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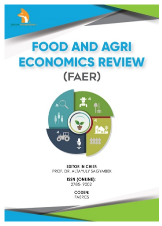

RESEARCH ARTICLE

AN ECONOMIC ANALYSIS OF RICE PRODUCTION IN RAUTAHAT DISTRICT OF NEPAL

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ABSTRACT

Study was conducted to analyze the production economics, socioeconomic status, potential and problems of rice in Rautahat district. Total 80 farmers were selected by simple random sampling method. Respondents were categorized into small and large scale based on the average land holding under rice cultivation. Result of socio demographic characters showed that the average household size and area under rice cultivation was 7.3 and 35.44 Katha respectively. Human labor was the major input used along with others viz. seed, tillage, FYM and chemical fertilizer and pesticides, irrigation in both large and small farms. The production per household (kg) and productivity (t/ha) were 4458.965 kg, 3.64t/ha respectively and there was significant difference in production (kg) per household between small scale farms (1811 kg) and large scale farms (7863.4 kg). The total average cost, gross revenue and gross margin per hectare were estimated as NPR.108214.79, NPR.120227.04 and NPR.12012.25 respectively. The average benefit cost ratio was 1.11. Cobb Douglas production function presented the inputs; human labor, tillage, FYM chemical and pesticides and irrigation were found to have positive relationship with income while other cost (mainly transportation cost) was found to have negative relation with the total income. The return to scale value was computed to be 0.96 indicating decreasing return to scale in rice production in Rautahat district. Therefore, the findings suggest that, the production and income can be maximized by efficiently solving problems of quality inputs and others mentioned.

KEYWORDS

Constraints, Economy, Productivity, Rice.

1. INTRODUCTION

1.1 Background information

"The rice *(Oryza sativa*) is edible starchy cereal grain belonging to the grass family Poaceae. Oryza sativa, the most important commercial species of rice is differentiated into three sub species: Indica, Japonica and Javanica based on their commercial production zones (CDD, 2015). Rice is the largest crop industry of South Asia including Nepal playing significant role in economic and agricultural development as well as in reducing poverty (Gumma, Gauchan, Nelson, Pandey, & Rala, 2011). As an important subsector, Rice is the most important crop in Nepal and accounts for about 50 percent of the total agricultural area and production in the country. Rice contributes approximately one-fourth of GDP and more than 75 percent of the working population is engaged in rice farming for at least six months of the year (pokhrel, n.d.). It is the most important staple food of Nepalese people supplying about 40% of the food calorie intake and contributes nearly 20% to the agricultural gross domestic product (AGDP) and almost 7% to GDP (CDD, 2015). Farmers traditionally flood rice paddies throughout the growing season - a practice known as continuous flooding - providing ideal conditions for microbes that produce large amounts of methane (CCAC, 2014). The optimum temperature for the normal development of rice plant ranges from 27 ^{0}C to 32 ^{0}C (Rathnayake, De Silva, & Dayawansa, 2016). Both higher maximum and higher minimum temperatures with high relative humidity decrease rice yields due to spikelet sterility (Rathnayake, De Silva, & Dayawansa, 2016). The Intergovernmental Panel on Climate Change (IPCC) estimates for 2050 showed that changing rainfall patterns and increasing temperature, along with flooding, droughts and salinity, will possibly decline rice and wheat production (Rahman, Kang, Nagabhatla, & Macnee, 2017). Rautahat is one of the potential districts for rice production; PM-AMP has selected Garuda municipality as the rice block in Rautahat district. The area of cultivation, production and productivity shows the increasing trend from the fiscal year (2074/75) in case of Rautahat district of Nepal (AKC, Rautahat). The soil type consists of alluvial soil. Total cost of paddy was 71132.3 among which fixed cost was 269.1 and 70863.2 as the variable cost whereas net profit was 8015.7 according to the data obtained in 2013/2014 (Bhandari, Bhattarai, & Aryal, 2014/2015).

South Asia has the largest food-insecure population in the world, and in several farming systems in the region, rice is the most important staple crop (John & Fielding, 2014). The difference between consumer's price and farmers' price is high in food commodities especially in the areas where inefficient marketing services and higher entrepreneurs profit exist (Shrestha, 2012). The food security situation has also not been satisfactory. The Global Hunger Index, which is a multidimensional approach to measuring hunger, ranked Nepal as 44 out of 76 countries in 2014 (MOAD, Agriculture Development Strategy (ADS), 2016). If South Asian farmers can improve farm productivity, increase resource-use efficiency, diversify their crops and gain better market access, then the

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livelihoods, nutrition, and income of millions of smallholder farmers and their families could be improved substantially (IRRI). The average economic, allocative, technical, pure technical and scale inefficiencies of rice farmers were 34%, 13%, 24%, 18%, and 7% respectively (Dhunganaa, Nuthal, & Nartea, 2014). Paddy grain discoloration disease is an emerging threat which degrades the grain texture and quality. In the case of unpredictable climatic conditions across different ecological zones, severity of the disease also ranges from minor to major. The shape and size of the grain are affected by grain discoloration which further leads to a significant lower yield of the crop (Chhabra & Vij, 2019)

The Terai region of Nepal is considered the granary of the country and it accounted for about 70 percent of the country's rice output, while the hills produces 26 percent and the mountain about 4 percent (CDD, 2015). Cereals are the main staple food of Nepal however; their production is dropped by 9% since last census (NPC, 2012). It has been estimated that by the year 2025, the world's farmers should produce about 60% more rice than at present to meet the food demands of the expected world population at that time (Fageria, 2007). Asia is home to 60% of the world's population and about 92 % of global rice is grown and consumed in Asian region (Singh, 1997). About 104 kg of milled rice is available per year per person in Nepal (MoAD, 2012). It is reported that Nepal imported food grains worth 30 billion during the first ten month of last fiscal year, which is five-fold increase on the corresponding Figure from a year earlier (Kaini, 2016).

The status of area, production and productivity of rice indicates that area, production and productivity is not following a systematic pattern. The status of rice sub sector stated that the cultivated area, Production and Productivity followed increasing and decreasing trend from the fiscal year 2009/10 to 2017/18. The area, production and yield of paddy has increased from fiscal year 2009/10 to 2011/12 while it has decreased in the year 2012/13 and again it followed the increasing pattern in the fiscal year 2013/14. The pattern followed the decreasing trend upto 2015/16 from fiscal year 2013/14. Although paddy cultivated in less area in fiscal year 2017/18 and less production than the fiscal year 2016/17, the yield was found to be higher than 2016/17 that is 3.5 mt/ha (MOALD, 2020). Terai region, hilly region and Himalayan region of Nepal consists of 34019, 61345, 51817 square kilometer area respectively (MOALD, 2020). APP has formulated terai development strategy as an essentially input-driven food grain strategy in that foodgrains will be the predominant commodities produced in this region. The prioritized productivity package for the terai has thus been designed around this basic concern. The terai region has good potential and comparative advantage in producing food grains in achieving national food grain self-sufficiency (APROSC, 1995). The Agriculture Perspective Plan (APP) was formulated in 1995 with a view to launching the agricultural sector of Nepal into a sustainable high growth path (APROSC, 1995). The area, production and productivity again increased from 2017/18 to 2018/19.

Table 1: Statistics of Rice in terms of Area, Production and Productivity (2008/2009-2018/2019) of Nepal

Year	Area(ha)	Production (Mt)	Productivity (Mt/ha)
2008/2009	1555940	4523693	2.90
2009/2010	1481289	4023823	2.7
2010/2011	1496497	4460278	2.98
2011/2012	1531493	5072248	3.31
2012/2013	1420570	4504503	3.17
2013/2014	1486951	5047047	3.39
2014/2015	1425346	4788612	3.35
2015/2016	1362908	4299079	3.15
2016/2017	1552469	5230327	3.37
2017/2018	1469545	5151925	3.51
2018/2019	1491744	5610011	3.76

Source: Adapted from Ministry of Agriculture and Livestock Development (2020).

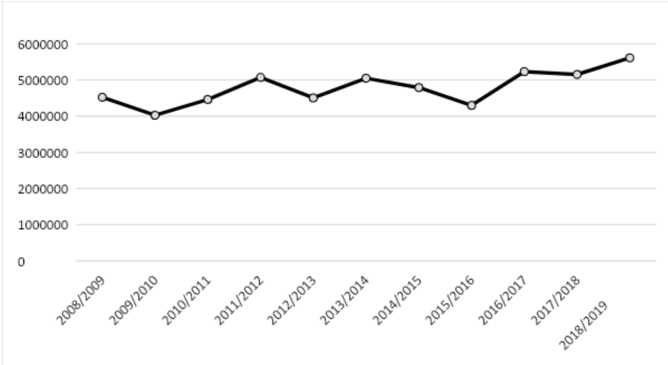

Figure 1: Rice production trend of Nepal, 2008/2009-2018/19 (MOALD, 2020)

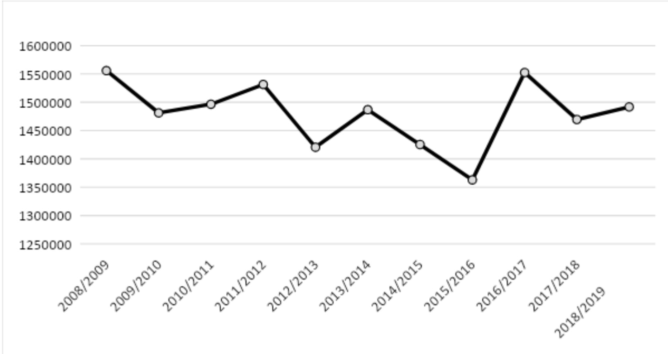

Figure 2: Rice production area of Nepal, 2008/2009-2018/19 (MOALD, 2020)

The area of cultivation, production and productivity shows the increasing trend from the fiscal year (2074/75) in case of Rautahat district of Nepal (AKC, Rautahat). The area, production and productivity of irrigated rice in Rautahat district of Nepal in the fiscal year 2074/75 are 18000 ha, 59400 mt and 3.3 mt per ha respectively. It is followed by the increasing trend in all the area, production and productivity as 20000 ha, 68000 mt and 3.4 mt/ha respectively in the fiscal year 2075/2076 (AKC, Rautahat). Similarly, in the fiscal year 2076/77, the area of cultivation was 22750 ha, with the production of 84175 mt giving the average productivity of 3.7 mt/ha (AKC, Rautahat). Very less are was under Summer rice cultivation in the fiscal year 2074/5, 2075/76, 2076/77 giving the average production of 1815 mt, 2070 mt, and 1000 mt respectively which resulted in less productivity of 2.2, 2.3 and 2.7 mt/ha during the fiscal year 2074/5, 2075/76, 2076/77 respectively (AKC, Rautahat). The less productivity might be due to lack of proper irrigation, diseases and pests, lack of availability of inputs in required time and quantity. The reason behind lower productivity might also be due to use of local seed variety and improper agronomic practices. Most of the farmer on Rautahat are not ready to use improved technology on rice production.

Table 2: Statistics of Rice in terms of Area, Production and Productivity (2008/2009-2018/2019) of Province 2

Province 2	Area	Production	Productivity
Saptari	71558	248231	3.47
Siraha	66235	221472	3.34
Dhanusa	102872	377631	3.67
Mahottari	74138	235794	3.18
Sarlahi	83163	284528	3.42
Rautahat	57986	199460	3.44
Bara	100391	386629	3.85
Parsa	73120	287502	3.93

Source: MOALD, 2020

Thus, lowest productivity is of Mahottari district (3.18) and highest productivity is of Parsa district (3.93) in province 2 of Nepal during the fiscal year 2075/76. The productivity of Rautahat during the fiscal year 2075/76 is 3.44mt/ha (MOALD, 2020).

Rice being a major cereal crop is also acting as a way of life. It contributes about 40 to 70 percent of the population total calorie intake. To secure food and nutritional security, sustained production and increased productivity of rice is critical (FAO Regional Office for Asia and the Pacific, n.d.). Rice ranks the first among cereal crops in Nepal in terms of area, production and livelihood (CDD, 2015)

The average total cost per hectare was found to be NPR. 102658.67 with average total cost of NPR. 102658.67 in small scale farm and NPR. 84936.54 in large scale farm in the study of Economics of Rice production in Pyuthan district of Nepal (Bhusal, Karn, Jha, & Ojha, 2020). Similarly, the average cost for agronomic operations (seed bed preparation, land preparation, transplanting, weeding, harvesting, threshing) was found to be NPR. 2694.78 which contributed the major cost of production (Bhusal, Karn, Jha, & Ojha, 2020). Total returns from rice per hectare was found to be NPR. 143049 with grain as the major contribution to the returns in rice production. The average gross profit per hectare was NPR. 48239.38 and benefit cost ratio was found to be 1.51. The B:C ratio was found greater in large farmers compared to small farmers (Bhusal, Karn, Jha, & Ojha, 2020). The results from the profitability analysis of paddy production from Niger state in Nigeria revealed cost of labor to account for the largest portion (54.0%) of the total variable cost (Bwala & John, 2018). It was also revealed the variable cost per hectare for rice production to be $126,100 per production cycle, while total revenue of $227,500 was realized by the respondents. The gross profit ratio was calculated to be 0.45 (Bwala & John, 2018). The average productivity of organic rice production on the basis of research conducted in Chitwan was found 3.15 Mt/ha. The B:C ratio of organic rice production was found to be 1.15 (Adhikari, 2013). The profitability differs among different size farmers' group and large farmers are more profitable in rice cultivation than small and medium farmers (Akter, Parvin, Mila, & Nahar, 2019). The use of high yielding crop varieties facilitates the growth of agroprocessing enterprises and non-farm sector and stimulates the transition from subsistence agriculture to high productivity agro-industrial economy (Just & Zilberman, 1988). Therefore, increasing rice productivity and production is crucial to ensure food security.

1.2 Statement of the Problem

Although Terai region of Nepal is called food basket of Nepal, insufficient production and low productivity of rice has resulted serious problem in food security due to increasing population as the demand and supply are not proportional to each other. Huge gap exists between the potential yield of rice varieties having 6.7t/ha (on station experimental yield), attainable yield 5.2t/ha (on farm yield with improved seed) and national yield 2.6t/ha in Rautahat district (MoALD, 2019). There are various problems in production of rice in Rautahat viz. insufficient and untimely supply of quality seeds and fertilizers, poor drainage and irrigation, labor shortage, incidence of diseases (blast, false smut), pests like American armyworm, and also the inefficient marketing and pricing system. Rapid increase in price of inputs like fertilizer, labor, seed, irrigation along with labor migration has resulted negative impacts in rice production. The increasing trend of buying processed form of rice from neighboring country like India has resulted in marketing problems to the majority rice farmers. As farmers are not capable of applying scientific farming practices in their farms, it has resulted in poorer quality and low production.

1.3 Rationale of the study

Rautahat district, inspite of having high potentiality for rice production, there has not been enough rice production as per its actual potentiality and productivity due to which farmers are discouraged to invest and adopt good agriculture practices. It is therefore utmost necessity to conduct local survey and research to generate ideas and disseminate knowledge and technology. Thus, overall scenario of rice is not found what it needs to be and farmers are always trapped in the vicious cycle of poverty. It is therefore necessary to conduct local research to generate and disseminate knowledge on economics of rice production in Rautahat. Thus, study of economics of rice production of in Rautahat district might be good approach in order to assess various factors and existing bottleneck and solving them in an effective way. The concerned stakeholders can plan and act in a package in holistic manner for overall benefit. This study is believed to be a very basis of planning and extension for the authorities like PMAMP, Ministry of Agriculture and Livestock Development, and other GOs, NGOs, INGOs, institutions and other concerned stakeholders so as to develop and implement the programs that would help improve the income and livelihood of rice farmers of study area.

1.4 Objectives

1.4.1 General Objective

To assess and analyze the economics of rice production in Rautahat district of Nepal

1.4.2 Specific Objectives

- To find out the production and productivity of rice in Rautahat district
- To determine the benefit cost ratio and gross margin of rice production in Rautahat district
- To determine the factors affecting rice production and estimate returns to scale of rice production in the site of study
- To know about constraints of rice production in the site of study

2. METHODOLOGY

A list of Rice growing farmers from Garuda municipality of Rautahat district was prepared separately. The study was carried out in Garuda municipality of Rautahat district. A sample size of 60 is generally regarded as the minimum requirement for larger population that yields a sufficient level of certainty for decision-making (Poate & Daplyn, 1993). A total of 80 rice farming households were selected from the municipality by simple random sampling method. Thus, total number of sample size was 80 and the respondents were categorized into small scale and large scale farm holders on the basis of average area under rice cultivation.

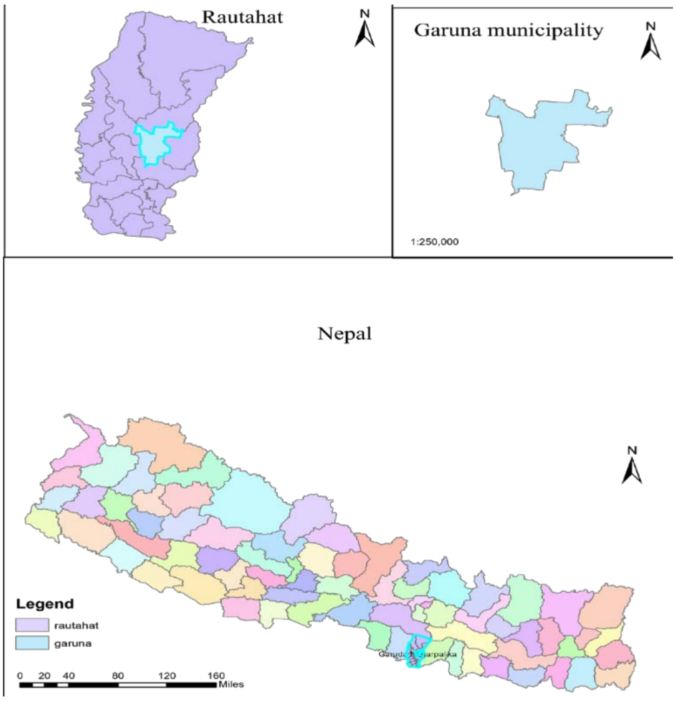

Figure 3: Map of Nepal showing study area in Rautahat district.

Pre survey field visits were conducted to gather preliminary information regarding the demographic, socio-cultural, and topographical settings of the site. This information was used in preparing questionnaires and designing a sampling framework. Pre - testing of interview schedule was done by administering the designed interview schedule to the 16 households around the study area. The final interview schedule was prepared by taking due consideration of the suggestions obtained during the pre- testing. The pre-tested interview schedule was administered to the respondent to collect the primary data on socio-demographic information, prevailing production practices, cost and return of production and others by carrying out the household survey. Similarly, to get the better picture of information regarding the various aspects of rice production face to face interviews and Key Informant's Interviews (KII) with rice block staffs, AKC officers, local traders and progressive farmers were conducted. Focus Group Discussions (FGD) were conducted in the study area. In the FGD, participants were local farmers along with other stakeholders. The secondary data were collected from various books, national reports and publications, reports of different NGOs and INGOs, web, published articles, etc. The statistical packages for social science (SPSS), Stata and Microsoft Excel were used for necessary qualitative and quantitative analysis of data. Descriptive statistics like average, percentage, standard deviation, charts and diagrams were estimated from the socio-demographic and economic data.

Qualitative data were taken into account to prepare the index. On the basis of responded frequencies, weighted indexes were calculated for the analysis of farmer's perception on the extent of production problems. Farmer's perception to the different production problems were ranked by using six points scales. Then the priority index was calculated by weight age average mean in order to draw valid conclusion. The index of importance was computed by using the formula:

$$I_{imp} = \sum \frac{Sifi}{N}$$

Where,

I_{imp} = index of importance

$\sum$ = summation

S_i = I^{th} scale value

F_i = frequency of i^{th} importance given by the respondents

N = total number of respondents

Benefit cost ratio, production, productivity, profitability, gross margin was calculated and analyzed. Similarly, Cobb-Douglas Production Function (CPDF) regression was carried out to find out the technological relationship between the factors used and gross revenue generated from rice production. Gross margin of the producer for a particular enterprise is the difference between the gross revenue earned and the total variable cost incurred. Gross margin is calculated as:

Gross margin= Gross revenue - Total variable cost where, (Bwala & John, 2018) also used this formula during the Profitability analysis of paddy production

Gross revenue= Price of rice × Total rice production

Total variable cost = Summation of all the variable costs

Variable costs = Cost of human labor, cost of seed, FYM and chemical fertilizers and pesticides, tillage cost, irrigation cost, others cost

Benefit-cost ratio was calculated using formula:

Benefit cost ratio(B:C) = Gross revenue/ Total variable cost

Rice being a short duration crop, only the variable cost was considered to calculate the cost of production (Adhikari, 2013).

The Cobb Douglas production function was used to estimate and analyze the technological relationship among the different inputs of production and output produced i.e. total income. Cobb Douglas production function is a mathematical representation of the relationship between capital, labor, and output (Biddle, 2012). Cobb Douglas production function is one of the common and frequently used economic function (Bajracharya & Sapkota, 2017). The regression coefficients represent the elasticity of respective inputs, and its sum gives the return to scale value.

The form of CPDF used in this study is as follows:

Y= aX1b1X2b2 X3b3 X4b4 X5b5 X6b6eµ

Where Y is the total income from rice production (NPR /ha), X_1 cost of seed (NPR. /ha), X_2 cost of labor (NPR. /ha), X_3 cost of tillage (NPR. /ha), X_4 cost of FYM and chemical fertilizer and pesticides (NPR. /ha), X_5 cost of irrigation (NPR. /ha), and X_6 other cost (NPR. /ha), e base of natural logarithm and b_1, b_2, b_3, b_4, b_5, b_6 are the regression coefficients to be determined.

Above mentioned equation was linearized in a logarithmic function for convenience during computation, which was then expressed as,

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

Where, ln = natural logarithm, a = constant and μ = error term/ random disturbance term.

Human labor cost was calculated by quantifying the total requirement of human labor from pre-cultivation to post cultivation activities of rice production namely seed bed preparation, field preparation, transplanting, weeding, fertilizer application, pesticide application, harvesting and threshing activities etc.

Return to scale indicates the response of output for the proportional change in inputs of any production activity. Returns to scale is a term that refers to the proportionality of changes in output after the amounts of all inputs in production have been changed by the same factor It was obtained by summing up the regression coefficients of respective inputs from CPDF regression analysis.

3. Results and Discussion

The information collected from the study area was analyzed as per objective using proper statistical tool like MS- Excel and SPSS and the results have been presented in this section.

3.1 Socioeconomic and farm characteristics

Information regarding the socio-economic and farm characteristics like age of respondents, sex, occupation, educational status, family size, land holding, rice cultivated land collected from the study is discussed briefly here.

3.1.1 Age of the respondents

The age of the respondents was classified into three categories i.e. Less than 35 years (ii) 35-55 years and (iii) Above 55 years. The study has revealed that majority of the respondents in study area were between the age group 35-55 years (71.25%), (45%) small scale and (26.25%) large scale followed by above 55 years (16.25%) and less than 35 years (12.5%). The mean and standard deviation of the age of the overall respondents in the study area were 45.5 years and 10.12 years respectively.

Table 3: Distribution of age of respondents by farm category in the study area

Age groups of the respondents	Small scale	Large scale	Total
Less than 35	3(3.75)	7(8.75)	10(12.5)
Between 35-55	36(45)	21(26.25)	57(71.25)
Above55	6(7.5)	7(8.75)	13(16.25)
Mean	46.02	44.83	45.5
Standard deviation	9.928	10.48	10.12

Note: Figures in parentheses indicates percentage of total cases

Source: Field Survey, 2020

3.1.2 Sex of the respondents

The study revealed that majority of the respondents were male (91.25%) with (47.5%) in small scale, (4.75%) in large scale and (8.75%) of the respondents were female (8.75%) only in small scale in the study area (Table 2).

Table 4: Distribution of sex of respondents by farm category in the study area

Sex of the respondents	Small scale	Large scale	Total
Male	38(47.5)	35(43.75)	73(91.25)
Female	7(8.75)	0(0)	7(8.75)

Note: Figures in parentheses indicates percentage of total cases

Source: Field Survey, 2020

3.1.3 Educational status of the respondents

Education is one of the important factors for socio-economic and cultural changes in society. It is one of the responsible factors in level of adoption of the technology. From the Figure below, it is evident that minimum respondents (5%) had primary level of education (3.75%) in small scale, (1.25%) in large scale and maximum number of respondents (43.75%) with (21.25%) in small scale and (22.5%) in large scale had secondary level of education.

Table 5: Distribution of respondents by farm category on the basis of educational status in the study area

Educational status	Small scale	Large scale	Total
Higher secondary	6(7.5)	5(6.25)	11(13.75)
Illiterate	7(8.75)	0(0)	7(8.75)
Lower secondary	6(7.5)	2(2.5)	8(10)
University	6(7.5)	9(11.25)	15(18.75)
Primary	3(3.75)	1(1.25)	4(5)
Secondary	17(21.25)	18(22.5)	35(43.75)

Source: Field Survey, 2020

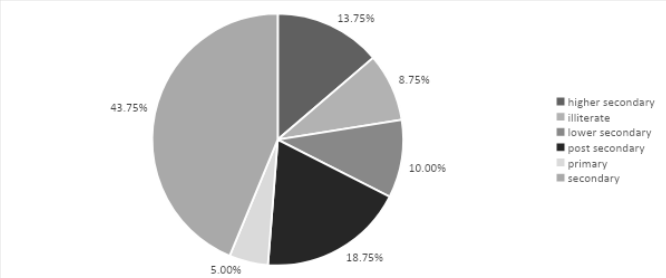

Figure 4: Educational status of the respondents in the study area

Source: Field Survey, 2020

3.1.4 Occupation of the respondents

The study revealed that majority of the respondents (88.75)% major occupation is agriculture with (47.5%) in small scale and (41.25%) in large scale followed by business (6.25%) and minimum respondents (5%), (3.75%) in small scale and (1.25%) in large scale has service as their major occupation. Also, it was found that all the respondents are involved in agriculture.

Table 6: Distribution of respondents by farm category on the basis of major occupation in the study area

Major occupation of the respondent	Small scale	Large scale	Total
Agriculture	38(47.5)	33(41.25)	71(88.75)
Business	4(5)	1(1.25)	5(6.25)
Service	3(3.75)	1(1.25)	4(5)

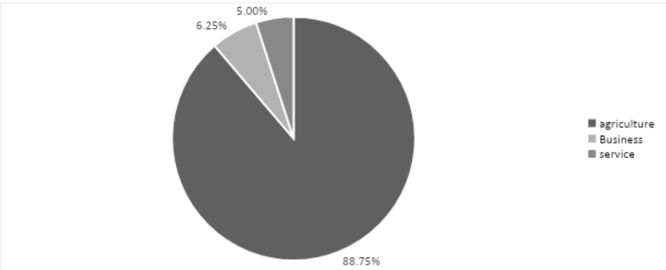

Figure 5: Primary Occupation of the respondents in the study area

Source: Field Survey, 2020

3.1.5 Castes/Ethnicity of the respondents

In the study area, the respondents were found to be belonging to different castes, namely- Brahmins, Chhetri, and Madhesi and Janjati. Majority of the respondents were Madhesi (81.25%) with (45%) in small scale and (36.25%) in large scale followed by Janjati (8.75%), Brahmin (6.25%) and minimum respondents belonged to Chhetri (3.75%), (3.75%) in small scale and (0%) in large scale. From this, we can conclude that the major portion of the area was covered by the Madhesi society.

Table 7: Distribution of respondents by farm category on the basis of Castes/Ethnicity of respondents in the study area

Ethnicity	Small scale	Large scale	Total
Madhesi	36(45)	29(36.25)	65(81.25)
Janjati	5(6.25)	2(2.5)	7(8.75)
Brahmin	1(1.25)	4(5)	5(6.25)
Chhetri	3(3.75)	0(0)	3(3.75)

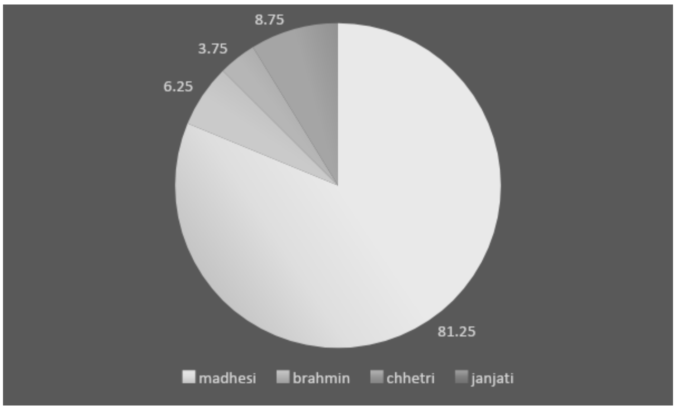

Figure 6: Castes/Ethnicity of the respondents in the study area

Source: Field Survey, 2020

3.1.6 Land holding and rice cultivated land

3.1.6.1 Total owned land

Land, labor and capital are the major factors for the cost of production. Table 5 shows that majority of the respondents (73.75%) had total land between 1-60 Katha i.e. below 2 hectare. (20%) of the respondent had total land between 2-4 hectare. Similarly, (6.25%) had land above 4 hectare. The average land holding of the respondents was 43.59 Katha while standard deviation was calculated 43.94 Katha

Table 8: Land holding status of the respondents in the study area

Total land holding in hectare	Frequency
< 2 hectare	59(73.75%)
2-4 hectare	16(20.0%)
> 4 hectare	5(6.25%)

Source: Field Survey, 2020

3.1.6.2 Rice cultivated land

It was found that, (56.25%) of the respondents had their area under rice in area less than (35.44 Katha) and remaining (43.75%) of the respondents had greater than (35.44 Katha) as their area under rice cultivation.

Table 9: Area under rice farming of the respondents in the study area

Area under rice farming	frequency
Small scale farming (<35.44 Katha)	45 (56.25%)
Large scale farming (>35.44 Katha)	35 (43.75%)

Source: Field Survey, 2020

3.2 Irrigation system used by respondents

In the study conducted, it was found that majority of the respondents (68.75%) used rainfed and underground water/boring with (45%) of small scale and (23.75%) of large scale while, (17.5%) used all three system viz. rainfed, river/dam and underground water/boring and remaining (13.75%) of the respondent (5%) of small scale and (8.75%) of large scale (irrigated their rice field through rainfed and river/dam irrigation.

Table 10: Source of irrigation by farm category in the study area

Irrigation system used	Small scale	Large scale	Total
Rainfed and river/dam	4(5)	7(8.75)	11(13.75)
Rainfed and underground water/boring	36(45)	19(23.75)	55(68.75)
Rainfed, river/dam and ad underground water/boring	5(6.25)	9(11.25)	14(17.5)

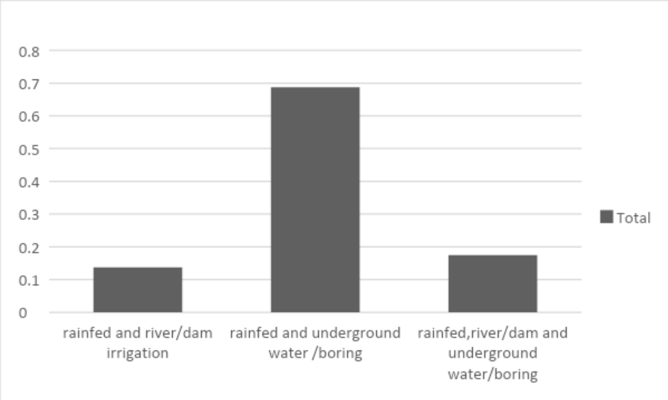

Figure 7: Sources of irrigation used by the respondents in the study area

Source: Field Survey, 2020

3.3 Times of irrigation

The study revealed that (27.5%) of the respondent irrigated the field during land preparation. (73.75%) of the respondent irrigated during tiller initiation. Majority of the respondent irrigated during panicle initiation (95%) of which (53.75%) small scale and (41.25%) large scale. (42.5%) of the respondent irrigated during flowering with (30%) in small scale and (11.25%) in large scale.

Table 11: Times of irrigation by farm category in the study area

Times of irrigation	Small scale	Large scale	Total
Land preparation	11(13.75)	11(13.75)	22(27.5)
Tiller initiation	27(33.75)	32(40)	59(73.75)
Panicle initiation	43(53.75)	33(41.25)	76(95)
Flowering	24(30)	9(11.25)	33(41.25)

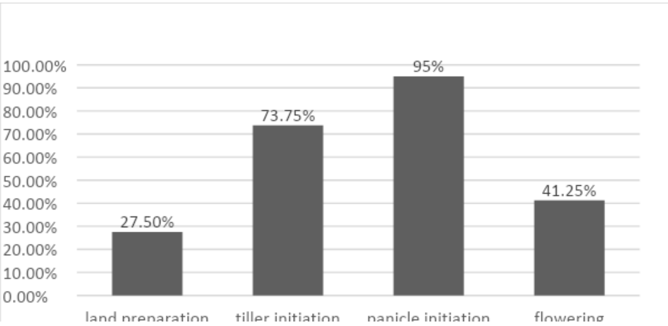

Figure 8: Times of irrigation done by the respondents in the study area

Source: Field Survey, 2020

3.4 Types of fertilizers and manures

Out of total respondents,76.3% used farmyard manure, 100% used urea, 100% used dap, 97.5% used potash, 47.5% used zinc, 23.8% used Zyme, 6.3% used complexal and only 2.5 % used single super phosphate as a source of fertilizers and manure during the rice cultivation practices.

Table 12: Farm categorical classification of fertilizers and manures used by the respondents in the study area

Types of fertilizers and manures	Small scale	Large scale	Total
FYM	38(47.5)	23(28.75)	61(76.3)
Urea	45(56.25)	35(43.75)	80(100)
Dap	45(56.25)	35(43.75)	80(100)
Potash	45(56.25)	33(41.25)	78(97.5)
Zinc	14(17.5)	25(31.25)	39(48.75)
Zyme	8(10)	12(15)	20(25)
Complexal	3(3.75)	2(2.5)	5(6.3)
SSP	2(2.5)	0(0)	2(2.5)

Source: Field Survey, 2020

3.5 Source of agriculture inputs

From the table given below, it was found that majority of the respondents (85%) of which (53.75%) small scale and (31.25%) large scale purchased inputs from agrovets only. (11.25%) of the respondents purchased seed from both agrovets and foreign country. Both agrovets and government were the source of agricultural inputs for (2.50%) of the respondents. Similarly, the source of agricultural inputs for remaining (1.25%) of the respondent was both agrovets and cooperatives with (0%) in small scale and (1.25%) in large scale. Similarly, (63.75%) of the respondents obtained inputs in required quantity and time whereas (36.25%) of the respondents did not obtain inputs in required quantity and time.

Table 13: Source of agricultural inputs for the respondents on the basis of farm category in the study area

Source of agriculture inputs	Small scale	Large scale	Total
Agrovets	43(53.75)	25(31.25)	68(85)
Agrovets &cooperatives	0(0)	1(1.25)	1(1.25)
Agrovets and government	0(0)	2(2.5)	2(2.5)
Agrovets and India	2(2.5)	7(8.75)	9(11.25)

Source: Field Survey, 2020

3.6 Economics of the rice production

Successful rice cultivation requires higher amount of different inputs along with proper care and management. It is labor-intensive enterprise. The foremost cost attributing items for the rice cultivation are manifold field preparation, improved seed, chemical fertilizers, pesticides, farmyard manure, and sufficient labor for several intercultural operations. The cost incurred by these items constitutes the total variable cost. The cost of production is the major factor that influenced the profitability of the enterprise and also shows the efficiency of the inputs used by the farmers.

In the study area, human labor was one of the major attributing items among all variable items and was computed in term of man per day. Human labor was required for performing different operations such as nursery bed preparation, land preparation, fertilizer application, pesticides application, transplantation, weeding, harvesting, threshing etc. Still, traditional way of farming is prevalent in the study area, which makes the rice production activity more labor intensive. Major types of organic manures and chemical fertilizers used in the study area, were farmyard manure, Urea, DAP and MOP whereas SSP and Complexal were used by few people. Micronutrients like zinc and enzyme were also used. In addition, farmers used pesticides to control pest problem in severe cases only. Since, cost of production is major factor for profit maximization; the average cost of rice production per hectare was computed in the study area.

The study depicted that the total variable cost for rice production in one hectare land was calculated NPR. 108,214.78. In addition, the average cost of seed per hectare was calculated NPR. 3989.56 whereas the cost of farmyard manure combined with chemical fertilizer and pesticides was estimated NPR. 21811.95. Likewise, the average cost of tillage per hectare was NPR. 13869.01. Similarly, the average cost of labor was calculated NPR. 56826.86 and cost of irrigation and others was estimated NPR. 10615.19 and NPR. 1102.20 respectively. This showed major cost attributing item was labor in the rice production. The details of the average cost of rice production are shown in the table below.

Table 14: Average cost of rice production per hectare in the study area

Materials	Average cost (NPR. /ha)
Seed	3989.56
FYM and chemical fertilizer and pesticides	21811.95
Tillage cost	13869.01
Labor cost	56826.86
Irrigation cost	10615.20
Others cost	1102.20
Total variable cost	108,214.78

Source: Field Survey, 2020

3.6.1 Item-wise cost of production

Labor cost occupied the major portion of the cost of production i.e. (52.5%) followed by FYM and chemical fertilizer and pesticides cost (20.2%), tillage cost (12.8%), irrigation cost (9.8%), seed cost (3.68%) and other cost (1.01%) as shown in the Table.

Table 15: Item wise cost of production of rice in the study area

Seed cost	FYM and chemical fertilizer and pesticides cost	Tillage cost	Labour Cost	Irrigation cost	Other cost
3.68%	20.2%	12.8%	52.5%	9.8%	1.01%

Source: Field Survey, 2020

The study showed that returns obtained from two product grains and straw. Total returns from rice production in one season per hectare was nearly NPR. 126622.04. Gross margin per hectare is calculated as the difference between Gross returns per hectare minus total variable cost per hectare.

Gross margin (per hectare) = Gross returns (per hectare) –Total variable cost (per hectare)

= 120227.04-108214.79

= 12012.25 per hectare

The total gross returns and total variable cost per hectare was taken as average.

Benefit Cost Ratio (BCR) = Gross returns/ Total cost

= 120227.04/108214.79

= 1.11

Gross margin is positive and the BCR is greater than one i.e. if we invest one rupee, we can get the returns of NPR. 1.11 from the business, which indicate that the investment is financially viable and business can run smoothly.

Table 16: Economic indicator of the rice production in the study area

Cost items	Amount (NPR)
Total variable cost (NPR. /ha)	108214.78
Gross returns (NPR. /ha)	120227.04
Gross margin (NPR. /ha)	12012.25
Benefit-cost ratio (B:C)	1.11

Source: Field Survey, 2020

3.6.2 Cost of production of rice on farm size basis

The average cost for the production of rice per hectare was (NPR. 108214.79) which is higher than the average cost of production of rice in Pyuthan district of Nepal (NPR. 94810.07) (Bhusal, Karn, Jha, & Ojha, 2020). The total cost of production per hectare in small scale farm (NPR. 109724.92) was higher as compared total cost of production per hectare in large scale farm (NPR. 106273.19), and the difference was not statistically significant. The average cost of rice production in small scale farm (NPR. 102658.67) was also higher in small scale farm than large scale farm (NPR. 84936.54) in Pyuthan district of Nepal (Bhusal, Karn, Jha, & Ojha, 2020). The average cost of seed per hectare was (NPR. 106273.19) and the data from the table suggests that there is statistically significant difference between the average cost of small and large scale farm at 10 % level of significance. The average cost of seed per hectare for rice production in Pyuthan district of Nepal on the basis of survey research on rice production in Pyuthan was (NPR. 3498.49). Similarly, the difference of per hectare production cost of labor was not statistically significant across the small scale farm and large scale farm. The significant difference was found between small and large scale farmers in survey research conducted in Pyuthan district of Nepal (Bhusal, Karn, Jha, & Ojha, 2020). The average cost of tillage per hectare in small and large scale farm was (NPR. 13619.06) and (NPR. 14190.37) respectively and the difference was not statistically significant. The cost of FYM and chemical fertilizers per hectare in small scale farm (NPR. 23870.95) was higher than that of large scale farm (NPR. 19164.66) and the difference was statistically significant at 5%level. Likewise, the difference of per hectare irrigation cost between small scale farm (NPR. 10658.40) and large scale farm (NPR. 10559.64) was not statistically significant. The cost of transportation per ha was found to be (NPR. 108214.79), and the data suggest that the mean difference across small and large scale farm was not statistically significant.

Table 17: Cost of Production per hectare by farm category in the study area

Cost items	Small scale farm	Large scale farm	Mean	Mean difference	t-value
Seed cost	4302.20 (2862.41)	3587.59 (1633.52)	3989.56	714.61	1.318*
Labor cost	56212.92 (12931.14)	57616.21 (9904.89)	56826.86	1403.29	-.532
Tillage cost	13619.06 (3636.07)	14190.37 (2895.46)	13869.01	-571.31	-.760
FYM, Chemical fertilizer and Pesticides cost	23870.95 (12174.24)	19164.66 (6277.80)	21811.95	4706.29	2.239**
Irrigation cost	10658.40 (4309.00)	10559.64 (3390.52)	10615.19	98.75	.111
Other cost	1061.37 (381.84)	1154.69 (482.32)	1102.20	-93.32	-.966
Total variable cost	109724.92 (25127.61)	106273.19 (15444.67)	108214.79 (21384.45)	3451.73	0.756

Source: Field Survey, 2020

Note. Values in parentheses indicate standard deviation ** and * Significant at 5% and 10% levels respectively

3.6.3 Production, productivity and benefit cost ratio analysis of rice

The average production of rice in total was found to be 4458.96 kg in the study area. The total production was lower in the small scale farms (1811 kg) in comparison with large scale farms (7863.4 kg), and the difference was statistically significant at 1% level (Table 19). The total average productivity of rice was found to be 3.64 t/ha in the study site which was lower than the national average productivity of 3.76t/ha (AICC, 2077). The difference of productivities between small and large scale farms was found statistically significant at 1 % level. The average gross revenue was found to be NPR. 120227.04 per hectare. The gross revenue of small scale farm (NPR. 115253.16/ha) was lower than the revenue of large scale farm (NPR. 126622.04/ha); and the difference was found to be statistically significant at 10% level. The average total revenue of rice production in Pyuthan district was NPR. 143049.45 with gross revenue of small scale farm lower than large scale farm (Bhusal, Karn, Jha, & Ojha, 2020). The average total variable cost per hectare was found NPR. 108214.79 and the variable cost per ha of small scale farm (NPR. 109724.92) was found higher than the variable cost of large scale farm (NPR. 106273.19), though the difference was not statistically significant. In the study area, the per hectare profit/ gross margin was found to be NPR. 12012.25 with per hectare gross margin of small and large scale farm was (NPR. 5528.23) and (NPR. 20348.84) and the difference was statistically significant at 1%level. The average gross margin per hectare was (NPR. 48239.38) and statistically significant difference between small scale farm and large scale farm was found in rice production in Pyuthan district (Bhusal, Karn, Jha, & Ojha, 2020). MRSMP found gross margin of NPR. 11793.98 which is similar to our findings. The average benefit cost ratio of rice production was 1.11 in the study area (Table 19). It is similar to the benefit cost ratio of rice in Dang district of Nepal 1.14 (Thapa, Bhattarai, Khaatri, & Bhusal, 2018). The benefit cost ratio for rice production in Pyuthan district of Nepal was found to be 1.51 (Bhusal, Karn, Jha, & Ojha, 2020). MRSMP (2015) found the benefit cost ratio of 1.17 in terai context. The benefit cost ratio of 1.11 in the study area implies that the production of rice was profitable and one rupee spent for the production could yield 11 paisa of profit. From the table, it is inferred that the benefit cost ratio of small scale farms was lower (1.05) than that of large scale farms (1.18), and the difference is statistically significant at 1% level of significance. The profitability differs among different size farmers' group and large farmers are more profitable in rice cultivation than small and medium farmers (Akter, Parvin, Mila, & Nahar, 2019)

Table 18: Production, Productivity, Profit and Benefit Cost Ratio analysis of rice by farm category in the study area

Items	Small scale farm	Large scale farm	Total	Mean difference	t-value
Production (kg)	1811.07 (1151.93)	7863.40 (3239.39)	4458.96 (3792.62)	-6052.32	- 10.547***
Yield (t/ha)	3.29 (1.02)	4.11 (0.95)	3.64 (1.06)	-0.82	-3.668***
Gross revenue (NPR. / ha)	115253.16 (28063.61)	126622.04 (32891.59)	120227.04 ((30601.70)	-11368.87	-1.667*
Total variable cost (NPR. / ha)	109724.92 25127.61	106273.19 (15444.67)	108214.79 (21384.45)	3451.73	0.756
Profit/Gross margin (NPR. /ha)	5528.23 19889.74	20348.84 (23422.85)	12012.25 (22609.58)	- 14820.61	- 3.058***
Benefit cost ratio	1.05 (0.18)	1.18 (0.22)	1.11 (0.20)	-0.12	-2.738

Source: Field Survey, 2020

Note. Values in parentheses indicate standard deviation *** indicates significant at 1%, level, * indicates significant at 10 %level.

3.7 Production function analysis

The table below represents the results of Cobb Douglas Production Function (CDPF) analysis of rice production in the study area. The Cobb Douglas production function model was found to be best fit since the F-ratio was highly significant (at 1% level of significance). The coefficient multiple determinations (R2) was found to be 0.67. The result showed that the F value (24.45) was statistically significant at 1% level of significance and has good explanatory power for the model function applied. Similarly, the R^2 value (0.67) pointed that about 67 % variations in the dependent variable were easily explained by explanatory variables included in the model. The table indicates increase in seed cost doesn't statistically increase the total income. It was found that increase in labor cost by 100% would result increase in total income (dependent variable) from rice production in the study area by 60%, and the increment was statistically significant at 1% level. The coefficient of labor cost according to the survey research conducted in economics of organic rice production in Chitwan pointed out to be .538 (Adhikari, 2013). The coefficient of tillage cost (0.17) indicated that 100% increase in the tillage cost would increase the total income by 17% and this was significant at 5% level. Similarly, the regression coefficient of farmyard manure (FYM) and chemical fertilizer along with pesticides (0.10) pointed that increasing the manure and fertilizer and pesticides cost by 100% would increase the total income by 10% which is significant at 5% level. Likewise, increase in the cost of irrigation by 100% would increase the total income by 21% (Table 20), and the increment is statistically significant at 1% level. The result of other cost coefficient (-0.15) indicates increase in other cost by 100 % would result in decrease in total income by 15%.

Table 19: Production function analysis of rice Production

Explanatory variables	Coefficient	Standard error	T value	P value
Seed cost (NPR. /ha)	0.001	0.041	0.035	0.972
Labor cost (NPR. /ha)	0.608	0.109	5.539	0.000***
Tillage cost (NPR. /ha)	0.176	0.085	2.060	0.04**
FYM and chemical fertilizer and pesticide cost (NPR./ha)	0.108	0.053	2.040	0.04**
Irrigation cost (NPR. /ha)	0.219	0.053	4.144	0.000***
Other cost (NPR. /ha)	-0.151	0.065	- 2.290	0.02**
Constant	1.279	0.939	1.361	0.177
R2	0.67			
Adjusted R2	0.64			
F-value	24.45			
Returns to scale	0.96			

Source: Field Survey, 2020

Note. ** and *** indicate significance at 5% and 1% level respectively.

3.8 Return to scale analysis

From the regression analysis of Cobb Douglas Production Function (CDPF) the sum of coefficient was computed to be 0.96 which signifies the decreasing return to scale in production of rice in the study area. It was estimated that diminishing returns seem to prevail in predominantly paddy areas (Bardhan, 1973). This means if we double the cost of variable factors, income will be increased by less than doubled.

3.9 Production problems of rice grower

In the study area, farmers were facing several problems related to the production. Based on the farmers' perception towards production problems, the ranking of the problem was carried out. The study revealed that, among the production problems, lack of availability of fertilizers in required quantity and time appeared as the most important problem followed by lack of availability of quality seed, unavailability of labor in required time and quantity and so on as shown in the table below. These problems may be due to the lack of stability of government and coordination among the famers and other concerned authorities including government.

Table 20: Problems of the rice production in the study area

Production problems	Index	Rank
Lack of availability of fertilizers in required quantity and time	0.813	I
Lack of availability of quality seed	0.791	II
Unavailability of labor in time and in required quantity	0.538	III
Lack of proper irrigation and drainage	0.492	IV
Incidence of Disease and insects/pests	0.447	V
Land fragmentation and lacking of mechanization	0.366	VI

Source: Field Survey, 2020

4. Conclusions

The analysis of returns to scale, gross margin and B:C ratio indicated rice production is economically suitable for the study area with more profitable production in large scale. Cost on labor incurred majority of the production costs during rice cultivation and contributed significantly on gross income. Availability of inputs in required time and quantity along with the assurance of proper drainage and irrigation would be pivotal for the development of rice subsector in Rautahat

5. Suggestions

On the basis of findings obtained from the study, some suggestions have been made which could be useful to the related government authorities and other concerned agencies who are involved in the better improvement in the field of rice production through minimum cost and maximum yield.

- There should be adequate extension works like trainings and workshops to enhance the farmers' knowledge on advanced production activities

- Farmers should be encouraged to use improved rice seeds along with modern technologies that help the farmer to get more return per unit investment
- As the economics of rice production was found profitable with decreasing returns to scale, farmers are suggested for specialization in rice subsector and scaling up of their area and production
- Concerned authorities should focus on farm mechanization as labor cost shares highest production cost

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