et al. (2021) further reported the benefit-cost ratio 1.11 in rice production at Rautahat district of Nepal.

Production Function Analysis

The calculation F value (36.21) was statistically significant at 1% level which showed that the model has good explanatory power. The value of the coefficient of determination (R^2) indicated that about 40.7% of the variations in the dependent variables were elucidated by the explanatory variables in the model (Table 4). Keeping all other factor constant, it is found that an 1% increase in the cost of seed and tillage would increase the total income by 0.072 and 0.032% respectively; these are significant at 1 and 10% level of significance respectively. Similarly, an increase in expenditure on FYM by 1% would increase the total income by 0.003% which was statistically significant at 1% level. Likewise, increase in expenditure on chemical fertilizer by 1% would increase the total income by 0.14% which was statistically significant at 1% level. Similarly, an 1% increase in the cost of human labor would increase the income from rice production by 0.071%; the increment was found statistically significant at 5% level. Further an 1% increase in the expenditure on micronutrient and pesticides increase the total income by 0.005% from rice production. Likewise, the result revealed that an 1% increase in the cost of harvesting increase the total income by 0.067% which was significant at 1% level.

Similar to this finding, Sapkota et al. (2021) revealed that human labor, tillage, FYM, chemical and pesticides and irrigation positively correlate with income while the other cost (mainly transportation costs) negatively affect the total income from rice production in Rautahat, Nepal. Subedi et al. (2020) reported that rice production was profitable in Jhapa, Nepal. Likewise, Rahaman et al. (2022) shows that rice is a profitable enterprise in the haor areas of Bhangladesh. Bwala and John (2018) reported that rice production in Bida Agricultural Zone of Niger State, Nigeria is profitable. Basnet et al. (2022) reported that the BC ratio of paddy as 1.66 indicates that it is a profitable enterprise.

Estimation of Resources Use Efficiency

The estimated Marginal Value Product (MVP) and efficiency ratios of different inputs used in rice production are presented in Table 4. The efficiency ratio of the inputs such as the seed (3.82), FYM (85.14), chemical fertilizers (1.50) and micronutrient cum pesticides (180.26) are found as greater than unity, which indicate the underused of these resources. On the other hand, the efficiency ratios of tillage (0.31), human labor (0.27) and harvesting (0.03) are less than unity, which indicate the overused of these resources. Thus, this implies that the resources used in the rice production are not optimally used.

For the optimal allocation of resources, the cost of seed, FYM, chemical fertilizers, and micronutrient cum pesticides need to be increased by 40.64, 98.83, 33.40 and 99.45 percent, respectively. On the other hand, the costs of tillage, human labor and harvesting should be decreased by 218.77, 266.60 and 2963.68 percent, respectively (Table 4). This shows the opportunity for re-adjustment such as use of more seeds by buying improved seeds for high productivity. Likewise, the farmers should increase the dose, quantity and quality of chemical fertilizers, micronutrient cum pesticides as per the estimates of resource use efficiency.

Likewise, the cost of human labor and harvesting can be decreased by introducing low-cost technologies. This is because the mechanization for the tillage can be decreased by adopting minimum tillage technologies, and other low-cost technologies. Ghimire and Dhakal (2014) and Danso-Abbeam et al. (2015) found that human labor was overused in their studies, which was in consistent with the results of this study.

Table 4. Estimation of efficiency ratios of inputs used in main season rice production

Variables	Coefficient	Std. error	t-value	MVP	MFC	r	D	Status
Ln tillage cost	0.032*	0.019	1.69	0.314	1	0.314	218.77	OU
Ln seed cost	0.072***	0.013	5.60	1.685	1	1.685	40.64	UU
Ln FYM cost	0.003***	0.001	3.59	85.141	1	85.141	98.83	UU
Ln Chemical fertilizer cost	0.140***	0.016	8.58	1.501	1	1.501	33.40	UU
Ln Labor cost	0.071**	0.034	2.05	0.273	1	0.273	266.60	OU
Ln Micronutrient and pesticide cost	0.005***	0.001	4.45	180.259	1	180.259	99.45	UU
Ln Harvesting cost	0.067***	0.018	3.76	0.033	1	0.033	2963.68	OU
Constant	7.980***	0.436	18.29					
Observations	360							
F-value (7, 352)	36.21***							
Prob>F	0.001							
R-square	0.419							
Adj. R-squared	0.407							
Return to scale	0.390							

Notes: ***, ** and * indicate significant at 1, 5 and 10 percent level of significance respectively. OU = Overused; UU = Underused

Return to Scale Analysis

The return to scale (sum of the regression coefficients of all the inputs) of main season rice production was found as 0.39. This indicates the decreasing return to scale in the production of paddy-rice. The additional proportion of output is smaller than the additional input employed. Subedi et al. (2020) reported that the coefficient for return to scale in rice production was 0.86 in Jhapa district. Likewise, Daniel et al. (2019) reported that the decreasing return to scale in rice production with a coefficient of 0.51 in Nigeria. The implication of decreasing-returns-scale in this study implies that the farmers can still increase the level of output at the current level of resources if they re-allocate the uses of resources in optimal combinations. Poudel et al. (2021) reported that the coefficient for the return to scale for of rice was 0.56 which means decreasing return to scale in Gorkha Nepal.

Conclusion

Study has found that inputs used such as the seeds, FYM, chemical fertilizer, micronutrients and pesticides are found underused in the main season rice production, on the other hand, inputs such as labor, tillage and harvesting were found overused. It means that the resources among different inputs were far from being optimally allocated in main season rice. For the optimum allocation of resources in main season rice production, the cost of seed, FYM, chemical fertilizers and micronutrient cum pesticides need to be increased whereas the cost of tillage, human labor and harvesting should be decreased. Thus, if one can ensure a balanced use of resources, the main season rice production could be increased economically, and it can be commercially more viable and also augment the food supply in the economy. It is found that main season rice production has decreasing returns to scale, which implies that the proportional increase in rice income would be lesser than the proportional increase in costs of all inputs taken together. Profitability of spring season rice are much better than the main season rice. Thus, the policymakers and farmers should focus on increasing the cropping area for spring season rice production; it offers huge scope to augment the supply of rice to meet the high domestic demand for rice in Nepal. To increase the profitability and raise the income of farmers from rice production, the major priority areas could be farmers' knowledge about optimum utilization of resources and adoption of improved technologies including increased use of inputs. With such measures, Nepal can still boost domestic supply of rice towards self-reliance in the food market.

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