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Resource Use Efficiency and Productivity of Potato Production in Kailali

Megh Raj Upadhyay *

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Resource Use Efficiency and Productivity of Potato Production in Kailali

Megh Raj Upadhyay

NAST College Dhangadhi Kailali: nastdhn@gmail.com

Abstract: ABSTRACT CONTEXT: Agriculture is the largest sector of Nepalese economy among the south-Asian developing countries that contributed 26.98 % share of Gross Domestic Product (GDP) in the year 2018/19. The capacity to derive maximum output by per unit of resource is resource use efficiency. Resource use efficiency of a producer explains the comparison between inputs and output value. Potato is staple vegetable in every parts of Nepal. Cobb-Douglas production function is used to predict the significance of inputs in income from cash crops. Due to lack of optimum utilization of available resources in cultivation of vegetable like lack of technical knowledge, low education level, and extensive service the productivity and production is low in Nepalese economy. It ensures vegetable security in Nepal. Though, there are extensive researches on the resource use efficiency and productivity issues on agriculture, very few papers explored in the case of Sudurpaschim province of Nepal OBJECTIVE: This study had the specific purposes: (1) To identify the factors affecting in resource use efficiency and productivity of potato production (2) to utilize the resource use efficiency and productivity in potato production and (3) to show the type of returns to scale in potato production. METHODS: Applying post-positivist paradigm and quantitative causal survey research design, it explored the resource use efficiency and productivity through the semi-structured questionnaire from 140 households by random sampling. Data analysis was carried out by multiple regression model using Cobb-Douglas production function. SPSS software was used to find quantitative results. From the analysis of data using mean, and SD, t-test, analysis of variance, Durbin-Waston test, Marginal Value Product and marginal Factor cost, findings of this research was emerged. RESULTS AND DISCUSSION: The major findings: education level, extension service, farm size and pesticide cost were significant variables in potato production; seed, hired labor, Family Yard Manure and pesticide cost were overused and needed to decrease their cost for optimum allocation and there was decreasing returns to scale in production. This study emphasized on increasing education level, extensive service and farm size for optimum utilization of resources and increasing returns to scale. SIGNIFICANCE: Barriers to Indian potatoes and increasing returns to scale are only possible through protection policy of government. For optimum use of resources and increasing returns to scale, government can introduce capital intensive technique. This study can be implied in policy making and improving existing situation of agriculture, and allocating budget.

Keywords: Keywords: agriculture; farmers; resource use efficiency; productivity; returns to scale; potato

1. Introduction

Agriculture is the largest sector of Nepalese economy among the south-Asian developing countries, that contributed 26.98 % share of Gross Domestic Product(GDP) in the year 2018/19 (MoF, 2019). The system of whole productivity is very low and inefficient in Nepal due to smallholder Nepalese farmers with livestock (Shrestha, 2016). There is 60.4 % population involved in agriculture sector in Nepal. Fifteenth development plan has emphasized on production and productivity of agriculture sector in Nepalese economy (NPC, 2019). Nepalese agriculture sector has low growth rate and low productivity and no use of new technology (Paudel et al., 2019).

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The capacity to derive maximum output by per unit of resource is resource use efficiency, while 'resource' is supply of money, materials, staff, and other assets that are used in production by function effectively (Rahman & Lawal, 2003). Parametric and non-parametric methods are adopted to measure the efficient utilization of inputs in production, developed by Farrell at 1957 (Shrestha et al., 2016). Productivity is defined as reduction of unit cost of production so that the changed output ratio is greater than the ratio of changed inputs used in production process (Chavas et al., 2005).

Potato is one of major cash crops in cropping pattern of Kailali district with in local bodies; Dhangadhi Sub Metropolitan city, Godawari Municipality and Kailari Rural Municipality of the district (NPDP, 1983). Farmers purchase seeds from informal sources (household/families, neighbors or local markets) in Kenya. There is lack of clean potato seed. Certified potato seeds by government are expensive in market to smallholder potato farmers. It affects resource use efficiency and productivity of potato (Muthoni et al., 2013).The potato production in winter session is 750, 00 metric ton whereas 100 metric ton is produced in rainy session in Kailali district(Terai). Mostly, potato is planted at winter session in Kailali district in Nepal. In rainy season, the share of potato production is negligible in Kailali. It is produced in Hilly region in the period of rainy season in Nepal (NPDP, 2017). But, most of farmers in Kenya produced the potato twice a year throughout the rainy season (Gildemache et al., 2009, p. 180).

The specific purposes of this study were: to identify the factors affecting, to analyze resource use efficiency and productivity, and to compute type of returns to scale in potato production. As we know that our production technique is labor intensive. The resources are used haphazardly which results low output. The Cobb -Douglas production function enables to estimate the extent of resource use efficiency and productivity in potato production (Heady & Dillon, 1961).

A scale factor measures the returns to scale and interprets the elasticity coefficients of variables by using Cobb-Douglas production function in production of a particular product (Beattie & Taylor, 1985). Technical knowledge of using resources would help to increase output and returns to scale in potato production (Sapkota & Bajracharya, 2018). The power β of each input is known as the degree of homogeneity function that shows the returns to scale. When value of β is 1, then it explains the constant returns to scale which is linear homogeneous function. When $\beta < 1$, it depicts the decreasing returns to scale and if $\beta > 1$, it shows the increasing returns to scale are analyzed in production process (Koutsoyiannis, 1975). Summation of coefficients of inputs is calculated by production function. It explains returns to scale in production of any crops. If the increased ratio of inputs is less than increased ratio of output then it deals with increasing returns to scale. If a ratio of change in inputs and change in output is equal then it explains constant returns to scale. If the increased ratio of inputs is greater than increased ratio of output then it deals with decreasing returns to scale (Coelli et al., 2005). Technology is subject matter to get the increasing returns to scale and productivity by scarce resources (Diewert, 2004). Macroeconomic and microeconomic models assume increasing returns to scale in production. An input in production has been increasing marginal productivity (Romer, 1986).

Agriculture economists have shown long-run relationship among level of cost of inputs, quantity of output and returns to scale in agriculture sector. Econometric models are focused on returns to scale in production. Farmers operate the production on its input efficiency locus (McClelland et al., 1986). Kabir Miah et al., (2006) argued that efficient use of resources is achieved when Marginal Value of Product (MVP) is equal to Marginal Factor Cost (MFC) under perfect competition market by potato farmers. But they are different in imperfect competition market.

This study used *Human Capital Theory* and *Theory of Productivity and Efficiency* in production. Human capital is a combined form of various inputs that improves agricultural productivity and the allocative capacity of farmers. Frank and Bemanke (2007), has defined human capital is collection of various qualitative characteristics and social cultural factors. Education level, training, skills, experience, energy, work habits, trust towards work and initiative to works are the output of human capital. Among them education level is widely recognized human capital in production process (Huffman, 2001). Education level enhances the marginal physical product of labour (Aggrey et al., 2010). Resource use efficiency of a producer explains the comparison between inputs and output value. Production technology, differences in the scale of operation, difference in operating efficiency

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and difference in the operating environment make inefficiency in production to get expected output (Fried et al., 2008). Proper management of resources and public policies improve the efficiency and productivity of producer of any types of goods (Leibenstein, 1966). There is great scope of optimizing of inputs/resources in developing countries. These resources are mainly fertilizers, labour, land, pesticides and seed. The demand of these inputs is tremendously increasing in agriculture sector (Goulding et al., 2008).

Many studies have observed that understanding of resource use efficiency and productivity are contributing to better farming and secure food security, especially, in developing country like Nepal. From the literatures, it is clear that resource use efficiency and productivity gives benefit to potato farmers and output increases by optimum allocation of resources.

Resource use efficiency explains that the farmers efficiently use the resources to increase the production from given farm size. Every countries of the world are facing the scarcity of resources in production. This study is equally important to farmers to know the resource use efficiency and productivity in vegetables, especially potato production. It is essential for policy maker to know how the resources are used for optimum production and what kind of production technology to be adopted by local, provincial and state government in Nepal (whether capital intensive or labour intensive). Further, the resource use efficiency and productivity of potato production helps to design appropriate agriculture policies for proper decision for the promotion and development of agriculture sector. Through this study, some policy tools suggested based on scientific facts and also paved the future path to upcoming researchers.

Resource use efficiency and productivity ensures vegetable security in Nepal. Potato is staple vegetable in every parts of Nepal. Most of the small holder farmers involve in potato production. Government of Nepal has been continuously allocating budget in agriculture sector's development in every fiscal year's budget but productivity is not satisfactory. However, most households have no secured of vegetables production. It does not give benefit to small holder farmers in society. Due to lack of optimum utilization of available resources in cultivation of vegetable like lack of technical knowledge, low education level, and extensive service the productivity and production is low in Nepalese economy.

Due to lack of original research and traditional technology, resources have not been utilized and low productivity in agriculture sector in Nepal (Paudel et al., 2019). The finding of this study guides farmers and policy maker to formulate new plans. It further supports to implement the targeted programs toward raising the output of vegetables (like Potato) in Sudurpaschim province. Interested researcher will be supported from this study in vegetable fields. Farmers will familiarize to use various inputs in vegetable production so that they can achieve increasing returns to scale in production. They are using various resources but unknown about the proper utilization of them in potato production. At present, the state, provincial and local governments have the objectives to reform and increase productivity in agriculture sector. Thus, this study helps to all stakeholders in agriculture field for efficient use of resources in different region of country. It will make self-sufficiency in vegetable production including potato in Sudurpaschim province in Nepal. Limited resources / inputs to produce the agriculture output are the main issue of farmers in production activities

Most of the persons are not giving priority to vegetables production like potato in our society. Farmers produce the vegetables for subsistence level only. It has not become commercial yet. The main cause is resources use problem by the farmers in different ecological regions of Nepal (CBS, 2011). Poor understanding of the efficient resource use is responsible for low productivity (Rahman & Lawal, 2003). Government of Nepal is providing huge amount of subsidy in agriculture sector as regular in every fiscal years but output is not satisfactory.

The contributing inputs for resource use efficiency and productivity of potato are compost, labour, land, seeds, farm capital, fertilizers and pesticides (Coelli et al., 2005). Seed cost, credit facility and extensive service are insignificant in vegetable production (Bozoğlu & Ceyhan, 2007). Improved technologies enhance the farmers' skill in agricultural efficiency and productivity regarding the vegetable production (Kuwornu et al., 2012). Despite, being keen in interest in resource use efficiency

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and productivity, and returns to scale, only few literatures were available at the local and regional level of Sudurpaschim province regarding potato production in Kailali district. Therefore, factors affecting the resources utilization, optimum utilization of resources and increment of productivity, and returns to scale were main issues in potato production in Kailali district.

In the light of the above, this study answered: What are the socio-economic and demographic factors that affect in potato production in the study area? What are the inputs that determine full utilization of resource use and increase the? What are the factors that make inefficient utilization of resources and reduce the productivity? What type of returns to scale is found in potato production? Are the resources optimum utilized, or underutilized or over utilized in potato production by farmers?

Technical efficiency is affected by various farmers' socio-economic and demographic factors such as educational level, extension service, credit facility, family size, fertilizer, tractor and improved seeds (Basnayake & Gunaratne, 2002). Credit facility, fertilizer quantity, output price and household head are significant in the productivity of vegetable farmers (Xaba & Masuku, 2013). Cobb-Douglas production function is used to predict the significance of inputs in income from cash crops. The expenditure made in Family Yard Manure (FYM), labour, fertilizers, seed and raw material have significantly effect on gross income of coffee (Acharya & Dhakal, 2014).

This study had following purposes:

This study has the purpose of analyzing the resource use efficiency and productivity of potato production. In line with this, the specific purposes are as: to identify the factors affecting in resource use efficiency and productivity of potato production, to utilize the resource use efficiency and productivity in potato production and to show the type of returns to scale in potato production

This study had following research questions:

1. What are the factors affecting the resource use efficiency and productivity of potato production?
2. How the resources are utilized by the farmers in potato production?
3. What type of returns to scale is operating in potato production?

This study had following hypothesis:

H_1: There is an effect of household size, education level, extensive service, farm size, seed cost, FYM, hired labour and pesticide used in resource use efficiency and productivity in potato production.

H_2: There is optimum utilization of resources by farmers in potato production.

H_3: Increasing returns to scale is applied in potato production.

The leading inputs used in potato production are labor, seed, bullock and Farm Yard Manure (FYM). Labour is used for farm preparation, weeding, harvesting and sowing potato tubers. Hired and family labours are both used in potato production in Baglung district of Nepal (Bajracharya & Sapkota, 2017). They have not explained about the utilization of resources and no study of returns to scale. In Kenya, most of the farmers cultivate the potato twice a year, during the rainy season (Gildemacher et al., 2009, p.180). Potato is cultivated commercially in all climates of the world (Midmore, 1992). But, potato is produced only in winter session in Kailali district.

Utilization of pesticides, labour, fertilizers, farm size, seeds and compost were highly significant in maize production in Eastern Nepal (Sankhuwasabha district) (Shrestha et al., 2015). The resources like seed, bullock, fertilizer and labour were over utilized regarding of production of maize in Sindhuli district in Nepal (Dahal & Rijal, 2019). Jhapa district has showed the decreasing returns to scale in rice production regarding the resources use efficiency of rice production in Nepal (Subedi et al., 2020). These research works were based on maize and rice production. These literatures have not shown the issue of the resource use efficiency and productivity, and returns to scale of potato production. There were quite different socio-economic and demographic features for vegetable production in Kailali district. We were interested in understanding how the farmers utilize the resource and get returns to scale from potato production.

2. Methods and Materials

2.1. Research Design

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This study used causal survey research design to find the impact of explanatory variables in potato production. This survey design is strong because it explains the utilization and analysis of numerical data in research. It shows the cause and effect of dependent and independent variables in study. It is popular design to apply the specific statistical techniques to answer question like how much, who, when, what, how many and how. It explains an issue by collecting data in numerical form that gives finding of the issue in research (Apuke, 2017). Explanatory research is used to investigate a phenomenon that has not been studied properly. It is responsible for finding the cause and effect relationship through hypothesis testing. It is used in focus groups that are source of information about the phenomenon under study and organizing sessions to obtain various data for study (Arias, 2012). Explanatory research design explains the relationship between variables (cause and effect). It studies the direction and covariance of any two variables. Researcher should explain the variables in objectives and questionnaire for this research design. It explains the relationship between variables by using statistical tools. It finds either the variables are related or not in research (Khadka, 2020). From these literatures, we used dependent and independent variables. The hypothesis testing has been setting. Similarly, households (families) / potato farmers are focus group of this research.

Resource use efficiency and productivity of potato was a comparatively new idea of investigation in Sudurpaschim province in Nepal. The research is based on quantitative method. Descriptive and explanatory research designs are popular designs to find the impact of independent variables to dependent variable in research. They are used for data analysis of this study. Survey method by using semi structured questionnaire/households schedule was used for data collection from the field.

2.2. Population and Sample

Krejcie and Morgan is a popular method to estimate the appropriate sample size in research. Krejcie and Morgan (1970) have stated the following formula to estimate the sample size:

$$S = X^2NP\ (1\text{-}P) \div d^2\ (N\text{-}1) + X^2P(1\text{-}P)$$

where, S = required sample size, X^2 = the table value of chi-square for one degree of freedom at the desired confidence level (3.841), N = the population size, P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size), d = degree of accuracy expressed as a proportion (0.05).

Based on Krejcie and Morgan's (1970) table for determining sample size, for a given population of potato farmers of 222 by Dhangadhi Sub- Metropolitan city, Godawari Municipality and Kailari Rural Municipality, a sample size of 140 would be needed to represent a cross section of the population. Based on this formula, 140 households/families were taken as sample size for the study of potato production.

2.3. Tools and Techniques of Data Collection

The data for the study were primary data. Primary data were based on cross section data from three local governments of Kailali, namely Dhangadhi Sub Metropolitan city, Godawari Municipality and Kailari Rural Municipality. I collected the primary data through semi structured questionnaire schedule from households/families. Descriptive, explanatory, regression analysis and Cobb-Douglas production function were applied to find the purposes of this study. Simple random sampling technique is the purest form of probability sampling and is commonly used in research. Under this technique, all items of the population have equal chance of being selected in this study. This method is used only in those studies where the entire population can be listed (Pant, 2011). It is the technique in which each and every unit in the population has an equal and independent chance of being included in the sample (Gupta, 2009 p. 15. 15). Thus this study used simple random sampling technique for data collection.

Rahman & Lawal (2003) stated that the ratio of Marginal Value of Product (MVP) to Marginal Factor Cost (MFC) estimates the efficiency of resource used in production. By the help of them, utilization of resources was predicted.

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2.4. Econometric Model

2.4.1. Model of Assessing Factors Affecting in Potato Production

Multiple regression model was used to show the effect of independent variables in dependent variable regarding of assessing the impact of factors in this study. Gujarati et al. (2012) explains the general multiple regression function as

$$Y_i = \beta + \beta_i X_i + ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$i=1, 2, \ldots\ldots\ldots, n$$

Where, Y_i: Dependent variable, X_i: Independent variable, β: Constant term, β_i: Unknown estimated regression coefficients, ui : Error term.

Thus regression equation of this study can be written as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_{7+} + \beta_8 X_8 + ui \ldots\ldots (2)$$

where, Y: Income from potato production in Nepalese Rupees (NRs), (dependent variable), explanatory variables are: X_1: Households size, measures as number of family members, X_2: Education level, measured in different level of schooling, X_3: Extension service from government, X_4: Farm size, in Kattha, X_5: Seed cost, in Rs., X_6: FYM cost, in Rs., X_7: Hired labour cost, in Rs., X_8: Pesticide cost, in Rs., ui: error term.

2.4.2. Model of Analyzing Resource Use Efficiency and Productivity in Potato Production

Cobb-Douglas production function is the important used form of production function in agricultural research in economics (Hayami, 1970). According to Gujarati (2004, P. 223), the Cobb-Douglas production function in stochastic form may be written as:

$$Y = \beta X_i^{bi} e^{ui} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, u: Stochastic disturbance, e: Base of the natural logarithm, I: 1, 2,…………, n.

Ulveling & Fletcher (1970) stated, the empirical Cobb- Douglas production function is as under:

$$lnYi = ln(Xi)\beta i + v_i - u_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where, βi is unknown parameters to be estimated, Xi is vector of inputs, v_i is a random error term, technical efficiency with zero mean and constant variance $\sigma^2 v$, u_i is technical inefficiency effects on farm enterprise.

From the above equations, it is clear that the relationship between output and inputs is non-linear. Now, transforming this model using logarithm and obtain,

$$ln\ Y = ln\beta + \beta_1 ln\ X_1 + \beta_2 ln\ X_2 + \beta_3 ln\ X_3 + \beta_4\ ln\ X_4 + \beta_5 ln\ X_5 + \beta_6 ln\ X_6 + \beta_7 ln\ X_7 + \beta_8 ln\ X_8 + ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\ln Y = \beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where, $\beta o = \ln \beta$. Thus, the model is linear in parameters β_0, β_1…………… β_8, and is therefore a linear regression model. In a short, it is a log-linear model. ln = natural logarithm.

Rahman & Lawal (2003) advocate the level of resource use efficiency is calculated by using following formula:

$$r = \frac{MVP}{MFC} \quad \text{……………………………………………………………………. (7)}$$

Where, r: Efficiency ratio, MVP is Marginal Value of Product which means increased in unit of inputs results increment the additional units of output in production. MFC (Marginal Factor Cost) is equal to unity. Since both dependent and explanatory variables are converted to monetary value; and is defined as the increase in the cost of inputs due to purchase of additional unit of inputs. The inputs /resources are seed cost, FYM cost, Hired labour cost and pesticide cost in this study for the purpose of analyzing the resource use efficiency and productivity in potato production.

$$Now, \overline{MVP} = \beta_i \frac{\overline{Y}}{\overline{X}} \quad \text{…………………………………………………… .(8)}$$

where, β_i : Estimated regression coefficient of input Xi, $\overline{Y}$: Geometric mean value of output, $\overline{x}$ = Geometric mean value of i^{th} resources used .

Decision rule: when, r = 1; it implies the inputs are used efficiently (optimum) utilization, r >1; it implies the inputs are underutilized and therefore output would be increased if more of that input is employed and r <1; it implies the inputs are over utilized and therefore both output and profit would be maximized (Mbanasor, 2002).

Finally, the relative percentage change in MVP is calculated using following way:

$$D= (1-MFC/MVP) \times 100$$

$$D= (1-1/r) \times 100$$

Where, D: absolute value of percentage change in MVP of each resource (Mijindadi, 1981). Thus this econometric model was used to fulfill the purpose to utilize the resource use efficiency and productivity in potato production.

2.4.3. Model of Computing the Returns to Scale in Potato Production

This was the third purpose of this study. After the computation of coefficient of explanatory variables, returns to scale was calculated. Dwivedi (2013, p. 258) argues the summation of respective coefficients inputs obtained from Cobb–Douglas production function gives the value of returns to scale.

$$RTS= \sum \beta_i \quad \text{………………………………. ……………………………... (9)}$$

Where, RTS: Returns to Scale, β_i: Coefficients of inputs.

Thus this econometric model was used to fulfill the purpose of showing the types of returns to scale in potato production.

2.4.4. Methods of Data Interpretation and Analysis

The field surveyed data initially inputted into excel sheet and IBM "SPSS" Statistics (Version 23). The preliminary data cleaning was done in SPSS. Data analysis was carried out in two stages. Initially, descriptive statistics such as minimum, maximum, frequency, mean, percentage and standard deviation was carried out. Similarly, Regression model by using Cobb-Douglas production function was used to establish relation, to identify the contribution/effects of independent variables to dependent variable and to analyze the resource use efficiency in potato production. Thus the analytical methods were based on descriptive and explanatory analysis.

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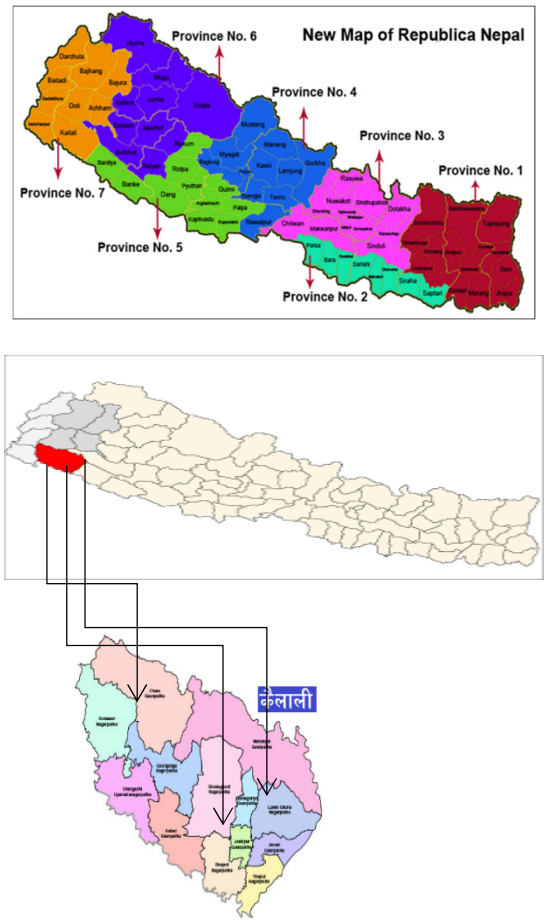

Figure 1. Map of Nepal and Kailali District Showing the Study Sites.

3. Results

3.1. Socio-economic and Demographic Characteristics

Descriptive analyses of various socio-economic and demographic variables are presented in Appendix A. Male household head had dominant role in decision making in potato farming in family. It showed 80% households were male headed. Maximum household size was 22 that showed joint family system in this study. Literacy rate of farmers was 94.80 %. Secondary education level of farmers was maximum % (31.4). The access of extensive service was 59.28 %. Maximum farmers (95%) were unable to get the expected price of their potato. There were many causes of it. Among them, free entry of Indian potato was major cause. The access of credit facility was 35.70 % to farmers. Out of them, 84 % farmers took credit from co-operatives. Farmers responded the complicated process of taking credit from banks (32.10 %). Thus farmers were compelled to take credit from co-operatives. Local governments had provided subsidies for the purpose of resource use efficiency and productivity to potato farmers. The access of potato farmers in subsidies was 65.70 %. Majority of subsidy was in seed (50.70 %). Descriptive analysis shows that 34.30 % farmers were far away from access of subsidies given by governments (local, provincial and state). It showed subsidies could not touch to every potato farmer. Similarly the major means of ploughing were *Bullock* and *Tractor* (65.70) % in this study.

3.2. Descriptive Statistics of Variables of Potato Production

Farm size, seed cost, hired labour cost and pesticide cost were the explanatory variables and Mean, Standard Deviation (SD), Minimum (Min) and Maximum (Max) values were taken for descriptive analysis of the result in this study.

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Table 1 showed descriptive statistics of the input variables of the research. It presented mean, standard deviation, minimum and maximum value of inputs. Farm size / land with potato farmers were minimum 2 Kattha and maximum 25 Kattha for potato production. It showed some households had very small size of land for potato production. Some households/families had not used FYM, hired labour and pesticide in potato production that have zero value.

Table 1. Descriptive Statistics of Variables of Potato Production.

Variables	Mean	SD	Min	Max
Farm size	6.36	3.86	2	25
Seed cost	19770.21	15101.02	1600	96000
FYM cost	11100.79	9068.75	0	137500
Hired labour cost	16427.86	21019.76	0	137500
Pesticide cost	3807.18	6988.67	0	70000

Source: Field Survey (2021). *Note:* N = 140, SD = Standard Deviation, Min = Minimum, Max = Maximum.

Standard deviation is deviation taken spread from mean. If standard deviation is less than mean value, then the data set is consistent and vice versa (Khadka, 2020). Standard deviation signifies the spread of distribution. The term standard deviation is generally used for variability of sample distribution, through it is also used to mean population variability (Singh, 2007). Except farm size, the standard deviation of seed cost (Rs.19770.21), FYM cost (Rs.11100.79), hired labour cost (Rs.21019.75) and pesticide cost (Rs.6988.60) was greater than their mean values .Therefore, they were inconsistent in this study. It means the data of these resources were deviated from mean value of resources in potato farmers in the study.

3.3. Conditions Tested for Regression Model

According to Singh (2007), if the value of Adjusted R^2 is 75 %, then the model is very good, if it is 50 to 75 % then it is good, if it is 25 to 50 %, it is fair and if it is up to 25 % the model is poor. The model had been tested in the given Table 2.

Table 2. Model Summary (dependent variable: b).

Model	R	R^2	Adj. R^2	Std. Error of the Estimate	Durbin-Watson
1	0.81[a]	0.66	0.62	0.46	1.95

Source: Computation through SPSS (2021).a = Predictors: (Constant), Ln Extensive service, Ln household size, Ln Pesticide, Ln seed, Ln Education level, Ln Hired Labour, Ln FYM, Ln Farm size. b = Ln Income Potato.

By the help of SPSS software R^2 and Adj. R^2 had been calculated in the Table 2. Thus from the above literature given by Singh (2007), the regression model was good for the study because R^2 and Adj. R^2 were 66 and 62 % respectively. The linear regression model is based on the assumption of non-auto correlation. If there is autocorrelation, it poses serious problem. Durbin -Watson test is used to detect the presence of autocorrelation. When the value of Durbin -Watson test is 1.5 to 2.5, then there is no autocorrelation (Aryal & Gautam, 2001). Durbin -Watson value from Table 2 was 1.95 that showed no autocorrelation in this study.

Table 3 showed the regression model was significant (Sig. = 0.00).

Table 3. ANOVA (dependent variable = a).

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	28.95	8	3.61	16.97	.00[b]
1Residual	14.93	70	.21		
Total	43.88	78			

Source: Computation through SPSS (2021). a = Ln Income Potato. b = Predictors: (Constant), Ln Extensive service, Ln household size, Ln Pesticide, Ln seed, Ln Education level, Ln hired Labour, Ln FYM, Ln Farm size.

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Explanatory variables should only be allowed if its VIF is less than five (5) in a regression analysis (Akinwande et al., 2015). Table 7 shows the VIF of every explanatory variable is less than five (5). Thus, there is no issue of multicollinarity in this study.

The tolerance is calculated which is the inverse of the VIF. More likely is the multicollinarity among the variables if there is lower the tolerance. The value of VIF shows the correlation to each input. If VIF = 1, then the explanatory variables are not correlated to each other in the model. If the value of VIF is from ranges 1< VIF < 5, it specifies that the explanatory variables are moderately correlated to each other's (Shrestha, 2020). Explanatory variables should only be allowed if its VIF is less than five (5) in a regression analysis (Akinwande et al., 2015). Table 4 showed the VIF of every explanatory variable is less than five (5). Thus, there was no issue of multicollinarity in this study.

Table 4. Coefficients (dependent variable = a).

Model	Unsta. Coeff. β	Std. Error	Stand. Coeff. Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
(Constant)	7.78	1.50		5.18	0.00		
Ln seed	0.04	0.10	0.03	0.46	0.64	0.75	1.32
Ln FYM	0.05	0.09	0.05	0.59	0.55	0.63	1.57
Ln Hired Labour	0.01	0.08	0.01	0.08	0.93	0.62	1.60
Ln Pesticide	0.16	0.05	0.20	2.76	0.01	0.91	1.09
Ln household size	0.10	0.14	0.05	0.73	0.46	0.83	1.19
Ln Education level	0.31	0.11	0.20	2.69	0.01	0.86	1.15
Ln Farm size	0.70	0.16	0.46	4.35	0.00	0.43	2.31
Ln Extensive service	0.82	0.18	0.33	-4.35	0.00	0.80	1.23

Source: Computation through SPSS (2021). a = Ln Income Potato. Variance Inflation Factor (VIF) measures the variance of the estimated regression coefficient is inflated if the explanatory variables are correlated. VIF is calculated as:.

$$\text{VIF} = \frac{1}{1-R^2} = \frac{1}{\text{Tolerance}}$$

The tolerance is calculated which is the inverse of the VIF. More likely is the multicollinarity among the variables if there is lower the tolerance. The value of VIF shows the correlation to each input. If VIF = 1, then the explanatory variables are not correlated to each other in the model. If the value of VIF is from ranges 1< VIF < 5, it specifies that the explanatory variables are moderately correlated to each other's (Shrestha, 2020).

3.4. Factors Affecting to Resource Use Efficiency and Productivity

Table 5 showed the results of the multiple regression of the research. Significant values and the coefficient (β) of explanatory variables were shown in the column.

Table 5. Factors Affecting in Resource Use Efficiency and Productivity in Potato Production.

Variables	Coefficient (β)	Sig.
Ln Household size	0.05	0.46
Ln Education level	0.20	0.00*
Ln Extensive service	-0.33	0.00*
Ln Farm size	0.46	0.00*
Ln Seed cost	0.03	0.64
Ln FYM cost	0.05	0.55
Ln Hired labour cost	0.00	0.93
Ln Pesticide cost	0.20	0.00*

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Source: Field Survey (2021). *Note:* N =140. '*' indicates statistically significant at 1 % level of significance. * P < 0.01.

Regression model is adopted to find the impact of resources used by farmers in potato production (Mustafa et al., 2023). Hence, regression model had been used to find the impact of independent variables on dependent variable. Table 5 showed regression model was statistically significant which was supported by the Table 3 in which ANOVA, F= 16.97, P = .00. The model explained 66 % (R^2) of the variance in resource use efficiency. Agricultural inputs significantly affect the yield of crops like seeds, fertilizers, pesticides and others affect the ultimate yield (Ozturk et al., 2008). From Table 5, education level, extensive service, farm size and pesticide were highly statistically significant at 1 % level of significant.

3.5. Analysis of Resource Use Efficiency and Productivity in Potato Production

Cobb-Douglas production function is major technique to calculate the Marginal Value Product (MVP) and Marginal Factor cost (MFC) in order to determine the optimum, over and under use of resources (Porter & Gujarati, 2009). Thus, resource use efficiency has been calculated by MVP and MFC. From above equations (3.7) and (3.8)

$$r = \frac{MVP}{MFC},\ MVP = \beta_i \frac{Y}{X},\ D = (1\text{-}1/r) \times 100$$

By using above formula/model the following values have been calculated.

Table 6. Analysis of Resource Use Efficiency and Productivity in Potato Production.

Variables	Coeff.(β)	MVP	MFC	r	D-value	Efficiency
Ln Seed cost	0.03	0.03	1	0.03	2885.07	Over utilized
Ln FYM cost	0.05	0.04	1	0.04	2023.14	Over utilized
Ln Labour cost	0.01	0.01	1	0.01	17020.35	Over utilized
Ln Pesticide cost	0.20	0.21	1	0.21	367.07	Over utilized

Source: Field Survey (2021).

Table 6 showed the resource use efficiency. By the help of SPSS software, the values of coeff. (β*)* had been calculated in the Table 6. MVP has been calculated from excel sheet. Under perfect competitive market MFC remains unity, which has already mentioned. The individual resources coeff. (β*) or* (elasticities) as obtained from multiple regression model by using Cobb-Douglas production function analysis, MVP and MFC were calculated for the computation of resource use efficiency and productivity .

3.6. Computation of Returns to Scale in Potato Production

By the summation of regression coefficients (β), returns to scale are calculated (Basu & Fernald, 1997). Whether the returns to scale either is increasing, constant or deceasing returns to scale is found by the sum of the coefficients in potato production. Table 7 showed the calculation of type of returns to scale.

Table 7. Calculation of Returns to Scale in Potato Production.

Variables	Coefficient (β)
Ln Household size	0.05
Ln Education level	0.20
Ln Extensive service	-0.33
Ln Farm size	0.42
Ln Seed cost	0.03
Ln FYM cost	0.05

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Ln Hired labour cost	0.00	
Ln Pesticide cost		0 .20
Summation of Coefficient(β)		0.42

Source: Field Survey (2021).

The summation value of coefficients of land, labour, fertilizer and seed was 0.75 <1, shows farmers were producing in decreasing returns to scale. Managerial inefficiency of farmers in using inputs created diseconomies of scale of resources that provided the decreasing returns to scale in production (Weldegiorgis et al., 2018).Table 7 showed summation value of coefficients (β) of this study was 0.42 that showed decreasing returns to scale to the potato farmers. It means when resources are increased by 1% then output of potato increases by 0.42 % in the production process.

4. Discussion and Conclusion

The output of potato is determined by various characteristics of farmers like socio-economic factors. They are considerable factors for full utilization of resources and increase the productivity. They are traditional in nature and farmers have hesitation to engage in development and commercialization of agriculture outputs (Taiy et al., 2017). Majority of household heads were male (67.20 %) of potato production (Dahal et al., 2019). From Appendix A of this research, potato production was dominated by male farmers (80 %). Thus male headed household made decision to apply inputs including technology in potato production in study area. Secondary education level (9 to 12 classes) of farmers was the maximum frequency in production. Farmers got extensive services from local government (59.29) %). Subedi et al., (2019) argued 35.2 % farmers sold the output at *Local Market/Hatbazzar* in their study. This study found 40 % farmers sold the product to *community* and 37.9 % in *Hatbazzar*. Nepal has open border with India in Kailali district .Vegetables including potatoes is imported from India freely. Thus Maximum farmers did not get expected price of output due to free entry of Indian potatoes. It was 95 % in study sites.

Cooperatives are major source of agriculture credit. They provide loan easily to farmers in time. The interest rate of cooperatives is also low and loan taking procedure is simple than financial institutions monitored by Nepal Rastra Bank (NRB) (Devi, 2012). Farmers did not have sufficient access of credit facility. It was only 35.7 %. Out of access of credit facility, most of the farmers got credit from co-operatives. It was 84 %. Potato farmers responded the complicated process of loan taking from banks. In spite of being sufficient banks, farmers were compelled to take credit from co-operatives in Kailali district.

The subsidy is really profitable to agriculture sector but due to mismanagement in distribution system, it is not reaching to final users. Subsidy helps to increase agriculture productivity (Salunkhe & Deshmush, 2014). The access of subsidy was 65.72 % to the farmers in this study. Most of the farmers (50.70 %) got subsidy in seed. The subsidy policy of government to farmers could not cover to all farmers in this study. The major means of ploughing were bullock and tractor for potato production.

Table 1 showed the descriptive analysis of socio-economic and demographic variables. When average value is greater than the value of standard deviation then the data shows the consistent of the series (Livingston, 2004). Hired labour cost, farm size, seed cost, FYM cost and pesticide cost have more standard deviation than mean value thus they were inconsistent in this study. Optimum use of resources and productivity in agriculture sector depend on socio-economic and demographic factors of farmers. They are significant for improving farmers' efficiency for potato production (Andaregie & Astatkie, 2020). Regarding the first question of the study, the analysis showed that education level, extensive service, farm size, and pesticide cost found to be statistically significant in this study. In the context of second question, all the resources are over utilized in research area. Finally, decreasing returns to scale in production is achieved regarding the third research question of this study.

The study showed that farmers adopted socio-economic, demographic factors and inputs in agricultural output. The perception of gaining utility is determined by the farmers' behavior which is determined by socio-economic, demographic and input variables. They are household size,

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education level, extensive service, farm size, seed cost, FYM, pesticide and labour. Education level, extensive service, farm size and pesticide were played an important role in resource use efficiency and productivity of potato production. Household size, seed, FYM and hired labour are insignificant in potato production. Maximum farmers used local FYM, Local seed, local labour, so they had less paid attention on utilization of these resources for potato production. Potato production was dominated by male farmers. Due to entry of Indian potato in Kailali district, the farmers of the sampled area were unable to get reasonable price of their outputs. There was lack of credit facility to farmers from banks in the study sites. Out of access of credit facility, most of the farmers got loan from co-operatives. Farmers responded that loan taking process was very complicated from banks. Thus farmers are compelled to take loan from cooperatives for potato production. Most of the farmers got subsidy in seed. But the seed cost is insignificant in income o farmers. The major means of ploughing were bullock and tractor in production. Bullock is traditional source of means of ploughing in Nepalese society. It reduces productivity in production.

Now female farmers should also engage in production. Farmers are far away from access of subsidy. Majority of subsidy is in seed where as it is insignificant in potato production. Socio-economic demographic factors and inputs used can enhance the utilization of resources and productivity in the changing context and transformation of agriculture sector. Regarding factors affecting, education level, extensive service, farm size and pesticide affect the resource use efficiency in potato production. The resources such as FYM, hired labor, seed and pesticide used are overused in potato production whose cost needs to be reduced for their optimum utilization. It suggests that the technical knowledge is required to farmers to appropriate use of existing resources so that productivity will be increase. This study concludes that the scarce resources must be used efficiently to get increasing returns to scale in production of any crops. Government and stakeholders should give priority to resource use efficiency and productivity and technical knowledge in agriculture practice.

5. Implications

The research on resource use efficiency and productivity in Nepalese agriculture sector and developing an effective mechanism to use resources at optimum level and enhance the productivity of potato through different measures such as enhancing education level, extensive service, increase in farm size, subsidy policy, formulating policies, developing research culture and mitigating the challenges faced by farmers were major implications to the farmers and policy makers.

The findings of the study like over utilization of resources and decreasing returns to scale in potato production showed the traditional method of production and paying less attention on the use of local resources showed that the significant variables; education level, extensive services, farm size can be useful to increase efficiency and productivity at local level. On the other hand, suppression in the local price due to uncontrolled import of Indian products was affecting commercialization of potato in the study area which should be a concerned of the government.

5.1. Implications in Policy Making

As indicated in this study, due to multiple causes, farmers were not getting reasonable price of their product. Import from legal and illegal channels of Indian potato was major cause of it. Major share of subsidy was in seed, extensive service was only few hands of the farmers, resources were over utilized and holding law of decreasing returns to scale in potato production need to be solved by the governments. Subsidy and bank credit needed to be extended to the farmers whose only profession is agriculture. Similarly, this study could be a part of new review for the research and agriculture centers and researcher community on local level government from which farmers can receive support and feedback. These centers can employ agriculture technician and necessary feedback to farmers.

This research might help to make the provision of subsidy in different stages of (not only seed) agricultural development programmes, and training to farmers. Therefore, it is necessary to train the farmers before planting the vegetables. Moreover, the governments can make protection policy to

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domestic vegetables and provision of chemical fertilizers in time in market. Likewise, the local governments might build cold store and purchases the output at reasonable price.

Household size, seed, FYM, hired labour were insignificant variables in this research that showed farmers should pay attention on the utilization of them in production. To use optimum level of the resources and increasing returns to scale, government can introduce the capital intensive technique in agriculture sector that may increase the quantity and quality of outputs. Finally, government should control the intermediates of the agriculture marketing and it should purchase the outputs itself.

5.2. Implications for Modernization and Commercialization

Decreasing returns to scale and over utilization of local resources presented the attitude of farmers was subsistence level of agriculture outputs which could not help the farmers to income generation. Therefore, they need to learn the global practices of farming. By gaining insights from the findings, government might collaborate with the farmers making close relationship that can create an environment for constructive and formative feedback to outputs. While giving feedback on the farmers' production technology and inputs, farmers need to focus on increasing returns to scale and modernization and commercialization of outputs.

Hence implications conclude:

5.3. Policy Suggestions

Imports of potato from Indian market should be controlled. Thus, protection policy is needed by government in agriculture sector by trade barriers. Household size, seed, FYM and hired labour are independent variables which are insignificant for potato production. Now the household head should make alert the family members towards the agriculture production. Seed should be qualitative and tested by government. FYM is organic fertilizer which is easily available in society of research sites in Kailali district. Government should teach the farmers of how to use it at certain interval so that productivity increases. Similarly, hired labour does not support the output so family labour should be encouraged. Ultimately farmers should use the resources as optimum level.

Agriculture extension services should be increased to handle the socio-economic and demographic factors so that resource use efficiency and productivity will be possible including increasing returns to scale in agriculture sector. Initially farmers' identity card should be given then subsidy should be given to real farmers by step to step by government. It should not be focused on seed only. It should also be diverted in marketing, chemical fertilizer, transportation and machineries. It will enhance the resource use efficiency and productivity of potato production in Sudurpaschim province so that optimum utilization of inputs and increasing returns to scale will be occurred. Subsidy should be given on the basis of productivity of vegetables. Efforts should be done how the farmers are using resources by existing technology of production so that it can provide optimum utilization of resources and increasing returns to scale in potato production.

5.4. Practice Ahead

Farmers use inputs like farm, pesticide and seed without testing their quality. They may train about the quality and use of the resources from agriculture extension programme on the specific nature of the resource use efficiency process**.** Even the resources are over utilized there is decreasing returns in potato production. The government and concerned agencies' activities including subsidy and use of capital-intensive production technique may help to optimize the utilization of resources that may hold increasing returns to scale in production.

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Appendix A

Table A1. Socio-economic and Demographic Characteristics of Farmers.

Variables	Frequency	%
Household size		
Maximum	22	15.7
Minimum	1	0.7
Gender	Frequency	%
Male	112	80
Female	28	20
Education level	Frequency	%
Primary	23	16.4
Lower secondary	43	30.7
Secondary	44	31.4
Bachelor degree	20	14.3
Masters	2	1.4
No Education	8	5.2
Extensive service	Frequency	%
Access	83	59.29
No excess	57	40.71
Marketing	Frequency	%
Whole sellers	4	2.9
Community	56	40
Whole seller sand community	27	19.3
Hatbazzar	53	37.9
Expected Price	Frequency	%
Yes	7	5
No	133	95
Total	140	100
Cause of no expected price	Frequency	%
Dominance of whole sellers	9	6.4
No cold store /Storage facility	34	24.3
Lack of Organized market	18	12.9
Entry of Indian potato	71	50.7
Others	1	0.7
Credit facility	Frequency	%
Yes	50	35.70
No	90	64.30
Source of credit	Frequency	%
Friends and relatives	4	4
Neighbors	1	1
Co-operatives	42	84
Bank	5	10
Cause of no credit	Frequency	%
No collateral	14	10.0
Complicated process	45	32.1
Unknown	6	4.3
No necessary	27	19.3
Others	5	3.6
Total	140	100.0
Access of Subsidy	Frequency	%
Yes	92	65.7
No	48	34.3

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Total	140	100
Subsidy title	Frequency	%
No subsidy	48	34.30
Subsidy in seed	71	50.7
Subsidy in power tiller	8	5.7
Subsidy in other equipment	2	1.4
Cash	11	7.9
Total	140	100
Means of ploughing	Frequency	%
Bullock	4	2.9
Tractor	12	8.6
Power tiller	1	0.7
Bull & Tractor	92	65.7
Bull & Power	31	22.1

Source: Field Survey (2021).

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