Resource Use Efficiency in Vegetable Production in the Kailali of Sudurpaschim Province

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Abstract

This study aimed to examine factors affecting, resources use efficiency and returns to scale in vegetable production by analyzing impact of resources utilization in Kailali. Applying quantitative causal survey including descriptive research design, it explored impact of resources utilization and socio-economic factors through structured questionnaire from 100 farmers by random sampling. Though, there are extensive researches of agriculture, inputs and returns to scale, very few papers explored in Kailali. Data analysis was carried by *frequencies, mean, SD, t-test, Durbin-Watson test* and *multiple regression model* using *Cobb-Douglas production function*. *Indian Vegetables* were major responsible for no expected price of vegetables in Dhangadhi Sub-Metropolitan city, Godawari Municipality and Kailari Rural Municipality. This study showed socio-economic factors of farmers played decisive role in resource use efficiency and returns to scale. Education level, extensive service, land, chemical fertilizer and seed were statistically significant to returns from vegetable to farmers whereas subsidy, household size, pesticide and labour could not support to income of farmers. Since efficiency ratio is greater than unity, the resources are underutilized. Chemical fertilizer and pesticide were underutilized and need to increase cost by 10.37% and 72.11% respectively whereas seed and labour were overutilized due to the efficiency ratio is less than unity and need to decrease cost by 14.05 % and 95.88 % respectively for their optimum allocation. Land was underutilized. Lack of training, exposure, education level and extension service were reasons for inefficient use of resources and decreasing returns to scale in production. It is recommended farmers should have technical knowledge for optimizing resources which would increase production and productivity, and increasing returns from vegetable production.

Keywords: *Agriculture, Farmers, Resource use efficiency, Returns to scale, Vegetable production*

Introduction

This quantitative causal survey study on the resource use efficiency and returns to scale in vegetable production is based on Kailali, Terai region of Sudurpaschim province. It analyzes factors affecting, utilization of resources and returns to scale, collecting data through quantitative causal survey. Vegetable is cash crop in Nepal especially in Hill and Terai region. It is a major component in Nepalese economy which provides huge employment and major source of income, and supplying plenty of nutrients for millions of people (NPDP, 2017). Potato is one of the major vegetables in Nepal. The area, production

and productivity of vegetables have been reported to be 192,410 ha, 3,299,750 Mt and 17.15 Mt/ha, respectively in Nepal in the year 2020/21 (MoF, 2021).

Agriculture is the largest sector of Nepalese economy among the south-Asian developing countries that contributed 23.95 % of GDP in the year 2022/23 (MoF, 2023). The system of whole productivity is low and inefficient in Nepal due to lack of resource use efficiency that leads decreasing returns to scale (Shrestha, 2016). Fifteenth development plan has emphasized on production and productivity of agriculture sector in Nepalese economy (NPC, 2019). Vegetable crops includes a large number of plants, mostly annual and a few perennials, grown for their edible leaves, stems, flowers, budgs, flowers fruits and roots. They are integral parts of a balance diet and are considered as protective foods and prevent several diseases.

Mt =Metric ton, ha= hectare, SD=Standard Deviation

Vegetable crops give 5 to 10 times more yield per unit area than cereals and millets. Potato leads in production followed by Tomato, Chilly, Onion, Cabbage and Brinjal (Gopalakrishnan, 2007).

The resource use efficiency refers to the value of all inputs used to obtain a product technically efficient must choose the one that attracts the minimum value of inputs (Chetroiu & Calin, 2013). In general sense resource use efficiency is technical efficiency. It is the ability of a farm to produce the maximum level of outputs from the given resources. It helps to produce the given level of outputs from the minimum quantity of inputs by using the fixed technology in production process. Price efficiency is occurred from allocative efficiency that makes the equality of the marginal product and the marginal cost to each other (Shrestha et al., 2016). Resource use efficiency is needed to find the resources are whether overused or optimally used or underused. Inefficient use of resources increases the cost of production which results low return from vegetable production (Ishtiaque et al., 2017).

Despite higher production of the vegetables, import of them has been continued in Kailali. The district imports 30,000 ton of vegetables worth Rs.500 million per year from India. A big chunk of these vegetables enter the country through *Gauriphanta custom point*. Despite domestic production, demand for vegetables is growing which is fulfilled from imported vegetables (*https://kathmandupost.com/money/2018/04/24)*. Kailali accessed inputs, extension services, markets, infrastructures and government incentive (Subsidy) that gives resource use efficiency and returns to scale. Most of the farmers have given the priority in vegetable production in Terai (Shrestha et al., 2015).

Farmers produce vegetables for subsistence level in Sudurpaschim province. This research paper may help in commercialization and modernization of vegetables production throughout the region and all over the country. 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). The general objective of this study is to analyze the resource use efficiency and returns to scale in vegetable production.

Remote rural farmers are partially informed about the utilization of inputs like hybrid seed; fertilizer, pesticides and types of soil that causing low production and low productivity. They have no knowledge to utilize various resources like seed, fertilizers, and pesticides. Farmers are producing the vegetables in traditional technique. Resource use efficiency identifies whether the resources optimally used or underused or overused in production process. Production cost increases due to inefficient use of resources and resulting low returns from vegetable production (Devkota et al., 2018). Resource use efficiency ensures vegetable security in Nepal. Government of Nepal has invested in agriculture development but productivity is low. 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 production like lack of technical knowledge, low education level, and extensive service, the productivity and production is low in Nepalese economy.

The leading inputs used in vegetable production are labor, seed, bullock and chemical fertilizer. Labour is used for farm preparation, weeding and harvesting. Hired and family labours are both used in production but male labour has dominant role in Nepalese farms (Bajracharya & Sapkota, 2017). Due to traditional technology, resources have not been utilized and low productivity is seen in agriculture sector in Nepal (Paudel et al., 2019). The finding of this study can guide farmers and policy makers to formulate new plans. It can further support to implement the targeted programs toward raising the output of vegetable in Sudurpaschim province. Interested researcher would be supported from this study in vegetable fields. Farmers can familiarize to use various inputs in vegetable production. At present, the state, provincial and local governments have the objectives to reform and increase productivity in agriculture sector.

There are only few literatures dealing with resource use efficiency and returns to scale in vegetable production of Sudurpaschim province in Nepal. So far, very limited study tries to capture factors affecting, resource use efficiency and returns to scale of vegetables production in Kailali district. In my knowledge, no any formal literatures have explained the utilization of resources, returns to scale, and determinants of vegetable production in Terai region of Sudurpaschim province.

Utilization of labour, fertilizers, farm size, seeds, fertilizer are highly significant in maize production in Eastern Nepal (Sankhuwasabha district) ((Shrestha et al., 2015).The resources like seed, bullock, fertilizer and labour are 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 efficient use efficiency of rice production in Nepal (Subedi et al., 2020). The above literatures show that

the efficiency of resources use in agriculture sector have been conducted in high hill of Eastern, hilly district and Terai district(Jhapa) but there are no perfect studies of the resource use efficiency and returns to scale in Kailali in Sudurpaschim province. Therefore, this study aims to contribute in addressing this research gap by conducting a study on the resource use efficiency and returns to scale in vegetable production in Kailali.

The objectives of this study were: To identify the factors affecting in resource use efficiency, to analyze the resource use efficiency and to show the type of returns to scale in vegetable production.

Technical efficiency is affected by various farmers' socio economic and demographic factors such as educational level, extension service, credit facility, family size, fertilizer, and improved seeds (Basnayake & Gunaratne, 2002). Credit facility, fertilizer quantity, output price organized 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 cost made in labour, fertilizers and seed have significantly effect on gross income of coffee (Acharya et al., 2014)**.** Thus this study had the hypothesis: H_1: Education level, extensive service, household size, farm size, seed cost, labour cost, chemical fertilizer cost, pesticide cost and access of subsidy have significant effect in income of vegetable production , H_2: There is optimum utilization of resources by farmers in vegetable production, and H_3: Increasing returns to scale is applied in vegetable production.

Methods and materials

Study Area

This study was conducted in Kailali district which is located in the Terai region of Sudurpaschijm province. The study area included Dhangadhi Sub-Metropolitan City, Godawari Municipality and Kailari Rural Municipality that are *Pocket* Areas and *Superzone* for agriculture sector. The reason of selecting this district was its cultivated area of potato and others (tomatoes, cauliflower, cabbage, Radish, Broccoli) were 198788 and 284000 hectare respectively. Similarly the total output of them was 3325231 and 2993000 Metric Ton. The most common vegetables are Potatoes, Tomatoes, Cauliflower, Cabbage, Radish, Brinjal, Green Leafy vegetables like mustard, spinach, squash, and many other seasonal local vegetables. But the productivity of potato and others were 16.17 and 14.02 Metric Ton per ha in FY2020/21 (MoALD, 2022). Prime Minister Agriculture Modernization Project (PMAMP) FY 2016/17 has the objective of commercialization, mechanization and modernization of agriculture sector in Nepal. Kailali is major *Superzone* for agriculture under this project. Thus, this research could help to this project and all other stakeholders in agriculture field for efficient use of resources and returns to scale in different region of a country. It can make self-sufficiency in vegetable Sudurpaschim province.

Research Design

Causal survey research design was used to find the impact of explanatory variables in vegetable production. It explained an issue by collecting data in numerical form that gives finding of the issue in research. The main tool of measurement in this design was structured questionnaire which collected objectives and reliable numeric data (Apuke, 2017, Dulock, 1993). This study was based on quantitative method, applying descriptive research design to find the impact of independent variables to dependent variable, using structured questionnaire for data collection from the field.

Sample Size

When designing a research, the most common question is how large should be the sample (Dawson, 2002). Greener (2008) argued that there is no exact answer to sample size while Zikmund et al,. (2013) explained that formally identifying the proper sample size requires applied statistical theory. Generally, the appropriate sample size needs three criteria: the level of confidence, the level of precision and variability degree in the attributes being measured (Miaoulis & Michener, 1976).

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:

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

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 = the degree of accuracy expressed as a proportion (0.05)

Based on above formula, the total sample size was 100 farmers (households of farmer). Thus, the data was collected from the primary source from field survey in the study sites.

Tools and Techniques of Data Collection

Frequencies, mean, SD, t-test, multiple regression model using Cobb-Douglas production function were applied to find the impact of inputs and socio-economic factors in production in 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 simple random sampling technique was used for data collection.

SD=Standard deviation, t-test=t-ratio

Initially, descriptive statistics such as minimum, maximum, frequency mean and standard deviation was calculated. In second stage, regression model using Cobb-Douglas production function was used to identify the contribution of explanatory variables to dependent variable, and to analyze the resource use efficiency and returns to scale in vegetable production.

Econometric Model

Model of Identifying Factors Affecting

Gujarati et al., (2012) explains the general multiple regression function as

$Y_i = \beta + \beta_i X_i + ui$; i =1……n

where, Y_i = Dependent variable , X_i= Explanatory variables , β = Constant term, β_i = Unknown estimated regression coefficients, u_t = Error term

Thus regression equation of this study can be written as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_{7+} + \beta_8 X_8 + \beta_9 X_{9+} ui$

where, Y: Returns from vegetable production in Nepalese Rupees (Rs), (dependent variable), explanatory variables were: X_1: Households size, measures as number of family members, X_2: Education level, measured in different level of schooling, X_3: Extensive service from government (Dummy; 0 for no receipt,1 for receipt), X_4: Land, in Katha, X_5: Seed cost, in Rs, X_6 : Chemical fertilizer cost, in Rs, X_7: labour cost in Rs, X_8: Pesticide cost Rs, in Rs, X_9:Access of subsidy (Dummy; 0 for no receipt,1 for receipt), ui: error term. By the test of multicollinearity of independent variables they were regressed in this study.

Model of Analyzing Resource Use Efficiency

Cobb-Douglas production function has been used to assess resource use efficiency following the methods mentioned by Rahman and Lawal (2003).

$Y = \beta X_i^{bi} e^{ui}$; i=1.....n.

Now in this study , $Y = \beta X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} e^{u}$

Where X_1: Land, in Kattha, X_2: Seed cost, in Rs, X_3 : Chemical fertilizer cost, in Rs, X_4: labour cost in Rs, X_5: Pesticide cost in Rs

$r = \frac{MVP}{MFC}$; 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 in competitive market structure.

Now, $MVP = \beta_i \frac{\overline{Y}}{\overline{X}}$

Where β_i= Estimated regression coefficient of input X_i, $\overline{Y}$= Geometric mean value of output

$\overline{X}$ = Geometric mean value of i^{th} resource 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 if less of that input is employed (Mbanasor, 2002).

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

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

Rs=Nepalese Rupees, one Katha=0.0126441 hectare

$D= (1 - \frac{1}{r}) \times 100$, Where,

D= absolute value of percentage change in MVP of each resource (Mijindadi, 1981)

Model of identifying the Returns to Scale

Dwivedi (2013, p. 258) argued the summation of respective coefficients inputs obtained from Cobb–Douglas production function gives the value of returns to scale.

RTS= $\sum\beta_i$; Where $\sum \beta_i$ = Sum of coefficients of inputs.

Results

Descriptive Statistics of Variables

The descriptive statistics of the variables used in this study was presented in **Table 1**.The household size of vegetable farming was joint family system where value being 8.04 in average. The majority of household head (78.42%) was male. Male household head had dominated role for decision making in various matters including technology used in vegetable production. The education level was minimum zero means some farmers were illiterate and few were of masters level where mean value was 2.18 that indicated basic level education of farmers dominated the study sites. The land was small in size where average size being 6.81. Majority of farmers had less than 7 Katha of land for cultivation of vegetables. From **Appendix1**, the major number of farmers (61.8%) accessed extensive service by the government and non-government institutions. Government provided subsidy for the purpose of increase in productivity to farmers in the study sites. The access of subsidy was 64.7% in the study areas given by government. Farmers (34%) were facing shortage of chemical fertilizer in the period of plantation or initiation, after harvesting they were not getting expected price of outputs due to free entry of Indian vegetables (45.1 %) in the study sites.

Table 1

Descriptive Statistics of Variables of Vegetable Farms

Variables	Mean	Standard Deviation	Minimum	Maximum
Household size	8.04	3.04153	3.00	16.00
Education level	2.18	1.15	0	5
Extensive service	1.37	0.49	1	2
Farm size	6.81	4.19	2	25
Seed cost	20613.30	14418.44	2400	70000
Chemical fertilizer cost	4384.92	4326.28	100.00	35800.00
Labour cost	21208.21	22215.58	0	137500
Pesticide cost	2981.50	2610.51	240.00	14000.00
Access of subsidy	1.34	0.48	1	2

Source: Field Survey (2024). *Note:* N = 100.

The mean, standard deviation, minimum and maximum values had been presented in the **Table 1**. 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.

RTS = Returns to Scale

The term standard deviation is generally used for variability of sample distribution, through it is also used to mean population variability (Singh, 2007). Except labour cost, other explanatory variables were consistent in this study. It leads the data of these inputs were closer to mean value in vegetable production in this study sites.

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.

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	0.61	0.44	1.98

Source: Computation through SPSS (2024).a = Predictors: (Constant).

Table 2 explained the regression model was good for the study because R^2 and Adj. R^2 were 66 and 61 % 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). Thus the Durbin –Watson value (1.98) showed no autocorrelation in this study.

Factors Affecting to vegetable farms

The results of the multiple regression of the research had been presented as **Table 3.** Null hypothesis was rejected due to the p-value (listed in the column called Sig.) was smaller than the alpha level (1%, 5% and 10 % significant level).

Table 3

Coefficients and Collinearity Statistics (dependent variable = a) (VIF)

Variables	Standard Error	Coefficient (β)	t-ratio	Sig. (p-value)	Collinearity Statistics	
					Tolerance	VIF
Ln_Household size	0.14	-0.04	-0.43	0.663	0.754	1.326
Ln_Educationlevel	0.11	0.17	2.18	0.033**	0.910	1.099
Ln_Extension service	0.18	-0.43	-5.35	0.001*	0827	1.210
Ln_Farm size	0.21	0.35	2.29	0.025**	0.227	4.399
Ln_Seed cost	0.10	-0.18	-1.80	0.076***	0.561	1.781
Ln_Chemical fertilizer cost	0.27	0.31	2.48	0.016**	0.353	2.837
Ln_Labour cost	0.01	0.01	0.11	0.913	0.585	1.708
Ln_Pesticide cost	0.06	0.07	0.53	0.595	0.327	3.058
Ln Access of subsidy	0.29	-0.13	-1.56	0.122	0.728	1.33

Source: Field Survey (2024). **, ** and *** indicate statistically significant at 1%, 5% &10 % level of significance, respectively.*p<0.01 *p<0.05. ***p<0.1. Computation through SPSS. a = Ln_Income from vegetable Production.*

VIF =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). Explanatory variables should only be allowed if its VIF is less than five (5) in a regression analysis (Akinwande et al., 2015). **Table 3** showed the VIF of every explanatory variable is less than five. Thus, there was no issue of multicollinarity in this study.

The first objective of this study was to identify the factors affecting in resource use efficiency and returns to scale in vegetable production at the household level in the selected study sites. Multiple regression model by using Cobb- Douglas production function had been carried out to find results.

Table 3 indicated extensive service was highly significant (1% level of significance), whereas education level, land and chemical fertilizer ware moderate significant (5 % level of significance) and seed cost was

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significant only at 10 % to income from vegetable production to farmers. Other explanatory variables were insignificant in vegetable production in the study sites.

Analysis of Resource use Efficiency in Vegetable farms

It was the second objective of this study. The resource use efficiency calculated by MVP and MFC was explained in econometric model. The value of 'r' showed whether the inputs were optimum, under or over utilized in vegetables production.

Table 4
Analysis of Resource Use Efficiency in Vegetable farms

Variables	Coeff.(β)	MVP	MFC	r	D-value	Efficiency
Ln_Land	0.35	6270.84	1	6270.84	185.94	Underutilized
Ln Seed cost	-0.18	1.16	1	-1.16	14.05	Over utilized
Ln Chemical Fertilizer cost	0.31	10.37	1	10.37	10.37	Underutilized
Ln Labour cost	0.01	0.04	1	0.04	95.88	Over utilized
Ln Pesticide cost	0.07	3.58	1	3.58	72.11	Underutilized

Source: Field Survey (2024)

Returns to Scale in Vegetable farms

It was third objective of the study. By the summation of regression coefficients (β), returns to scale are calculated (Basu & Fernald, 1997). It showed the types of returns to scale in production.

Table 5
Returns to scale in vegetable farms

Variables	Coeff. (β)
Ln Household size	-0.04
Ln Education level	0.17
Ln Extensive service	-0.43
Ln Farm size	0.35
Ln Seed cost	-0.18
Ln Chemical Fertilizer cost	0.31
Ln labour cost	0.01
Ln Pesticide cost	0.07
Ln Access of subsidy	-0.13
Sum of Coefficient(β)	0.13

Source: Field Survey (2024)

The returns to scale parameters presented in **Table 5** for vegetables farmers in the study sites was computed by the addition of coefficients of explanatory variables. The sum of the coefficient of explanatory variables was 0.13 which indicated decreasing returns to scale to the farmers in the study sites.

DISCUSSION

Majority of household head are male (68%) of vegetable production (Dahal et al., 2019). This study had male dominant in vegetable production (78.42%) **(APPENDIX 1)** who decided to apply the inputs including technology in vegetable production in study sites. Majority of the farmers had not got expected price (93.1%) in the study sites. Import from India was major cause of it. But some farmers of *Kailari Rural Municipality* found distinct situation. They were producing organic vegetables and gave priority to local seeds, pesticides and fertilizers in vegetable production. Therefore, their products were demanded in Indian market (*Suda*). Hence, they had no marketing problem of the vegetable outputs. They got reasonable price. Again, one of the interesting matters was; they themselves made pesticides to control crop diseases. They made liquid spray by mixing lots of local herbs and shrubs like *Neem* (one type of local plant) and others, which were found in locality.

Over 700 farmers got subsidy in agriculture sector in Kailari rural municipality, especially in *Pabera Village*, and other local bodies of Kailali district. *Prime Minister Agriculture Modernization Project (PMAMP) FY 2016/17* was lunched in Kailali district to enhance productivity and commercialization of agriculture sector. But access of subsidy was insignificant in vegetable production. It showed there was no positive impact of subsidy in agriculture production, productivity and increasing returns to scale. It was concluded that without farmers' awareness, higher education, attitude to commercialize farming, counseling, extensive services from local governments the production and productivity of agriculture sector in Kailali district and even in Nepal is not possible.

When average value is greater than the value of standard deviation then the data shows the consistent of the series (Livingston, 2004). **Table1** revealed farm size, seed cost, chemical fertilizer cost and pesticide cost were consistent inputs in production whereas labour cost was inconsistent in this study sites.

Resources used and returns to scale in agriculture sector depend on socio-economic and demographic factors of farmers. They are major affecting factors and significant for improving farmers' efficiency for vegetable production (Andaregie & Astatkie, 2020). **Table 3**, showed extensive service is highly significant, and education level, land(land), chemical fertilizer and seed were statistically significant resources in vegetable production. They affected the resource use efficiency and returns to scale. But access of subsidy household size, labour cost and pesticide cost were found to be statistically insignificant in this study sites.

The resources like seed, bullock, fertilizer and labour were overutilized regarding of production of maize in Sindhuli district in Nepal (Dahal & Rijal, 2019). Household size, farm size, seed, labour and chemical fertilizer cost affect the resource use efficiency to farmers in vegetable production which were underutilized in vegetable production. Higher cost of inputs, small farm size, and inadequate capital are major constraints in vegetable production. They reduce the efficiency and productivity of farmers (Ajibare et al., 2022). **Table 4** showed the resource use efficiency analysis showed that the major inputs in vegetable production. Farm size, chemical fertilizer and pesticide were underutilized and need to increase their cost whereas seed and labour cost were over utilized and need to decrease their cost for optimum allocation of these inputs. This might be lack of training to farmers and insufficient extensive service to farmers in study sites

The overall productivity of resources presents the returns to scale of various inputs in production. The summation value of elasticity of land, labour, fertilizer and seed is 0.75 <1, shows farmers are producing in decreasing returns to scale. Managerial inefficiency of farmers in using inputs creates diseconomies scale of resources that provides the decreasing returns to scale in production (Weldegiorgis et al., 2018). **Table 5** revealed the sum of coefficients was 0.13 that shows the decreasing returns to scale in production of this study. Thus, this study showed the socio-economic factors of farmers that play decisive role in resource use efficiency and returns to scale.

Conclusions and implications

Vegetable production is one of the major components of agriculture sector to ensure food security, nutritional value and reduce poverty in Terai regions of Nepal. The objectives of this study were to investigate factors affecting, use of resources and returns to scale in vegetable production in Kailali of Nepal. The results indicated that education level, extensive service, farm size, seed cost and chemical fertilizer affected in vegetable production. Farm size, chemical fertilizer and pesticide were underutilized and need to increase their cost whereas seed and labour cost were over utilized and need to decrease their cost for optimum allocation of these inputs. This study indicated decreasing returns to scale. This might be due to lack of training exposures to farmers and insufficient extension service to farmers in study site. 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 increasing returns to scale, and technical knowledge in agriculture practice. Hence, broader understanding of the socio- economic, demographic factors and resources used enhances the farmers' efficiency in agriculture development in Nepal.

The findings of this research might be applied for understanding the socioeconomics demographic factors, resource utilization and returns to scale in agricultural sector that enhances the productivity in Nepalese agriculture sector and developing an effective mechanism to use optimum use of resources(inputs)

through the various measures such as enhancing education level, increase in land, managing organized market to farmers. It would be highly recommendable to enrich the farmers with appropriate technical information, exchange of ideas and exposure, so they could be able to obtain optimum price for their resources for increasing production and returns from vegetable production.

Apart from agriculture sector, this research will be equally applied in manufacturing companies, small, medium and large-scale industries. Entrepreneurs who want to involve innovative products needs analyze the resource utilization and returns to scale. They can use its findings for future business plans formulation

Relevance to the UN Sustainable Development Goals

United Nation (UN) has given the Seventeen Sustainable Development Goals (SDGs) that should be fulfilled up to 2030.The first goal of sustainable development by the UN is: *No poverty*. It aims eradicating extreme poverty by applying technology and mobilization of resources (NPC, 2020). Poverty alleviation is the main objective of economic plan of Nepal since the 7^{th} plan. Nepal has subsistence level farming. This study may help to apply improved seeds, new machineries, and supply of chemical fertilizers in time, and increase in access of subsidy to farmers. Ultimately, it results commercialization and modernization of agriculture sector. Thus, this study may support to fulfill the first objective of the SDGs (no poverty) in Nepal. NPC (2020) states the UN Sustainable Development Goal-2 is *Zero Hunger*. It aims to end hunger, achieve food security and improved nutrition. Thus, this study may support to achieve zero hunger targeted by SDGs.

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References

Acharya, B., & Dhakal, S. C. (2014). Profitability and major problems of coffee production in Palpa District, Nepal. *International Journal of Applied Sciences and Biotechnology*, *2*(4), 460-463.

Ajibare, D. B., Anthony, L., Alabi, O. O., Njoku, V. O., Ukaoha, C. A., & Oluleye, O. D. (2022). Resource Use Efficiency and Profitability Analysis of Tomato Production (Lycopersicum Esculetum Species) in Federal Capital Territory, Nigeria. *European Journal of Agriculture and Food Sciences*, *4*(5), 75-82.

Akinwande, M. O., Dikko, H. G., & Samson, A. (2015). Variance inflation factor: as a condition for the inclusion of suppressor variable (s) in regression analysis. *Open journal of statistics*, *5*(07), 754.

Andaregie, A., & Astatkie, T. (2020). Determinants of technical efficiency of potato farmers and effects of constraints on potato production in Northern Ethiopia. *Experimental Agriculture*, *56*(5), 699-709.)

Apuke, O. D. (2017). Quantitative research methods: A synopsis approach. *Kuwait Chapter of Arabian Journal of Business and Management Review*, *33*(5471), 1-8.

Aryal, J.P., & Gautam, A. (2001). *Quantitative techniques (2nd ed.*). Kathmandu: New Hira Books Enterprises

Bajracharya, M., & Sapkota, M. (2017). Profitability and productivity of potato (Solanum tuberosum) in Baglung district, Nepal. *Agriculture & Food Security*, *6*(1),47.

Basnayake, B.M.J.K. & Gunaratne, L.H.P. (2002). "Estimation of Technical Efficiency and it`s Determinants in the Tea Small-Holding Sector in the Mid Country Wet Zone of Sri Lanka". *Sri Lanka Journal of Agricultural Economics*, *4*:137-150.

Basu, S., & Fernald, J. G. (1997). Returns to scale in US production: Estimates and implications. *Journal of Political Economy*, *105*(2), 249-283.

Beattie, B.R., & Taylor, C.R. (1985). *The Economics of Production*. Montana State University, John Wiley and Sons, New York, USA.

Chetroiu, R., & Călin, I. (2013). The concept of economic efficiency in agriculture.

Dahal, B. R., & Rijal, S. (2019). Resource Use Efficiency and Profitability of Maize Farming in Sindhuli, Nepal: Cobb-Douglas Production Function Analysis. *International Journal of Applied Sciences and Biotechnology*, *7*(2), 248-256.

Dawson, C. (2002). *Practical research methods: A user-friendly guide to mastering research techniques*. How to Books.

Devkota, B., Timsina, J., Singh, S., Dhakal, I. P., Singh, U. M., Subedi, A. P....& Pyakuryal, K. N. (2018). Agriculture and Forestry University Rampur, Chitwan, Nepal Journal of Agriculture and Forestry University (JAFU) Volume 2 2018.*Journal of Agriculture and Forestry University*

(JAFU), *2*.

Dulock, H. L. (1993). Research design: Descriptive research. *Journal of Pediatric Oncology Nursing*, *10*(4), 154-157.

Dwivedi, D.N. (2013). *Microeconomics: Theory and Application*, 2nd edition, New Delhi: Dorling Kindersley publication Pvt. ltd.

Gopalakrishnan, T. R. (2007). *Vegetable crops* (No. 4). New India publishing.

Greene, W. H. (2008). The econometric approach to efficiency analysis. *The measurement of productive efficiency and productivity growth*, *1*(1), 92-250.

Gujarati, D. N., Porter, D. C., & Gunasekar, S. (2012). *Basic econometrics*. Tata McGraw-Hill Education.

Gupta, S. C. (2009). *Fundamentals of statistics* (pp. 15-15). New Delhi: Himalaya Publishing House.

Ishtiaque, A., Shrestha, M., & Chhetri, N. (2017). Rapid urban growth in the Kathmandu Valley, Nepal: Monitoring land use land cover dynamics of a himalayan city with lands at imageries. *Environments*, *4*(4), 72.

Khadka, J. (2020). *Quantitative Research, Data analysis and use of SPSS.*, Kathmandu: Symphony Publication Pvt.

Krejcie, R. V., & Morgan D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30, 607-610.

Livingston, E. H. (2004). The mean and standard deviation: what does it all mean? *Journal of Surgical Research*, *119*(2), 117-123.

Mbanasor, J.A. (2002). "Resource Use Pattern among Poultry Enterprises in Abia State, Nigeria". *Nigerian Journal of Animal Production*, 29(1):64-70.

Miaoulis, G., & Michener, R. D. (1976). *An introduction to sampling*. Kendall.

Mijindadi, N. B. (1981). Production efficiency on farms in northern Nigeria.

MoALD, (2022). *Statistical Information on Nepalese Agriculture 2020/21*. Ministry of Agriculture & Livestock Development Planning & Development Cooperation Coordination Division Statistics and Analysis Section, Government of Nepal, Kathmandu, Nepal.

MoF. (2016). *Economic Survey 2015/16*. Ministry of Finance (MoF), Government of Nepal, Singh Durbar, Kathmandu.

MoF. (2019). *Economic Survey 2018/19*. Ministry of Finance (MoF), Government of Nepal, Singh Durbar, Kathmandu.

MoF. (2023). *Economic Survey 2022/23*. Ministry of Finance (MoF), Government of Nepal, Singh Durbar, Kathmandu.

NPDP. (2017). *National Potato Development Program and Statistics Book FY 2016/17*. Government of Nepal, Ministry of Agricultural Development, Agriculture Division, Khumaltar,

Lalitpur, Nepal.

NPC (National Planning Commission) (2019). Fifteenth Development Plan (2019-2023). Kathmandu: NPC , Government of Nepal.

Pant, P.R. (2011). *Social science research and thesis writing*. Kathmandu: Buddha Publications.

Paudel, G. P., Kc, D. B., Khanal, N. P., Justice, S. E., & McDonald, A. J. (2019). Smallholder farmers' willingness to pay for scale-appropriate farm mechanization: Evidence from the mid-hills of Nepal. *Technology in society*, *59*, 101196.

Rahman, S. A., & Lawal, A. B. (2003). Economic analysis of maize based cropping systems in Giwa local government area of Kaduna State. *ASSET Report Series*, (3).

Shrestha, R. B., Huang, W. C., & Pradhan, U. (2015). *Resource use efficiency in vegetable production in the high hills of Eastern Nepa*l. *Nepalese Journal of Agricultural Economics*, 65.

Shrestha, J. (2016). A review on sustainable agricultural intensification in Nepal. *International Journal of Business, Social and Scientific Research*, *4*(3), 152-156.

Shrestha, R. B., Huang, W. C., Gautam, S., & Johnson, T. G. (2016). *Efficiency of small*-scale *vegetable farms: policy implications for the rural poverty reduction in Nepal*. *Agricultural Economics*, *62*(4), 181-195.

Singh, K. (2007). *Quantitative social research methods*. New Delhi: SAGE Publication India Pvt Ltd.

Subedi, S., Ghimire, Y. N., Gautam, S., Poudel, H. K., & Shrestha, J. (2019). Economics of vegetable (Solanum tuberosum L.) production in Terai region of Nepal. *Archives of Agriculture and Environmental Science*, *4*(1), 57-62.

Weldegiorgis, L. G., Mezgebo, G. K., Gebremariam, H. G. E., & Kahsay, Z. A. (2018). Resources Use Efficiency of Irrigated Tomato Production of Small-scale Farmers. *International Journal of Vegetable Science*, *24*(5), 456-465.

Xaba, B. G., & Masuku, M. B. (2013). Factors affecting the productivity and profitability of vegetables production in Swaziland. *Journal of Agricultural Studies*, *1*(2), 37-52.

Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2013). *Business research methods*. Cengage learning.

(Administrative State7 2019 (un.org.np)
http://www.dhangadhimun.gov.np/
(https://en.wikipedia.org/wiki/KanchanpurDistrict
https://kathmandupost.com/money/2018/04/24/kailali-imports-veggie-worth-rs500m-annually
https://en.wikipedia.org/wiki/KailaliDistrict.
https://kathmandupost.com/money/2017/07/23/pm-agri-project-raises-farmers-access-tomodernfarm .

APPENDIX: 1

Socio-economic and Demographic Features of Vegetable Farmers*:*

Variables		
Gender	Frequency	%
Male	80	78.42
Female	20	19.6
Types of Seed	Frequency	%
Improved	70	68.6
Local	4	3.98
Both	26	25.5
Education level	Frequency	%
Uneducated	7	6.9
Basic level	21	20.6
Secondary level	33	32.4
Bachelor level	27	26.5
Masters level	10	9.8
Others	2	2
Extensive service	Frequency	%
Access	63	61.8
No	37	36.3
Marketing	Frequency	%
Whole sellers	4	3.9
Hatbazzar	33	32.4
Community	42	41.2
Community and *Hatbazzar*	33	32.4
Expected Price	Frequency	%
No expected price	95	93.1
Cause of no expected price	Frequency	%
Dominance of whole sellers	9	8.8
No storage facility	21	20.6
Lack of organized market	18	17.6
Entry of Indian vegetables	46	45.1
Others	1	1
Access Subsidy	Frequency	%
Yes	66	64.7
No	34	33.3

Source: Field Survey (2024). Two farmers did not sell the output