ANALYSIS OF RESOURCE USE EFFICIENCY AND PROFITABILITY OF WHEAT PRODUCTION IN KAILALI DISTRICT, NEPAL

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ABSTRACT

A study was done in 2021 in the Kailari rural minicipality, Gauriganga municipality, Godawari municipality, and Dhangadhi sub-metro politian city of the Kailali district to analyze the economics of wheat production. A total of 200 samples (50 from each village) were selected by using a simple random sampling technique. Most respondents (91 percent) had agriculture as a primary occupation. The area under wheat (Triticum aestivum) cultivation per household was 0.6 hectare with no significant difference between super zone of the Prime Minister Agriculture Modernization Project and non-super zone areas. The average production per household was 1814.5 kg whereas the yield was 3.3 mt/ha. The average cost of production was NRs. 64,526.62 per hectare and the B:C ratio was found to be 1.492. The Cobb-Douglas function showed that fertilizer, pesticide, land preparation, irrigation, and threshing costs were significant contributing factors to wheat production. The return to scale was found to be 0.261. An Index of severity was constructed to study the problems of wheat production in the study area. Weed infestation, lack of fertilizers, and insect pests were found to be three major problems.

1. INTRODUCTION

Wheat (*Triticum spp.*) is a cereal grain, originated from the Southwest Asia, but now cultivated worldwide. It has been described as the "King of Cereal" (Agam *et al*., 2017). It can be grown from below sea level to 5000 m altitude and in areas where rainfall ranges between 300-1130 mm(Kumar *et al*., 2014). Wheat (Triticum aestivum) belongs to the family Gramineae (grass family). Wheat is one of the most important food grains of Nepal and is the staple food of Nepalese people. It is cultivated in 21% area of land and accounts for 17% of total cereal production in Nepal (Sharma, 2018). Wheat contributed 7.1 % in agricultural Gross Domestic Product (GDP) following rice (20.575%) as well as vegetable (9.69%) and followed by maize (6.88%) during the fiscal year 2017/18(Sharma, 2018). Nepal so far has forty two (42) wheat varieties (SQCC, 2023). Wheat was cultivated in 703,992 ha of land in fiscal year 2018/19 and the production was 2,005,665 metric tons with the productivity of 2.849 mt/ha (MoALD, 2020). In most of the urban areas in the country, the use of baked leavened bread, cakes, and biscuits are increasing at faster rate creating higher demand of wheat flour and the higher deficit of flour in the country (Sharma and Chauhan, 2003).

Ministry of Agricultural and Livestock Development (MoALD) has launched the 10 years Prime Minister Agriculture Modernization Project (PMAMP) in 2016/17. The MoALD has envisaged pockets, blocks, zones and super zone for agriculture commodity to address the fragmentation of arable land, which is considered to be a major barrier for agriculture commercialization and mechanization in the country (PMAMP, 2016/17). As per PMAMP, at least 10 ha of land is needed to identify it as a 'pocket area'; 100 ha to be considered a 'block'; 500 ha to be termed as a 'zone', while a 'super zone' would make up of 1,000 ha of area. Kailali is one of the super zones established in 2017 A.D for specialization and commercialization of wheat in that region. Wheat superzone not only assists in mechanization and commercialization, but it also provides various technical assistances to the farmers through its technicians and specialists (Devkota *et al*., 2020). It also aims to enhance the livelihood and economy of the region through a transformation in wheat cultivation and production technology (Wheat Super zone, 2018). But little is known about the perception of farmers towards the activities of super zone and its impact at the farm level. It is, therefore, necessary to know how far PMAMP, Project Implementation Unit (Wheat Super zone) has been able to promote the adoption of improved wheat cultivation practices in the area. Farmers were facing high cost of inputs, adulteration of seeds, shortage of chemical fertilizers, insecticides & pesticides (Kumar S. , 2001).Thus, this study was deemed necessary and was undertaken to determine the profitability and resource use efficiency of the beneficiaries of super zone compared to non-beneficiaries.

2. MATERIALS AND METHODS

2.1. Site of study

Kailali district was selected as the research area. The Kailali district lies between 28022'N to 81030'E and elevation ranging from 109 and 1950 meters above sea level. The climate varies from tropical to subtropical. Kailali district has been selected as a wheat production super zone to be established under the Prime Minister Agricultural Modernization Project (PMAMP).

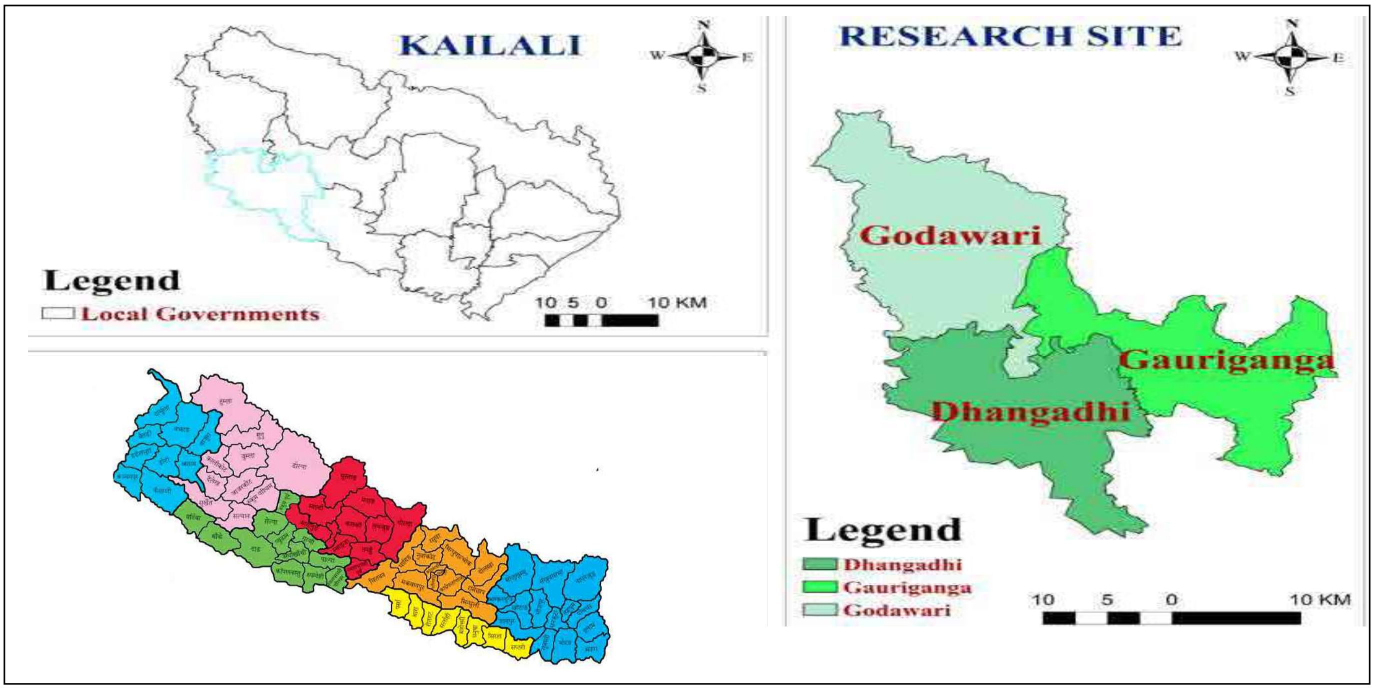

Figure 1. Map of Nepal showing research sites (GIS, Extract)

2.2. Sample size

The size of the sample, and amount of variation, usually affect the quantity and quality of information obtained from the survey. Using appropriate sampling methods, both factors can be controlled (Scheaffer, 1979). Casley and Kumar (1988) and Kinnear and Tayler (1987) suggested that a good survey sample should have both a small sampling error and minimum standard error. 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 and Daplyn, 1993). Selection of wheat growers was from different rural municipalities. Altogether 200 wheat growers were selected randomly for the survey taking 50 growers each from Kailari Rural Municipality, Gauriganga Municipality, Godawari Municipality and Dhangadhi Sub-Metro Politian. A total of 100 samples were taken from household who were member of PMAMP (Kailari and Rajipur villages) while remaining samples were from non-member households.

2.3. Sample selection procedure

The best way to avoid bias in the sample selection process is use of simple random sampling in which each unit of the population has an equal chance for selection (Scheaffer, 1979). Thus by using sampling frame, a simple random sampling procedure was used to collect necessary information from wheat growers. The procedure was comprehensive and representative of the whole population.

2.4. Methods of data collection

Various sources and technique were used for the collection of necessary data. In this study, both the primary and secondary data were collected. The methodologies consisted of field survey, review of previous studies, and interviews with key informants.

2.5. Techniques of data collection

Primary data were collected through interview schedule. Information on various aspects of wheat production was collected. Information regarding the farm and household characteristics, production and management aspects was collected through face to face interview.

2.6. Pre-testing of interview schedule

Organizing fieldwork plan, testing the validity of the questionnaire and estimating the various cost components such as financial costs, travel time, interview time etc. before main survey were taken into consideration. The interview schedule was pre-tested in nearby villages with 10 farmers from Mahara village, prior to administering to the actual respondents which is common in the pre-test of the questionnaire (Perneger *et al*., 2015). Necessary modifications were made and the schedule was revised and put in the final form.

2.7. Methods and techniques of data analysis

After collection of necessary data, they were coded and entered into the computer for analysis. Data was fed and analysis was done by using statistical packages for social sciences (SPSS) and Stata-16.

2.8. Quantitative data analysis

Quantitative data were analyzed by using both descriptive and analytical statistics. Socioeconomic and farm characteristics of the respondents like family size, age, gender, occupational pattern, land holding size, economically active population etc. were described using simple descriptive statistics like frequency count, percentage, mean, standard deviation etc.

2.9. Benefit-cost ratio

Benefit cost analysis is done by the calculation of total variable cost and gross return from wheat cultivation. Cost of production was calculated by summing the variable cost items incurred in the production process. Benefit cost ratio is the quick and easiest method to determine the economic performance of a business (Dhakal *et al*., 2015). For calculating gross return, income from product sale was accounted. So, the benefit cost analysis was carried out by using formula:

$$B/C = \frac{Gross\ return}{Total\ variable\ cost}$$

2.10. Cobb-douglas production function

Cobb-Douglas production function is one of the most commonly used function type especially in agricultural economic studies (Kip and Isyar, 1976). Cobb-Douglas production function is employed to estimate the coefficient of variables analyzed and Marginal Physical Product (MPP), Minimum Viable Product (MVP) and allocate efficiency index, which is also used to estimate the efficiency of resources use (Osti *et al*., 2017). Cobb-Douglas production function was used to assess the factors determining production of wheat in 0.0038 ha of land in the study area. The choice of the functional form was based on its theoretical fitness to agriculture and its computational manageability. Further most production studies in agricultural sector have used this function. The model specified and used was represented by:

$$Y = AK^{b_1}L^{b_2}M^{b_3}N^{b_4}O^{b_5}P^{b_6}Q^{b_7}R^{b_8}$$

Where Y was dependent variable and K, L, M, N, O, P, Q and R were the explanatory variables. 'A' was the constant and b_1, b_2, b_3, b_4, b_5, b_6, b_7 and $b_8$were the production coefficients. The production function was converted into logarithmic form so that it could be solved by least square method i.e.

$$Log\ Y = Log\ A + b_1\ Log\ K + b_2\ Log\ L + b_3\ Log\ M ++ b_4\ Log\ N ++ b_5\ Log\ O ++ b_6\ Log\ P ++ b_7\ Log\ Q ++ b_8\ Log\ R + E$$

Where,

Y = Production in 0.0038 ha (kg)

K =Seed (NRs)

L = Fertilizers (NRs.)

M = Manure (NRs.)

N = Pesticides (NRs)

O = Land preparation (NRs)

P = Irrigation (NRs)

Q = Harvesting (NRs)

R = Threshing (NRs)

E = Error Term

2.11 Efficiency ratio estimation through cobb-douglas production function

The efficiency of a resource used was established by the proportion of the Marginal Value Product (MVP) of variable input and the Marginal Factor Cost (MFC) for the input. However, the denominator always sets its value as one, and consequently, the ratio will be equal to their respective MVP (Majumder *et al*., 2009).

The efficiency of resource use was calculated as:

$$r = \frac{MVP}{MFC}$$ (Goni *et al*., 2007)

Where,

r: Efficiency ratio

MVP: Marginal value product of a variable input

MFC: Marginal factor cost

MVP = dy/dx

MVPi = bi.Y/Xi

Where,

bi: Estimated regression coefficients

Y and Xi are the values from the geometric mean

Decision criteria as given by Effiong (2005):

r = 1 indicates the efficient or optimum use of resource

r > 1 indicates under-use of resource

r < 1 indicates over-use of resource

The relative percentage change in MVP of each resource was estimated as:

$$D = (1-\frac{MFC}{MVP}) \times 100$$

or, $$D = (1 - \frac{11}{rr})\times 100$$

Where,

D: absolute value of percentage change in MVP of each resource

r: efficiency ratio

2.12. Return to scale analysis (RTS)

Return to scale provides the technical property of production which examines changes in output consequent to the relative change in all inputs. It is obtained by summing up of coefficients (Bajracharya and Sapkota, 2017). For the calculation of return to scale on wheat production, coefficients from Cobb Douglas production function was used and calculated using the formula:

Return to scale (RTS) = $\sum bi$

Where, bi = Coefficient of ith explanatory variables

2.13. Indexing

Qualitative data was analyzed using indexing. Index of severity was constructed for various problems faced by wheat growers in super zone and non-super zone area using three point scale. The scale value assigned for three scales of problems viz. high, little bit and no problem were 2, 1 and 0 respectively. The problems were ultimately ranked on the basis of index values. The formula given below was used to find the index for intensity of production and marketing problem faced by producers and traders respectively.

$$Iprob = \sum(\frac{Sifi}{N})$$

Where,

Iprob = Index value for intensity of problem

Si = Scale value of ith intensity

fi = Frequency of ith response

N = Total number of respondents

3. RESULTS AND DISCUSSION

3.1. Socio-economic and demographic characteristics

Descriptive analysis of various socioeconomic, demographic, and institutional variables are presented in Tables 1 and 2. The average age of household heads indicated that farmers had sufficient skills and experience in the production process. The average household size was higher than her national average of 4.88 (CBS, 2012). This data is higher than the national proportion of the population engaged in agriculture (65.6), as suggested by CBS (2012).

Table 1. Description of socio-economic, demographic and institutional variables

	Total (n=2000	Super zone (n=100)	Non-super zone (n=100)	Chi-square value
Occupation				
Agriculture	182 (91)	89(89)	93 (93)	
Teaching	7 (3.5)	4(4)	3(3)	
Business	4 (2)	2(2)	2(2)	
Study	2 (1)	1(1)	1(1)	0.977
Government or Private sector Job	4 (2)	4(1)	1(1)	
Ethnicity				
Brahmin	58 (29)	37(37)	21(21)	13.569***
Chhetri	30 (15)	23(23)	7(7)	
Janajati	106 (53)	40(40)	66(66)	
Dalit	6 (3)	0(0)	6(6)	
Total	200 (100)	100(100)	100(100)	

Source: Field Survey, 2021

Figures in parentheses indicate percent

Table 2. Description of socio-economic, demographic and institutional variables

Variables	**Total (n=200)**	**Super zone (n=100)**	**Non-super zone (n=100)**	**Mean Differences**	**T-value**
Age of the respondents (year)	43.56	42.94	44.19	1.250	0.700
Year of schooling of respondents (year)	5.83	7.57	4.10	-3.470	-4.761***
Age of household head (year)	46.745	47.59	45.90	-1.690	-1.050
Landholding(hectare)					
Lowland own	0.64	0.53	0.76	0.23	3.127***
Lowland rented in	0.17	0.24	0.11	-0.13	-2.123**
Lowland rented out	0.10	0.13	0.06	-0.068	-1.665**
Upland own	0.075	0.081	0.069	-0.012	-1.626*
Total own	0.72	0.611	0.832	0.22	2.851***
Total rented in	0.17	0.24	0.11	-0.13	-2.123**
Total rented out	0.109	0.14	0.06	-0.081	-1.912**

Source: Field Survey, 2021

*** indicates the significant at 1% level of significant

3.2. Wheat production

Table 3 shows that area, production and productivity of wheat in the study area. The average land area under wheat cultivation was found to be 0.59 hectare. The average wheat production was found to be 1814.5 kg per household while the productivity was 3.3 mt/ha.

Table 3. Wheat production status in study area

Wheat production	Total (n=200)	Super zone (n=100)	Non-super zone (n=100)	Mean Differences	T-value
Area	0.566	0.59	0.575	-0.015	0.331
Wheat production	54435	54675	54195	480	0.778
Productivity	3.3	3.55	3.04	0.51	0.9

Source: Field Survey, 2021

3.2.1 Purpose of wheat production

Majority of respondents (55 percent) cultivated wheat for home consumption. In super zone area, 50 percent farmers cultivate wheat for home consumption while remaining 50 percent cultivate to sell in the market. Likewise, in non-super zone area 60 percent farmers were found cultivating wheat for home consumption while 40 percent were cultivating for sale. The details are presented in Figure 2.

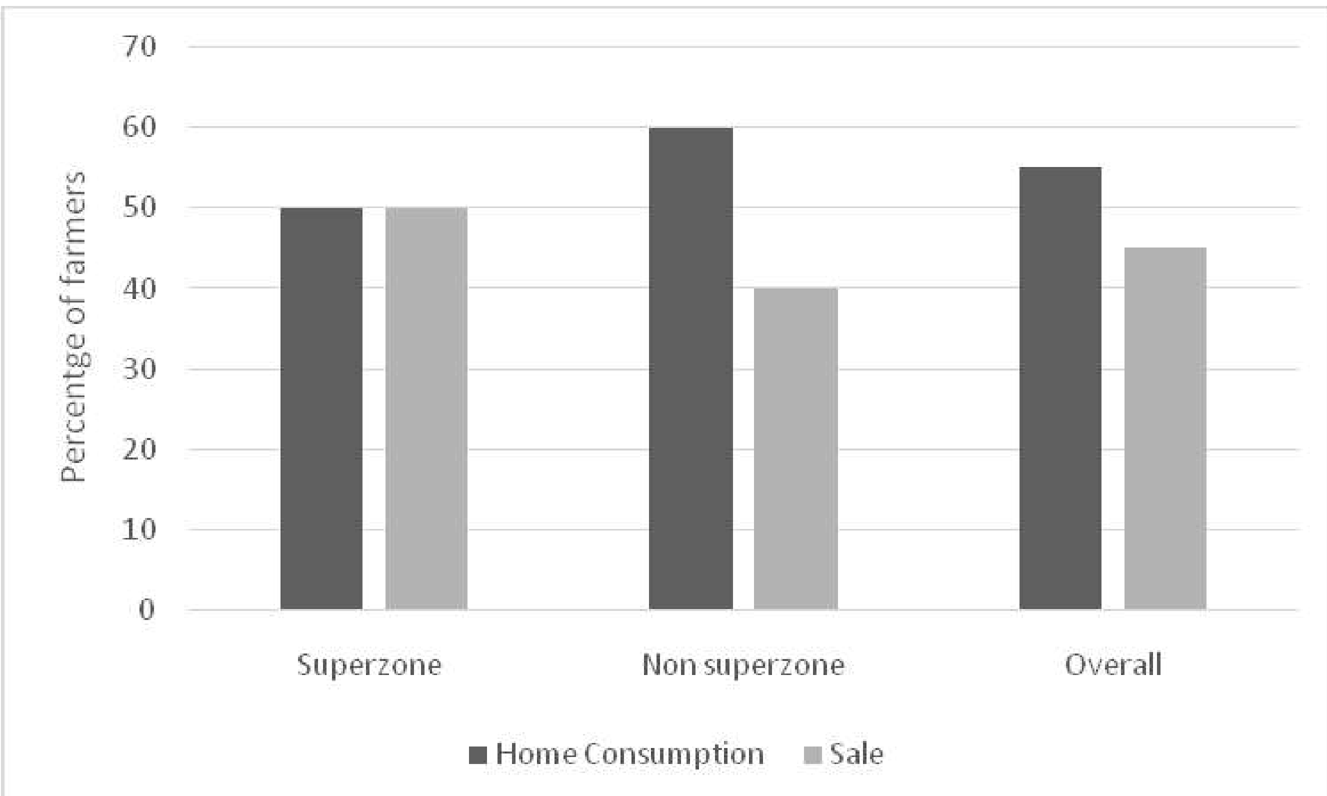

Figure 2. Bar diagram showing the purpose of cultivation of wheat in the study area

3.2.2 Production economics of wheat

3.2.2.1 Benefit and cost from wheat production in the study area

The benefit cost ratio from wheat enterprise in the non-super zone and super zone area were found to be 1.487 and 1.497 respectively. The difference was found to be statistically non- significant but the ratio was higher in super zone area than in the non-super zone area. The average B:C ratio was found to be 1.492 as shown in Table 4.

Table 4. Average cost, benefit and B:C ratio from wheat production in the study area

Description	Overall	Super zone	Non-super zone
Average cost of production(NRs./ hectare)	65430	63330	67560
Average benefit(NRs/ hectare)	91410	90000	92850
B:C ratio	1.492	1.497	1.487

Source: Field Survey, 2021

3.2.3 Factors affecting the production of wheat

The different factors affecting wheat production is shown in Table 5. A Cobb-Douglas production function was estimated to determine the effect of different inputs (NRs.) on total wheat production (mt/ha). The Cobb-Douglas function was transformed into linear form by using the natural logarithm of both dependent and independent variables. After transformation, the Cobb-Douglas production function was estimated using Ordinary Least Square (OLS) method. The obtained coefficient represents the elasticity of individual inputs. The elasticity associates with all inputs were less than one. So, for inputs less than one, a unit increase in the respective input would result in less than a unit increase in wheat production. The overall F value was 23.64 and it was statistically highly significant at 1 percent level of significance. This indicates that the explanatory variables includes in model were important for the explanation of variation on wheat production. The R^2 value was 0.49 which implies that about 49 percent of variation on wheat production was explained by the explanatory variables.

There were five variables found significant at the 1 percent, 5 percent, and 10 percent levels. Regarding fertilizer, we found that a 1% increase in fertilizer cost, keeping the other factor constant, resulted in a 0.06% decrease in wheat production, which was found to be highly significant at the 1% significance level. . Similarly, a 1% increase in pesticide costs leads to a 0.01% increase in wheat production, while the other factors remain constant and is statistically significant at the 10% significance level. We find that a 1% increase in land preparation costs reduces wheat production by 0.15% while other factors remain constant, which is statistically significant at the 5% significance level. . A 1% increase in irrigation costs was found to reduce wheat yield by 0.083%, which was found to be statistically significant at the 5% significance level. We also found that a 1% increase in threshing costs resulted in a 0.60% increase in wheat production, which was found to be statistically significant at the 1% significance level, suggesting that mechanization achieves efficiency.

The return to scale was calculated by summing up the elasticity of respective individual inputs which was estimated using Cobb-Douglas production function and found 0.261 which implies that there was decreasing returns to scale of wheat production.

Table 5. Factors affecting the production of wheat in the study area

Variables	Coefficient	Std. Err.	T	p>t
Log seed	-0.009	0.049	-0.18	0.854
Log manure	0.0037	0.003	1.16	0.248
Log fertilizer	-0.061***	0.015	-3.87	0.000
Log pesticides	0.010*	0.006	1.79	0.075
Log land preparation	-0.154**	0.070	-2.20	0.029
Log irrigation	-0.083**	0.035	-2.36	0.019
Log harvesting	-0.054	0.045	-1.20	0.233
Log threshing	0.604***	0.049	12.18	0.000
Summary Statistics				
Number of observation	200			
F	23.64			
Prob>F	0.000			
R square	0.497			
Adjusted R^2	0.476			

Source: Field Survey, 2021

***, ** and * indicate 1%, 5% and 10% levels of significance, respectively.

3.2.4 Extension services in the study area

The percentage of respondents who were in personal contact with the extension workers was found very low (17 percent). The figure reached to 28 percent in the super zone while it was down to 6 percent in the non-super zone area. Chi squared value showed that the difference was significant at 1 percent level of significance. The percentage of respondents who were involved in trainings related to wheat cultivation was only 9 percent. The percentage of respondents involved in training was higher in super zone area but the difference was found to be insignificant.

A total of 36 percent of respondents from super zone area were taking regular advice from technicians while the percentage doing so was significantly lower (11 percent) in non-super zone area. Overall, 23.5 percent of farmers were taking advice from technicians. Likewise, about 42 percent of total respondents were involved in different types of farmers' group. The detail about the status of extension worker is represented in Table 6. Devkota *et al*., (2020) reported that when a farmer has contact with extension agent, yield increases by 0.419 mt/ha keeping other factors constant.

Table 6. Status of extension services in the study area

Extension Services	Total (n=200)	Super Zone (n=100)	Non-super zone (n=100)	Chi-square value
Personal contact (Yes)	34 (17)	28 (28)	6 (6)	17.151***
Training (Yes)	18 (9)	12 (12)	6 (6)	2.198
Advice from technician (Yes)	47 (23.5)	36 (36)	11 (11)	17.383***
Involve in group (Yes)	84 (42)	46 (46)	38 (38)	1.314

Notes: Figures in parentheses indicate percent. *** indicates significant different at 1% level

3.2.5 Problems in wheat production

Table No. 7 represents the index of severity regarding the problems in wheat production. Index of severity was constructed to study the problems in wheat production in the study area. The four major problems in non- super zone area were lack of fertilizers, weeds, insect problems and labor scarcity in descending order. Similarly, the four major problems in wheat production in super zone area were weeds infestation, lack of fertilizers, insect problems and nutrient management in descending order.

Due to high temperature and high rainfall, most of the farmers were sowing poor quality seeds, which might be one of the main causes of low productivity of wheat in Nepal (Thapa, 2005).

Table 7. Index of severity regarding problems in production of wheat in super zone and non-super zone areas

In super zone	Index value	Rank	In non-super zone	Index value	Rank
Weeds	0.85	I	Lack of fertilizers	0.97	I
Lack of fertilizers	0.83	II	Weeds	0.88	II
Insect problems	0.78	III	Insect problems	0.86	III
Nutrient management	0.77	IV	Labor scarcity	0.81	IV
Diseases	0.77	V	Climatic variability	0.79	V

Source: Field survey, 2021

3.3 Cost, return and profitability of wheat

The average production cost of wheat in the study area was NRs. 65430 per hectare. An average cost was slightly higher in non-superzone than in superzone. Similarly, average benefit from a 0.0038 ha of wheat cultivation was NRs. 3095 and NRs. 3000 for non super-zone can be explained by the fact that the non super-zone areas are nearer to market thus fetching higher prices in comparison to super-zone. . The B:C ratio was found to be 1.492 which is higher than the national figure. The average benefit cost ratio of irrigated wheat in terai and hill district were about 1.39 and 1.53, respectively and Kailali district has the benefit cost ratio of 1.27 (MoAD, 2017). The higher B:C ratio can be simply explained as the survey site is the pocket region for wheat cultivation and it is expected to have higher profitability than the national average. To support our finding, study done in Bangladesh in wheat showed B:C ratio of wheat to be 1.42 (Rahman & Hasan, 2019). The difference in B:C ratio was not statistically significant.

The average profit from 1/30 ha of land from wheat cultivation was NRs. 949.61 with B/C ratio of 1.43 (Yadav et al., 2022). BCR ration can be increased by RUE, found the overall undiscounted benefit cost ratio considering total variable cost to be 1.79 in neighboring district Kanchanpur (Bist et al., 2017). Bhujel et al.,(2009) reported a benefit-cost ratio of 1.77 in a traditional method and2.19 in machine used RCT in wheat production in the eastern terai region of Nepal. Ghimire, (2013) and Dhital, (2017) found BCR of 1.38 and 1.22 respectively in wheat production in Nepal. Similarly, Gairhe et al.(2017) also reported BCRin wheat production under irrigated and rainfed conditions as 1.2 and 1.3 respectively.

3.4 Factors contributing to wheat production

Cobb- Douglas production function is a kind of differentiable function type applied in industry and economy and has a bilateral logarithmic pattern (Tanriover and Genc, 2005; Gujarati, 2009). The regression estimates showed negative and significant contribution of fertilizers, land preparation, and irrigation costs on production of wheat. This showed that those resources were being overused and to obtain efficiency spending on these factors had to be decreased. Similarly, threshing showed positive and significant results. This showed that using thresher properly for longer period of time increases the production by decreasing the loss during threshing. The return to scale was found to be decreasing which means increase of factor proportion by a certain scale would result increase in output by a smaller scale.

The results of the efficiency estimation reveled that land was 6.63, fertilizer was 1.76 and seed was 10.84 were underutilized and labor was 0.000036 and chemical were being highly over utilized in the study area (Osti *et al*., 2017). The study examine resource use efficiency on yam production in Delta and Kogi States of Nigeria show that there were under utilization of land, labor and planting materials (seed yam) as the ratio of the value of marginal product to marginal fixed cost were greater than one in both state (Ekunwe *et al*., 2008). Marginal value product to the factor cost ratio of human labor, seed, fertilizer and irrigation were negative and less than one that means there was excess used of these inputs, hence, there should be reduction in the use of these inputs for efficient wheat production (Mane *et al*., 2015).The study to examine resource use efficiency and the constrains faced in production of wheat crop in Betul district of Mdhya Pradesh by the farmers to achieve the potential yield of wheat in 2013-2014, reveals that human labor was found significant for large (0.419) and overall (0.156) farm, while it non-significant for small and medium farms. Machine labor was found significant for all size of farm i.e. small (0.551) medium (0.526) large (0.370) and overall (0.687) farm size. Seed and fertilizer was found significant for small and overall farm. In case of marginal value productivity, it was found that in small size farm the factor of production i.e. machine labor, seed, fertilizer and irrigation had been found underutilized, whereas human labor implying overutilization under the study area (Gautam *et al*., 2017).

4. CONCLUSION

The benefit cost ratio of wheat in the study area was 1.492 which indicates wheat is a profitable crop in the area and thus wheat cultivation needs to be promoted. Chemical Fertilizers and land preparation showed negative contribution to production which shows the need to decrease fertilizers use and decrease the number of tillage, opening a door for conservation agriculture. Increase in thresher use showed positive effect on production which hints towards achieving efficiency through mechanization. The major problems of wheat cultivation in the study were lack of balanced dose of fertilizers, weed infestation and insect pests which shows the need of input suppliers, government organizations and agriculture experts.

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