Journal of Nepal Agricultural Research Council
Vol. 8: 72-87, May 2022
ISSN: 2392-4535 (Print), 2392-4543 (Online)
DOI: https://doi.org/10.3126/jnarc.v8i.44865

Resource Use Efficiency (RUE) in Lentil Production in Terai and Inner Terai Regions of Nepal

Damodar Gautam[1@], Shiva Chandra Dhakal[2], Rishi Ram Kattel[2] and Narayan Prasad Khanal[3]

[1]National Maize Research Program (NMRP), Rampur, Chitwan, Nepal; [@]gautam.damodar.np@gmail.com
: https://orcid.org/0000-0002-1009-0340
[2]Agriculture and Forestry University (AFU), Rampur, Chitwan, Nepal; SCD: scdhakal@afu.edu.np
: https://orcid.org/0000-0002-2801-8937; RRK: rrkattel@afu.edu.np,
: https://orcid.org/0000-0002-6234-5595
[3]CIMMYT-SARO, Khumaltar, Lalitpur, Nepal; n.khanal@cgiar.org
: https://orcid.org/0000-0002-6069-234X

Received: January 12, 2022, Revised: March 15, 2022, Accepted: April 25, 2022, Published: May 9, 2022.
Scientific Editors: Krishna Prasad Timsina and Hari Krishna Panta

The authors declare that there is no conflict of interest.

ABSTRACT

A study was carried out to estimate and analyze the profitability and resource use efficiency of lentil grain and seed production in Nepal's terai and inner terai regions. Using a pre-tested questionnaire, primary data and information were collected from 300 lentil grain producing farmers, categorized by local seed users, improved seed users, and 100 seed producing farmers in Kailali, Dang, and Siraha districts. The study revealed that the B:C ratio in lentil seed production was higher (1.59) than in lentil grain production (1.41). The benefit in both grain and seed production realized by farmers was mainly due to increased prices rather than production. Return to scale was found to be increasing (1.016) in lentil grain production using local seed, but it was decreasing at a rate in lentil grain production using improved seed (0.854) and in lentil seed production (0.822). Analysis on resource use efficiency revealed that labor input is excessively overused, reflecting the Marginal Value Product of less than unity in lentil production. To get the maximum profit from lentil grain production using improved seed, input use in land preparation, threshing, and post-harvest should be increased while decreasing the amount of other inputs.

Keywords: lentil, production, resource allocation, total cost, variable cost.

सारांश

नेपालको तराई र भित्री तराई क्षेत्रमाको मुसुरो दाल र बीउ उत्पादनको मुनाफा र श्रोत उपयोगको दक्षता अनुमान र विश्लेषण गर्न एक अध्ययन गरिएको थियो । पूर्व-परीक्षण गरिएको प्रश्नावली प्रयोग गरी कैलाली, दाङ र सिरहा जिल्लाका ३०० दाल उत्पादक किसान, स्थानीय बीउ प्रयोगकर्ता, उन्नत बीउ प्रयोगकर्ता र १०० बीउ उत्पादक किसानहरूद्वारा वर्गीकृत गरी प्राथमिक तथ्याङ्क र जानकारी सङ्कलन गरिएको थियो । दालको बीउ उत्पादनमा B:C अनुपात (१.५९) मुसुरोको दाना उत्पादन (१.४१) भन्दा बढी थियो । कृषकहरूले गरेको अन्न र बीउ उत्पादन दुवैमा लाभ मुख्यत: उत्पादन भन्दा मूल्य बढीको कारण थियो । स्थानीय बीउ प्रयोग गरी मुसुरोको दाना उत्पादनमा (१.०१६) वृद्धि return to scale देखिएको र उन्नत बीउ प्रयोग गरेर दालको दाना उत्पादनमा (०.८५४) र दालको बीउ उत्पादनमा (०.८२२) घट्दो return to scale पाइएको छ । स्रोतको उपयोग दक्षताको विश्लेषणले श्रम इनपुटको अत्यधिक प्रयोग भएको देखाएको छ । जसले दाल उत्पादनमा एक भन्दा कमको सीमान्त मूल्य उत्पादनलाई प्रतिबिम्बित गर्दछ । उन्नत बीउ प्रयोग गरी दालको दाना उत्पादनबाट अधिकतम नाफा लिनको लागि जमिनको तयारी, थ्रेसिङ र फसलपछिको लागतको प्रयोग बढाएर अन्य सामग्रीको मात्रा घटाउनुपर्छ ।

INTRODUCTION

In the developing countries like Nepal, legumes are the major part of the dietary protein for the poor families having low level of income who cannot afford expensive animal proteins, as they supply up to 20-25% of protein by weight, which is 2-3 times that of wheat and rice (Shahwar et al 2017). Pulses not only provide multiple nutrients to the human diet but also serve as important feed for the animals. They are the major components of cereal-based cropping system improving soil fertility by providing nitrogen, carbon and organic matters (Sarkar and Kumar 2011). In the developing countries like Nepal, pulses are crucial source of income generation improving livelihood of smallholder farmers. Because of the high protein content and low cost, pulses are called poor man's meat (Sumera and Ali 2020). So, most of the low-income populations can use this nutritious crop as their staple food. Along with other legumes, globally, lentil is also an important food legume crop component of farming and food systems. It plays an important role in human, animal and soil health improvement occupying a unique position in cereal based cropping systems (Erskine et al 2009). It is proven fact that, lentil is more preferred over the other grain legumes in human nutrition because of low level of nutrition hindering factors, high protein content and shorter cooking duration than the other grain legumes. Likewise, higher level of protein content and insignificant level of cholesterol, fat and anti-nutrients found in lentil cotyledon attributed to it being the most preferred protein source for human consumption (Sultana and Ghafoor 2008). Whole lentil contains 25.8% protein while split lentil contains 25% protein (Kim et al 2016). Lentil is a rich source of protein, minerals (K, P, Fe, Ca, Mg and Zn) and vitamins (Vitamin C, Thiamin, and Riboflavin) and Lipids (Fatty acids and cholesterol)contribute nutritional security to the Nepalese being main pulse of Nepal (Pant et al 2019). Lentil also have various potential health benefits such as anti-carcinogenic, blood pressure-lowering, hypo-cholesterolemic and glycemic load lowering effects (Faris et al 2013).

During the period of 1980 to 2013, globally, Nepal ranked first in terms of share of lentil area compared with total legume area of the country which constituted 37.2% during 1980-82, 44.1% during 1990-92 and 70% during 2011-13. Lentils are grown in terai, inner terai and mid hills of the country (Prasai et al 2019). The area under lentil cultivation had more than doubled from 97 thousand hectare to 207 thousand hectare, with an average annual growth of 2.5%. The yield of lentil increased from 497 kg ha^{-1} to 1033 kg ha^{-1} in the same time period (FAOSTAT 2022). A more than two fold increase in the area as well as the yield of lentil has resulted in a rise in production by more than four times, from 48.7mt to 214mt(ANSAB 2011). Similarly, area, production and productivity of lentil have been increased by 111%, 257% and 69%, respectively in between 1985/86 and 2012/13. During the period of 2012/13, Lentil was the major grain legume and accounted for 62% of area and 65% production of total grain legumes in Nepal and has emerged as an important agricultural export commodity. During that period, lentil was recognized as one of the major agricultural product among 12 goods having high export potential and medium socioeconomic impacts by Nepal Trade Integration Strategy (Gharti et al 2014). From the period of 2012/13 to 2014/15, area under lentil cultivation decreased while productivity remains increased and in 2015/16, area slightly increased while productivity still increased. From the year 2015/16 to 2017/18, area under lentil cultivation decreased resulting decrease in total production while productivity increased. Among the newly formed seven provincial regions, Madhesh province (Province 2), Lumbini province (Province 5) and Sudurpaschim province (Province 7) are the most potential provinces in terms of area cultivation and production. Province 2 shares 36.68% of total lentil area, 35.48% of total lentil production and yield is slightly lower than national yield, Lumbini province shares 35.83% of total lentil area, 37.15% of total lentil production and yield is slightly higher than national yield, while Sudurpaschim province shares 13.56% of national lentil area, 14.34% of national lentil production and yield is slightly higher than national yield (MoALD 2021). Analyzing the trend of area cultivated of lentil, 2018 was the year of much less area cultivated but having the higher productivity in Nepal. In the year 2018, productivity was comparatively higher than that of any years in between 2010 to 2020. From the year 2010 to 2014, area of lentil had shared almost 5% of global area and production had shared greater than 4% to the global production but the productivity was lower than global productivity. In the year 2015 to 2018, on an average, share of area of Nepalese lentil to the global area decreased to about 4%, share of total production to global production also decreased to below 4% while on an average, productivity during that period had been increased. In the year 2018, productivity of lentil in Nepal was almost 8.8% higher than global productivity. National data obtained from Ministry of Agriculture and Livestock Development (MoALD) shows that, in the years 2019 and 2020, area of lentil cultivation and total production of lentil in Nepal have been increased, sharing the 4.34% and 4.24% of global lentil cultivated area in respective years. Similarly, Nepalese lentil production has shared 4.38% and 4.02% to the global lentil production in the year 2019 and 2020 respectively (MoALD 2021). Lentil from Nepal covers only 3% of total world market of lentil (ITC 2019).

Considering the diverse benefit of the lentil in Nepal, these sectors should be the most prioritizing ones to address the food and nutrition security as well as the livelihood improvement of rural smallholder farmers.After the year 2016, total lentil production and yield in Nepal have stagnated due to various factors including low levels of investment in inputs, low level of use of improved technology, cultivation of older varieties, and increased biotic and abioticstresses.Although the yield of lentil has increased in recent years, while comparing with other crops, current yields are still low mainly because of the limited yield potential of lentil landraces, low levels of resource use along with the vulnerability to an array of stresses.Study conducted by (Thapa et al 2019) suggested that demand of lentil will increase rapidly in the near future and in order to meet the demand for lentil, both production or productivity has to be increased.Increased health awareness among the rural and urban people has changed the food consumption patterns. Domestic demand of lentil is increasing every year but the production is decreasing which has caused ballooning trade deficit of lentil in Nepal. To address these issues, it is crucial to increase the production and productivity. Increased production and productivity can be achieved by using the number of techniques. Use of improved varieties of lentil is one of the suitable techniques in terms of higher production, productivity and profitability (Sarker et al 2020, Tithiand and Barmon 2018). Use of improved seed of diversely adopted and of better performing varieties also enhances efficiency and productivity of other inputs such as fertilizers, irrigation, farm machinery and human labor, ultimately helping sustainable crop production. Reducing cost of production and thereby getting higher profit can be achieved by the optimum use of resources in crop production. Analysis of economics of crop production helps to measure per unit cost of various resources and their per unit revenue. Likewise, proper allocation and efficient utilization of inputs has ultimately and significantly impact on food security. However, lentil farmers of Nepal are traditionally using different inputs without considering their efficient use levels. Most of the Nepalese farmers follows relay cropping with rice and this crop depend primarily on residual moisture and nutrient (Shrestha et al 2011). So, lentil is also called is low resource used crop in Nepal. Study on input used status and determining optimum level always offer the direction of efficient utilization of inputs to the farmers. Resource use efficiency examines the efficiency of each input and indicates the over-utilization or under-utilization of inputs (Ali et al 2017). Realizing the benefits of efficient use of input in crop production, number of researcher had estimated resource use efficiency in various crops like rice, mustard, tomato, Ginger etc (Ali et al, 2017, Chandra et al 2017, Dhakal et al 2015, Gurung et al 2021, Subedi et al 2020, Umar and Kadir 2015).Likewise, researchers Sapkota et al (2018) have estimated the resource use efficiency of maize seed production. Bist et al (2021) has estimated the resource use efficiency of wheat seed production. However, the study on resource use efficiency in lentil grain and seed production is scarce in Nepal. It is crucial to evaluate the efficiency level of input use to maximize profit by minimizing cost. Therefore, the present study was designed to analyze the production economics and resource use efficiency of lentil grain and seed producing farmer of Nepal.

MATERIALS AND METHODS

Description and selection of the study area

Among the seven provinces of Nepal, Province 2 (Madhesh Province) comes first in total area of lentil production (36.68% of total national area) followed by Lumbini Province (35.83% of total national area) and Sudurpaschim Province (13.56% of total national area). According to the production, Lumbini Province has higher lentil production (37.15%) followed by Province 2 (35.48%) and Sudurpaschim Province (14.34%)(MoALD 2021). Considering this production potential, firstly, three provinces namely: Madhesh Province, Lumbini Province and Sudurpaschim Province were selected for the study. Among all lentil producing districts of Nepal, top six lentil producing districts are Dang, Kailali, Rautahat, Bardiya, Siraha and Bara. Top six lentil producing districts shares 58.52% of total production and 47.27% of total lentil cultivated area (MoALD 2021). Considering Terai region of Nepal and provincial representation, Kailali, Dang and Siraha districts were purposively selected for this study.

Selection of lentil grain producer

Among the lentil grower, two categories were made; lentil grain producer using local seed and lentil grain producer using improved seed. To find the population frame of both categories of farmers during the study, field visit and consultation were made with the agrovets, seed companies, cooperatives, local government bodies and with other government and non-government organization. To get the appropriate and representative sample size for lentil grain producer, Cochran formula was used.

$$n_0 = Z^2pq/ e^2$$

Where, n_0 = the sample size
Z = Selected critical value of desired confidence level
e = the desired level of precision
p = the estimated proportion of an attribute that is present in the population
q = 1-p

Using the Cochran formula, 100 lentil grain producing farmers from each targeted study district were selected randomly. Among those 100-lentil grain producing farmers for each district; 50 farmers were improved seed users and 50 farmers were local seed users.

Selection of seed producing farmers

In the study area, seed producing organization make contract with the seed producing farmers, so ultimately farmers were the improved seed producer at field level. Nearly 200 seed producing farmers had contract with selected seed companies, cooperatives, farmers groups and NSCL in the Kailali and dang district. So, nearly 20% of total contracted seed producing farmers i.e. 35 each from Kailali and Dang district were selected for household survey. Similarly, in Siraha district, nearly 150 farmers had contract with selected seed companies, cooperatives, farmers groups and NSCL. So, nearly 20% of total contracted seed producing farmers i.e. 30 from Siraha district were selected using simple random sampling technique for household survey. Altogether 100 seed producing farmers were selected for the study.

Techniques of data collection

To obtain the necessary information for the study, different techniques of data collection such as interview/field survey by using structured questionnaire, Focus Group Discussion (FGD) with concerned stakeholder, Key Informants Interview (KII) with local collector and local lentil consuming industries were conducted.

Sources of data

Primary data was collected using the primary techniques of data collection. For the secondary data, national and international reports, publications, articles, newspapers and online data published by FAO, ADB and World Bank was used for the study.

Analysis on cost of lentil grain and seed production

For analyzing the cost of production, the variable cost items and fixed cost items were considered. The variable cost includes expenditure on seed, field preparation, labour, fertilizers, irrigation, plant protection chemicals, micronutrients, harvesting, packaging, transportation, etc. Total cost of production was calculated by using following formula:

Total cost = Total variable cost + Total fixed cost

Gross margin analysis

Gross margin analysis was used as to determine profitability and as a means of selecting farm plan. The gross margin depends on the service provided, market structure, market price, perishability of the product and distance between producers and consumers. Gross margin was calculated using following formula:

$$GM = \Sigma P_i Q_i - \Sigma C_j X_j$$

Where,

GM = Gross Margin
P_i = Unit price of product i
Q_i =Quantity produced of product i
C_j = per unit variable cost of input j
Q_j = quantity of input used
$\Sigma P_i Q_i$ = Gross Return
$\Sigma C_j X_j$ = Variable cost

Benefit cost analysis (B/C ratio)

Benefit cost ratio was analyzed by two methods. First total gross return was compared with total variable cost and second, total gross return was compared with total cost.

B:C (Over total variable cost) = Gross return / Total variable cost

B:C (Over total cost) = Gross return / Total cost

Resource use efficiency in lentil cultivation

In order to assess efficiency of resources used in lentil production, Cobb-Douglas production function was used because agricultural production is best represented by this type of production function. The marginal value productivities was calculated as an indicator of resource use efficiency (RUE). The production function used is presented as:

$$Y = \alpha X_1 X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} e^{\mu}$$

The function was log transformed as:

$$\ln Y = \ln \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \mu$$

Where,
Y = Total income from lentil seed/grain production
X_1 = Total cost of labor
X_2 = Total cost of land preparation
X_3 = Total cost of seed
X_4 = Total cost of FYM, fertilizers and micronutrients
X_5 = Total cost of pesticides
X_6 = Cost of harvest and post harvest activities
μ = Error term
α and β_1,…………….β_6 = parameter to be estimated

Correlation coefficient below plus or minus 0.8 between explanatory variables will be considered free from multicollinearity problem considering equation developed by Heady and Dillon in 1960.

Estimation of marginal value products (MVP_s)

The marginal vlaue products MVP_s of the resources was estimated by multiplying the average value product of particular resource (AVP_{Xi}) with its elasticity of production (β_i). The actual mechanism of estimating MVP_s is shown below:
The considered production function is

$$Y = \alpha X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} e^{\mu} \ldots\ldots\ldots\ldots\ldots.(1)$$

Partial derivative of Y with respect to X_1 is

$$\frac{\partial y}{\partial X_1} = \alpha\beta_1 X_1^{\beta_1-1} X_2^{\beta_2} \ldots\ldots\ldots X_6^{\beta_6} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

$$= \frac{\alpha\beta_1 X_1^{\beta_1} X_2^{\beta_2} \ldots\ldots\ldots\ldots X_6^{\beta_6}}{X_1}$$

$$= \frac{\beta_1 Y}{X_1} \qquad (Y = \alpha X_1^{\beta 1} X_2^{\beta 2} X_3 \ldots\ldots\ldots\ldots X_6^{\beta 6})$$

By definition,

$\frac{\partial y}{\partial x_1}$ = marginal value product of X_1 (MVP_{X1})

And, $\frac{Y}{X_1}$ = average value product of X_1 (AVP_{X1})

Thus, MVP_{X1} can be obtained by multiplying its elasticity of production (β_1) with its AVP at geometric mean level of both Y and X_1. In general for i^{th} resource,

$AVP_{Xi} = \frac{\overline{Y}}{\overline{X_i}}$

Where,

$\overline{Y}$ = value of Y at geometric mean level

$\overline{X_i}$ = value of X_i at geometric mean level

Then,

RUE = MVP/MFC

$MFC_{Xi} = VMP_{Xi} = MPP_{Xi} \times P_Y$ (at profit maximizing condition)

The level of resource use efficiency was calculated using following formula:

r = MVP/MFP, Where, r = Efficiency ratio

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

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

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

Where,

D= absolute value of percentage change in MVP of each resource.

The Resource Use Efficiency (RUE) 1, means resources are optimally used and RUE less than or greater than 1 represents resources are either overused or under used (Heady and Egbert 1964).

RESULTS

Cost of production of lentil

Considering the variable cost items, total cost of production of lentil was NRs. 21919.8 per hectare for those farmers who are using locally reserved seed of previous season while the total cost of lentil production was almost 5% higher for improved seed using farmers. This non-significant difference was mainly due to slightly higher price of improved seed than local seed. Out of the total cost of lentil cultivation, almost 33.3% and 29.3% of total cost was incurred in labor for local seed using farmer and improved seed using farmers. Total labor cost involved in lentil grain production was statistically same for both categories. However, cost involved in other inputs found significantly higher for improved seed using farmers. This significant difference was mainly contributed by the price of seed. Average improved seed price in the study area was NRs.123 per kg. However average seed price of locally available seed was only NRs. 65 per kg. About 85% of the cost involved in local seed user and improved seed user categories of farmers was under variable cost category. Among the variable cost items, human labor, seed, harvesting and processing were major items.

Table1: Cost of production (Per hectare) of lentil grain among local seed user and improved seed user

Variable	Overall (n=300)	Local seed user (n=150)	Improved seed user (n=150)	Mean difference	t-value
Total labor cost	7004.6 (3127.5)	7317.4 (2241.5)	6691.9 (3478.1)	625.5	0.65
Total input cost (other than labor)	15364.2 (7236.4)	14602.4 (7654.2)	16126 (6418.7)	-1523.6*	-2.56
Total cost (labor + inputs)	22368.8 (6284.8)	21919.8 (5741.7)	22817.9 (5403.2)	-898.1	-0.91

Considering the lentil grain and seed production, significantly higher production cost was there in lentil seed production than grain production. In case of lentil seed production, NRs. 28765.5 per hectare was incurred while in grain production NRs. 22368.8 was involved and this production cost difference was statistically significant. Out of the total lentil grain production cost, 31.3% was in labor. Likewise, in case of lentil seed production, 36.1% of total seed production cost was in labor (**Table** 2). Cost incurred in other variable items was significantly higher in seed production than in grain production. Major reason behind the higher input cost in lentil seed production than lentil grain production was due to higher cost of foundation seed of lentil. For the improved seed production of lentil, farmers need to buy foundation seed which cost NRs. 160 per kg while for lentil grain production, farmers are using both local and improved seed and average per kg seed price was NRs. 94.5. Similarly, processing cost was also higher in lentil seed production than grain production.

Table 2: Cost of production (NRs./ha) of lentil grain and seed production

Variable	Overall (n=400)	Grain producer (n=300)	Seed producer (n=100)	Mean difference	t-value
Total labor cost	8688.4 (2772.7)	7004.6 (3127.5)	10372.3 (3131.8)	-3367.7***	-5.54
Total input cost (other than labor)	16878.7 (6452.5)	15364.2 (7236.4)	18393.2 (4129.8)	-3029*	-4.74
Total cost (labor + input)	25567.1 (5394.17)	22368.8 (6284.8)	28765.5 (6958.8)	-6396.7***	-7.36

Note: Figure in parenthesis indicates standard deviation. *** and * indicates significant difference at 1% and 10% levels respectively.

Production and price trend of lentil

The study also found that, total lentil production and amount of lentil sold in market is decreasing year after year **(Table 3)**. Lentil production in 2019, among local seed user and improved seed user found significantly different at 5% significance level. Farmers who are using improved seed of lentil are getting significantly higher production than local seed user. The average sold of lentil over consecutive three years by improved seed user was statistically higher than that of local seed user. Considering both local and improved seed user, the price of lentil found increasing in last three years and can be predicted that, despite the decreasing trend of lentil production, price of lentil is increasing in current years. However, the seasonal fluctuation of price was one of the major marketing constraints in the study area. During year 2017, price of lentil grain was NRs. 50.9 kg while it rises to NRs. 55.9 in 2019.

Table 3: Trend of differences in production and price of lentil grain among local and improved seed user

Variables	Overall (n=300)	Local seed user (n=150)	Improved seed user (n=150)	Mean difference	t-value
Total production (kg)					
2019	259.4 (201.4)	238.8 (181.9)	280.1 (228.8)	-41.3**	-1.73
2018	285.8 (234.3)	251.2 (205.7)	320.4 (256.7)	-69.2***	-2.89
2017	293.5 (226.8)	246.6 (162.4)	340.5 (320.1)	-93.9***	-4.37
Price (NRs./kg)					
2019	55.9 (10.3)	55.2 (9.9)	56.6 (10.7)	-1.4	-1.1
2018	53.0 (9.2)	52.7 (8.4)	53.3 (9.7)	-0.6	-2.05
2017	50.9 (9.7)	50.8 (9.8)	51.1 (9.7)	-0.3	-1.17

Figures in parentheses indicate standard deviation. ***, and ** indicates significant difference at 1% and 5% levels respectively. Average lentil cultivated land is 8.09 kattha for local seed user and 9.74 kattha for improved seed user.

In the year 2017, total lentil grain production was 293.5 kg and it decreased by almost 11.6% in 2019. Likewise, total seed production in the year 2017 was 340.8 kg and it decreased by almost 22.1% in 2019. Bothe the lentil grain and seed production is decreasing and compared with decreasing rate of lentil grain production, lentil seed production is decreasing at higher rate. However, amount of lentil sold by farmers is significantly higher for seed producer than grain producer. In the year 2019, almost 90% of the total seed produced by seed producing farmer are selling their product while only 68.2% of total grain produced is being sold by grain producing farmers. This result suggests that, grain production farmers are reserving higher proportion of their total production mainly for home consumption and to use as a seed for next season than seed producing farmers. This study revealed that, price of both lentil grain and seed is increasing. In the year 2017, average price of lentil grain was only NRs. 50.9 per kg and price increased by almost 9.8% and reached to NRs. 55.9 in 2019. Similarly, average price of lentil seed in the year 2017 was only NRs. 63.5 and price increased by almost 14.6% and reached to NRs. 72.8 per kg in 2019. Comparing with price of lentil grain and seed, seed producing farmers are getting significantly higher price than grain producing farmers.

There is a high variation in profit margins for producer and for market actors in the lentil business compared to other cereals and vegetables. Lentil productivity is found low, but farmers do not hesitate to agree that lentil cultivation is more profitable than other cereal crops. The reason is that the cost of inputs is low and farm gate prices are appreciable. Considering the total variable cost only, for improved seed user, about 29.3% of total variable cost was involved in labor, 9.5% was in land preparation, 28.1% was in seed and 17.5% was in threshing. While for local seed user, about 33% of total variable cost was involved in labor, 12.5% was in land preparation, 20% was in seed and 20.7% was in threshing. Similarly, for seed producer, about 36.1% of total variable cost was involved in labor 25.2% was in seed and 18.7% was in threshing. Due to the higher number of labor requirement for processing, harvesting, and intercultural operation in seed production, cost of labor was high for seed producer than grain producer. Analyzing the total variable cost only and gross income from lentil grain and seed production, this study revealed almost 28% higher cost in seed production than grain production. However, seed producing farmers had almost 13% higher revenue than grain producing farmers.

Table 4: Total variable cost and income (Per hectare) from lentil grain and seed production

Parameters	Local seed user		Improved seed user		Seed producer	
	Cost (NRs.)	Share of total cost (%)	Cost (NRs.)	Share of total cost (%)	Cost (NRs.)	Share of total cost (%)
Labor cost	7314.4	33.3	6691.9	29.3	10372.3	36.1
Land preparation cost	2739.9	12.5	2167.7	9.5	3250.5	11.3
Seed cost	4365.7	19.9	6411.8	28.1	7245.4	25.2
FYM, fertilizers and micronutrients cost	1841.2	8.4	2099.2	9.2	949.2	3.3
Disease and pest management cost	1139.8	5.2	1460.3	6.4	1553.3	5.4
Harvesting, threshing and post-harvest cost	4537.4	20.7	3993.1	17.5	5379.1	18.7
Total cost	NRs. 21919.8		NRs. 22817.9		NRs. 28765.5	
Income from lentil production	NRs. 48881.2		NRs. 48830.5		NRs. 54942.1	

Benefit cost analysis in lentil production

Considering the total variable cost and total fixed cost items, the study revealed that, for improved seed user, local seed user and seed producer, about 65.13%, 64.43% and 83.04% of the total cost was under variable cost category respectively. Among the variable cost items, labor, seed, land preparation and threshing cost were major cost items. Among improved seed user, net profit was found as NRs. 17.81/kg, while it was NRs. 15.25 for local seed user (**Table** 5).

Table 5: Cost and benefit analysis of lentil production for improved seed user and local seed user

Cost items	Improved seed user	Local seed user	Seed producer
Variable cost items	Cost per kg of lentil Grain production	Cost per kg of lentil Grain production	Cost per kg of lentil seed production
Labor	9.42	11.04	15.49
Land preparation (tractor/bullock)	2.42	2.54	0.17
Seed	7.87	5.92	13.02
Farm Yard Manure (FYM)	0.16	0.39	0.28
Urea	0.23	0.45	1.3
DAP	0.36	0.64	0.12
Micro nutrients	0.23	0.1	1.19
Disease/pest management	0.18	0.1	1.69
Threshing	4.31	4.56	4.61
Drying/processing	0.1	0.1	0.1
Total variable cost	25.28	25.75	37.97
Fixed cost items			
Land rent	8.33	9.54	4.64
Depreciation on farm equipment's	2.87	1.89	1.76
Repair and maintenance	2.31	2.78	1.35
Total fixed cost	13.51	14.21	7.75
Total cost	38.79	39.96	45.72
Average revenue per kg	56.60	55.21	72.80
Net profit per kg	17.81	15.25	27.08
B:C ratio over variable cost	**2.23**	**2.14**	**1.91**
B:C ratio over total cost	**1.45**	**1.38**	**1.59**

Note: Average lentil produced by improved seed user (280.1 kg), by local seed user (238.8 kg) and average lentil produced by seed producer (265.6 kg)

Comparing with seed production and grain production, study found NRs. 12.22/kg of higher profit of seed than grain production.

Resource Use Efficiency (RUE) in lentil grain production for improved seed user

Efficiency in any system is an expression of obtainable output with the addition of unit amount of input. Resource use efficiency (fertilizer, water etc.) is the output of any crop per unit of the resource applied under a specified set of soil and climatic conditions. The major resources used in lentil cultivation were labor, seed, farm yard manure, pesticides and fertilizers. The cost items in lentil cultivation includes labor cost, land preparation cost, seed cost, farm yard manure, fertilizers and micronutrients cost, cost for disease and pest management and harvest and post-harvest cost. Cobb-Douglas production function used to determine efficiency of resources for improved seed user showed that the model has good explanatory power; all the independent variable included in the model explained the variation of output with highly significant F- value of 38.05 at 1% level.

The R-squared value was 61.48%, indicates that 61.48% of the variation in income of lentil for improved seed user was explained by the independent variables included in the model (**Table** 6). Among the tested variable, seed and harvest and post-harvest cost had significant effect on output produced. Labor cost, FYM, fertilizers and micronutrients and plant protection cost had negative effect while land preparation cost had non-significant but positive impact on output produced. Return to scale indicates the proportionate change in output as a result of proportionate change in input. The summation of all the coefficients of explanatory variables included in the regression model gives the value of return to scale. The value of return to scale was 0.854 in lentil grain production using improved seed. Thus, lentil grain production function using improved seed in the study area exhibited decreasing return to scale and 85.4% increase in the gross return could be realized if all the inputs specified in the function are increased by 100%.

Table 6: Production function of lentil for improved seed user

Variables	Coefficient	Standard Error (S.E)	t-stat	p-value
Ln (labor cost)	-0.012	0.009	-1.38	0.169
Ln (land preparation cost)	0.005	0.007	0.83	0.407
Ln (seed cost)	0.033**	0.016	2.06	0.041
Ln (FYM, fertilizers and micronutrients cost)	-0.014	0.007	-1.99	0.048
Ln (Disease and pest management cost)	-0.007	0.011	-0.71	0.476
Ln (Harvest and post-harvest cost)	0.873***	0.083	10.49	0.001
Constant	2.473	0.602	4.10	0.001
R- square	0.6148			
Adjusted R-square	0.5987			
F-value	38.05***			
Return to scale	0.854			

Note: ** and *** indicates significant different at 5% and 1% level.

For improved seed user, total cost of major variable resources like labor, seed, FYM, micronutrients and fertilizer was NRs. 22817.9 per hectare. Among the major variable cost items, almost 29.3% of total variable cost was incurred in labor, 28.1% in seed, 17.5% in harvesting, threshing and post-harvest cost while only 25.1% was in other cost items. The ratios of MVP and MFC are greater than unity for land preparation and harvest and post-harvest indicating that these inputs were underutilized. The ratio of MVP and MFC for labor, seed, FYM, fertilizers and micronutrients and plant protection are less than unity implying that such key input was over utilized. This suggests that farmers can reduce the use of inputs like labor, seed, FYM, fertilizers and micronutrients as well as inputs used in disease and pest management to make its use efficient. Overall, the study revealed that all the inputs used in lentil production were not optimally utilized (**Table** 7). Needed adjustments in the MVPs shown in the **Table** 7 indicated that the level of input use should be increased and amount of some inputs items should be decreased for optimal allocation of resources. This study revealed that, labor, FYM, fertilizers and micronutrients, seed and plant protection inputs should be decreased by 61.2%, 99.9%, 126.3% and 99.9% respectively while inputs used in land preparation and harvest and post-harvest should be increased by 99.1% and 80.5% respectively for getting the highest profit.

Table7: Estimation of resource use efficiency of lentil grain production for improved seed user

Variable	Coefficient	MVP	MFC	r	D-value (1-1/r)	Efficiency
Ln (Labor cost)	-0.012	-2.56	1	-2.56	61.2	Overused
Ln (Land preparation cost)	0.005	103.97	1	103.97	99.1	Underused
Ln (Seed cost)	0.033	0.442	1	0.442	126.3	Overused
Ln (FYM, fertilizers & Micronutrients cost)	-0.014	-3784.7	1	-3784.7	99.9	Overused
Ln (Disease & pest management cost)	-0.007	-2470.54	1	-2470.5	99.9	Overused
Ln (Harvest & post-harvest cost)	0.873	5.12	1	5.12	80.5	Underused

Resource Use Efficiency in lentil grain production for local seed user

Cobb Douglas production function was used to determine the efficiency level of variable inputs used in lentil grain production using the locally reserved seed by farmers. Gross income from lentil production is regressed with independent cost items (**Table** 8). Statistically highly significant F-value showed that the model has good explanatory power; all the independent variable included in the model significantly explained the variation of output at 1% level. The value of R-squared indicated that 74.6% of the variation in income from lentil grain production was explained by related cost variables included in the model. From the model, it can be concluded that, land preparation cost, seed cost and harvest and post-harvest cost were significant predictor of income collected from lentil grain production. This relationship also revealed that, other things remaining constant, one percent increase in seed cost and harvest and post-harvest cost would increase the total revenue from lentil production by 0.63% and 0.36% respectively. Summation of coefficient of variable cost items used in the production function signifies the return to scale in lentil grain production using local seed of lentil. The value of return to scale was 1.016 in lentil grain production using local seed. Thus, lentil grain production function using local seed in the study area exhibited increasing return to scale and 101.6% increase in the gross return could be realized if all the inputs specified in the function are increased by 100%.

Table 8: Production function of lentil for local seed user

Variables	Coefficient	Standard Error (S.E)	t-stat	p-value
Ln (labor cost)	0.002	0.008	0.30	0.764
Ln (land preparation cost)	0.011**	0.006	1.90	0.060
Ln (seed cost)	0.630***	0.057	10.90	0.001
Ln (FYM, fertilizers and micronutrients cost)	0.009	0.006	1.54	0.126
Ln (Harvest and post-harvest cost)	0.364***	0.066	5.46	0.001
Constant	2.161	0.392	5.51	0.001
R- square	0.746			
Adjusted R-square	0.737			
F-value	83.00***			
Return to scale	1.016			

Note: ** and *** indicates significant impact at 5% and 1% level respectively.

Total cost of lentil grain production for those farmers using local seed was NRs. 21919.8 per hectare. Among the variable cost incurred in lentil grain production, 33.3% of total variable cost was involved in seed, 12.5% in land preparation, 19.9% in seed, 20.7% in harvesting, threshing, and post-harvest cost, 8.4% in FYM, fertilizers and micronutrients cost and 5.2% in plant protection. The study revealed that, except labor all other major resources used in lentil production using local seed found underutilized (**Table** 9). Comparing total income with major resources used, marginal value compared with labor cost found as 0.145, which revealed that per rupee investment in seed resulted NRs. 0.145. Similarly, marginal value for land preparation cost found as 674.81, for seed cost it was 6.44, for FYM, fertilizers and micronutrient 1629.6 and for harvest and post-harvest cost was 2.04, signifying underutilization of those resources.

Table 9: Estimation of resource use efficiency of lentil grain production for local seed user

Variable	Coefficient	MVP	MFC	r	D-value (1-1/r)	Efficiency
Ln (Labor cost)	0.002	0.145	1	0.145	589	Overused
Ln (Land preparation cost)	0.011	674.81	1	674.81	99.86	Underused
Ln (Seed cost)	0.630	6.44	1	6.44	84.53	Underused
Ln (FYM, fertilizers and micronutrients cost)	0.009	1629.6	1	1629.6	99.44	Underused
Ln (Harvest and post-harvest cost)	0.364	2.04	1	2.04	50.25	Underused

Resource Use Efficiency in lentil seed production

Cobb Douglas production function showed that the model has good explanatory power; all the independent variable included in the model explained the variation of output with highly significant F-value of 43.06 at 1% level. The R-squared value was 69.6%, indicates that 69.6% of the variation in income of lentil for lentil seed producer was explained by the independent variables included in the model (**Table** 10). Model used to determine effect of resources used in lentil production with total income of lentil seed production showed that labor cost, seed cost and cost for harvest and post-harvest are the significant predictor of income collected from lentil seed production. Cobb Douglas production function revealed that, other things remaining constant, one percent increase in labor cost, seed cost and harvest and post-harvest cost would increase the total revenue from lentil seed production by 0.022%, 0.54% and 0.25% respectively. Lentil seed production function also revealed the decreasing return to scale having the aggregated coefficient value of all variable items as 0.822. This result signifies that, 82.2% increase in the gross return from lentil seed production could be realized if all the inputs specified in the function are increased by 100%.

Table 10: Production function of lentil for seed production

Variables	Coefficient	Standard Error (S.E)	t-stat	p-value
Ln (Labor cost)	0.022***	0.008	2.66	0.009
Ln (Seed cost)	0.541***	0.071	7.56	0.001
Ln (FYM, fertilizers and micronutrients cost)	0.004	0.003	1.35	0.182
Ln (Disease and pest management cost)	0.001	0.003	0.59	0.553
Ln (Harvest and post-harvest cost)	0.254***	0.072	3.52	0.001
Constant	3.039	0.498	6.10	0.001
R- square	0.696			
Adjusted R-square	0.679			
F-value	43.06***			
Return to scale	0.822			

Note: *** indicates significant effect at 1% level.

For seed production in one hectare of land, NRs. 28765.5 was incurred in variable cost items while NRs. 54942.1 was taken as gross income by the seed producing farmers. Total cost and income was higher in seed production than grain production. However, considering the variable cost items, B:C ratio was higher in lentil grain production than seed production. Labor, seed, threshing and post-harvest cost were the major variable cost items. Almost 36.1% of total variable cost was incurred in labor, 25.2% and 18.7% of total cost was involved in seed and threshing and post-harvest cost. Analyzing the marginal value product produced by per unit input used, except for labor, MVP was higher than one for all other inputs. MVP value less than unity for labor cost suggested the intensive and overused nature of labor input in the seed production and use of labor input should be decrease for to maximize the profit. However, MVP value of all other variable inputs found higher than unity signifying the underused condition of inputs. Therefore, to get the maximum profit from the lentil seed production, use of all inputs except labor should be increased.

Table11: Estimation of Resource Use Efficiency of lentil seed production

Variable	Coefficient	MVP	MFC	r	D-value (1-1/r)	Efficiency
Ln (Labor cost)	0.022	0.316	1	0.316	216	Overused
Ln (Seed cost)	0.541	2.746	1	2.746	63.6	Underused
Ln (FYM, fertilizers and micronutrients cost)	0.004	11.08	1	11.08	91.0	Underused
Ln (Disease and pest management cost)	0.001	36.42	1	36.42	97.3	Underused
Ln (Harvest and post-harvest cost)	0.254	1.131	1	1.131	11.6	Underused

DISCUSSION

Total labor cost involved in lentil grain production was statistically same in lentil grain production either using local seed or using improved seed. However, cost involved in other inputs found significantly higher for improved seed using farmers. This significant difference was mainly contributed by the price of seed. Average improved seed price in the study area was NRs.123 per kg. However average seed price of locally available seed was only NRs. 65 per kg. Several studies conducted in different regions of South Asia also revealed the similar finding and concluded that seed cost had contributed 13%-18% of the total cost involved in lentil grain production and compared with locally reserved seed, price of improved seed is significantly higher (Kumar et al 2016, Chatterjee et al 2015, Panda et al 2019). Though the price of improved seed is higher than local seed, it has directly contributed in higher production. Study revealed that, farmers who are using improved seed of lentil are getting significantly higher production than local seed user. Study conducted by Cokkizgin and Shtaya (2013) had also found the higher yield of lentil using the improved or hybrid seed than using the local seed. In this study higher portion of the total cost was incurred in the variable cost items and this result found similar with the study of Miah et al (2021) in which 57% of the total cost was in variable cost items for improved seed user and 55% of the total cost was in variable cost items for local seed user. Total cost of lentil production for local seed user, improved seed user and seed producer was found as NRs. 21919.8/ha, NRs. 22817.9/ha and NRs. 28765.5/ha while total gross income was NRs. 48881.2/ha, NRs. 48830.5/ha and NRs. 54942.1/ha respectively. Net profit found higher in the study area comparing with the finding of Thapa Magar et al (2014) and reason might be due to comparatively higher production and price of lentil in study area but study conducted by Kumar et al (2016) found that total net profit of NRs. 48128/ha for contract farmer and total profit of NRs. 23482/ha for non-contract farmer, signifying comparatively lower profit in the study area. Lower profit found in this study might be due to lower average yield of lentil in the study area compared with study of Kumar et al (2016) and majority of the farmers had performed relay cropping in which cost of cultivation found lower than other cropping pattern. Similarly, farmers had used certain portion of their production for consumption as well as for next season planting as seed which decreased the total sold amount resulting lower net profit per hectare of land. Study revealed the decreasing trend of lentil area and production and this finding is supported by the study of Paudel et al (2020) in which they revealed that, erratic rainfall pattern during the pre-flowering and flowering stage had brought the severe yield loss. Several biotic and abiotic factors affect the production and yield of lentil (Sehgal et al 2021). However, winter rainfall pattern during the flowering season and prevalence of fungal diseases mainly Stemphylium Blight are the major threating factors for the yield reduction of lentil in Nepal (Sharma and Joshi 2021).

The overall benefit cost ratio for lentil grain producer was found as 2.18 over variable cost and 1.41 over total cost while for seed producer it was found as 1.91 over variable cost and 1.59 over total cost depicting lentil cultivation as a profitable business with good return potential in the study area. Benefit cost ratio found almost 13% higher for seed producer than for grain producer implying seed production of lentil is highly profitable than grain production. Similarly, price of lentil seed was found as average of NRs. 72.8/kg which is almost 25% higher than per kg lentil as grain. This result found similar with the study of Thapa Magar et al (2014) in which benefit cost ratio of lentil cultivation was found as 1.16 as sole crop, 1.15 as mixed crop and 1.26 as relay crop. The price for lentil as pulse ranged from NRs. 60/kg to NRs. 75/kg while price of lentil as seed ranged from NRs. 80/kg to NRs. 90/kg, depicting price of lentil as seed is higher than as grain. Similar study conducted by Tithi and Barmon (2018) found the benefit cost ratios (BCR) of lentil and mustard production were 2.32 and 1.73 respectively, indicating that both lentil and mustard cultivation in Bangladesh are profitable and comparison with mustard cultivation, lentil cultivation is more profitable. Likewise another study conducted by Kumar and Bourai (2012) reported that the net profit was only Rs. 3787/ha in lentil and Rs. 3719/ha in pigeon pea with the estimated benefit cost ratio (BCR) of 1.27 in lentil and 1.30 in pigeon pea.

Farmers are always shown constraints regarding resources, especially small and marginal farmers and their objective is to maximum farm return from the available resources. To operate the farm business at the economical optimum level, they have to make adjustment in the allocation of their limited resources. For local seed user, improved seed user and seed producer, 65%, 63% and 83% of total cost was used in variable cost respectively. For improved seed user, about 37% of total variable cost was involved in labor and found overused, 31% was used in seed, which was also overused. For local seed user, about 43% of total variable cost was involved in labor and found over used, 23% was in seed, which is found under used. Similarly, for seed producer, about 43% of total variable cost was under labor cost, 32% was under seed cost and 11% was under threshing cost. This result found consistent with the findings of Kumar et al (2016) in which almost 55% of total cost was used in variable cost items and out of total variable cost, 8.6% was used in seed and 39.6% was used in labor for contracted farmer while 8.9% of total cost was used in seed and almost 40 % of total cost was used in labor for non-contracted farmers signifying, among all variable cost, seed and labor are the major cost items in lentil cultivation. Similarly, study conducted by ANSAB (2011) found almost 41% of total cost was spent on labor, 8% was spent on seed, 34% was spent of irrigation and almost 8% was spent in fertilizers in lentil cultivation. Likewise similar study conducted by Tithi and Barmon (2018) reported that, out of total cost involved, variables cost constituted almost 75.1% while fixed cost constituted almost 24.9% and among total cost, 36.1% was spent of labor while only 5.4% of total cost was spent in seed. This study also revealed that, for lentil seed as well as grain production, labor and seed are the major variable cost items and labor cost is being overused signifies the labor intensive business of lentil seed and grain production. Cost of labor should be reduced to get the maximum profit and for this mechanization in lentil seed as well as grain production is the urgent need. This result is also supported by the study of Tithi and Barmon (2018) and Miah et al (2021) and suggested that labor and seed are the major but mostly overused variable cost items in lentil production. For seed producing farmers, except labor resource, all other resources found under used. In order to get the optimum benefit from the lentil cultivation for improved seed user; labor cost, seed cost, FYM, fertilizers and micronutrients cost and disease and pest management cost should be decreased while land preparation cost, and harvest and post-harvest cost should be increased. Similarly for local seed user and seed producer; except labor cost, which should be decreased, all other inputs cost should be increased to get the optimum profit from lentil cultivation. This study also revealed very poor use of machinery in lentil cultivation, which could be the best option to decrease the labor cost. Higher seed cost might be due to higher seed rate applied in the study area.

CONCLUSION

Despite the higher cost of lentil seed production, farmers are getting higher profit from lentil seed production than from grain production. Seed cost, labor cost and threshing and post harvesting cost are the significantly contributing cost items in lentil grain and seed production. Only labor cost contributes one third of total variable cost signifying the labor-intensive nature of lentil grain and seed production. Considering only variable cost, benefit cost ratio is higher (2.23) in lentil grain production using local seed followed by using improved seed (2.14) and seed production (1.91). However, considering total cost involved, seed production is comparatively profitable (B:C ratio of 1.59) than grain production (B:C ratio of 1.41). which showed farmers can be benefitted higher by involving in lentil seed production than grain production. Labor cost being overused in lentil seed and grain production; it should be decreased by any other alternatives. In seed production of lentil, except labor cost, all other inputs are in underused condition and increased amount of those inputs could give higher output and profit to the farmers. Return to scale found increasing (1.016) in lentil grain production using local seed but it was in decreasing rate in lentil grain production using improved seed (0.854) and in lentil seed production (0.822). To get maximum profit in lentil grain production using local seed and in seed production, labor cost should be decreased while other variable inputs should be increased. However, in lentil grain production using improved seed, labor cost, seed cost, fertilizers and plant protection cost should be decreased while other inputs should be increased.

ACKNOWLEDGMENTS

The authors want to acknowledge Nepal Seed and Fertilizer Project (NSAF) implemented by International Maize and Wheat Improvement Center (CIMMYT) for providing the financial and technical support. All the helping hands from National Maize Research Program (NMRP), CIMMYT-SARO, Nepal and Agriculture and Forestry University (AFU) are highly acknowledged.

REFERENCES

ANSAB. 2011. Value chain / market analysis of the lentil sub-sector in Nepal. https://ansab.org.np/storage/product/nepal-neat-subsector-market-analysis-lentil-aug-2011-1579689501.pdf

Bist P, P Bhatt, SN Bist and R Kafle. 2021. Resource use efficiency of wheat seed production: a case of wheat superzoneKailali, Nepal. Azarian Journal of Agriculture **8**(2): 67-75. **DOI**: http://dx.doi.org/10.29252/azarinj.054

Chandra SD, RP Prasad, TR Bahadur, SS Kumar and KCD Bahadur.2017. Allocative efficiency of resource use on beekeeping in Chitwan district of Nepal.International Journal of Environment, Agriculture and Biotechnology **2**(4): 1447-1451. **DOI**: http://dx.doi.org/10.22161/ijeab/2.4.1

Chatterjee S, J Ray, R Nath, SK Gunri, T Biswas and A Sarker. 2015.Economics of lentil cultivation in Nadia district of West Bengal. Journal of Crop and Weed **11**(1): 38-42.

Cokkizgin A and MJ Shtaya. 2013. Lentil: Origin, cultivation techniques, utilization and advances in transformation. Agricultural Science **1**(1): 55-62.

Dhakal SC, PP Regmi, RB Thapa, SK Sah and DB Khatri-Chhetri. 2015. Resource use efficiency of mustard production in Chitwan district of Nepal. Int. J. Appl. Sci. Biotechnol. **3**(4): 604-608. **DOI**: 10.3126/ijasbt.v3i4.13525

Erskine W, JF Muehlbauer, A Sarkar and B Sharma. 2009. The lentil: Botany, production and uses. In B Erskine, W Muehlbauer, Jf Sarkar, A Sharma (Ed.) The lentil: Botany, Production and Uses. CABI International; **pp**. 1–4.

FAOSTAT. 2022. Statistics division, Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat/en/#data

Faris MAIE, HR Takruri and AY Issa. 2013. Role of lentils (*Lens culinaris* L.) in human health and nutrition: A review. Mediterranean Journal of Nutrition and Metabolism **6**(1): 3–16. **DOI**: https://doi.org/10.1007/s12349-012-0109-8

Gharti DB, R Darai, S Subedi and S Kumar. 2014. Grain legumes in Nepal: Present scenario and future prospects. World Journal of Agricultural Research **2**(5): 216–222. **DOI**: https://doi.org/10.12691/wjar-2-5-3

Gurung B, R Regmi, A Paudel, U Paudel, A Paudel and S Shrestha. 2021. Profitability, marketing, and resource use efficiency of ginger production in Rukum west, Nepal. Archives of Agriculture and Environmental Science **6**(4): 426-435.**DOI**: https://doi.org/10.26832/24566632.2021.060403

Heady EO and AC Egbert. 1964.Regional programming of efficient agricultural production patterns.Econometrica: Journal of the Econometric Society 14-38.

ITC .2019. Trade Help Desk. International Trade Center (ITC). https://globaltradehelpdesk.org/en/export-071340-from-ca-to-np/explore-markets.

Kumar A , D Roy, PK Joshi, G Tripathi and RP Adhikari. 2016. Impact of contract farming on profits and yield of smallholder farms in Nepal: An evidence from lentil cultivation (No. 333-2016-14567).

Kumar S and VA Bourai. 2012. Economic Analysis of Pulses Production Their Benefits and Constraints"(A Case Study Of Sample Villages Of Assan Valley Of Uttarakhand, India). IOSR Journal of Humanities and Social Science **1(**4): 41–53. **DOI**: https://doi.org/10.9790/0837-0144153.

Miah MM, MA Rashid and MS Rahman. 2021. Profitability analysis and comparative advantage of lentil production in Bangladesh. The Bangladesh Journal of Agricultural Economics **42**(2): 49-64.

MoALD .2021. Statistical information on Nepalese agriculture 2076/77 (2019-20). Government of Nepal, Ministry of Agriculture and Livestock Development, Statistics and analysis section. https://s3-ap-southeast-1.amazonaws.com/prod-gov-agriculture/server-assets/publication-1625998794412-f37e4.pdf

Panda CK, R Kumar and LK Meena. 2019. Lentil production economics and constraints: An empirical study in mokamataal of bihar.

Pant KR, SB Gurung, NB Dhami, J Shrestha, L Aryal and R Darai. 2019. Agro-morphological traits variability of lentil genotypes. Nepalese Journal of Agricultural Sciences **18**: 108-114.

Paudel GP, M Devkota, A Keil and AJ McDonald. 2020. Climate and landscape mediate patterns of low lentil productivity in Nepal. Plos one **15**(4): e0231377.**DOI:**https://doi.org/10.1371/journal.pone.0231377

Prasai HK, S Sharma, UK Singh Kushwaha, BP Joshi and J Shrestha .2019. Performance evaluation of lentil and chickpea genotypes in Doti district of Nepal. International Journal of Applied Biology **3**(2): 46-56.

Qamar A, M Ashfaq and MTI Khan. 2017. Resource use efficiency and return to scale analysis in off-season cucumber production in Punjab, Pakistan. Sarhad Journal of Agriculture **33**(1): 47-52.**DOI**: http://dx.doi.org/10.17582/journal.sja/2017.33.1.47.52

Rahman MS, MA Hossain, MJU Sarker and MA Bakr. 2012.Adoption and profitability of bari lentil varieties in some selected areas of Bangladesh. Bangladesh Journal of Agricultural Research **37**(4): 593-606.409-419.

Sapkota M, NP Joshi, RR Kattel and M Bajracharya. 2018. Profitability and resource use efficiency of maize seed production in Palpa district of Nepal. SAARC Journal of Agriculture **16**(1): 157-168.**DOI**: http://dx.doi.org/10.3329/sja.v16i1.37431

Sarkar MMA, MH Rahman, MR Haque, S Islam and R Sultana.2020. Socio-economic determinants and profitability analysis of Binamasur-8 production in some selected areas of Bangladesh. IOSR Journal of Economics and Finance **11**(6): 20-27. **DOI**: 10.9790/5933-1106052027

Sarker A and S Kumar.2011. Lentils in production and food systems in West Asia and Africa.International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. Grain Legumes **57**: 46-48.

Sehgal A, K Sita, A Rehman, M Farooq, S Kumar, R Yadav and KH Siddique. 2021. Lentil. In Crop Physiology Case Histories for Major Crops. Academic Press; **pp.** 408-428. **DOI**: https://doi.org/10.1016/B978-0-12-819194-1.00013-X

Shahwar D, TM Bhat, MYK Ansari, S Chaudhary and R Aslam. 2017. Retracted Article: Health functional compounds of lentil (*Lens culinaris*Medik): A review. International Journal of Food Properties **20**(sup1): S1-S15.**DOI**: 10.1080/10942912.2017.1287192

Sharma S and LP Joshi. 2021.Current Insights on Stemphylium Blight of Lentil with its Management Strategies. Sarhad Journal of Agriculture **37**(1): 247-261. **DOI**: http://dx.doi.org/10.17582/journal.sja/2021/37.1.247.261

Shrestha R, RK Neupane and NP Adhikari. 2011.Status and future prospects of pulses in Nepal. In Regional Workshop on Pulse Production held at Nepal Agricultural Research Council (NARC), Kathmandu, Nepal; **pp**. 24-25.

Subedi S, YN Ghimire, M Kharel, B Sharma, J Shrestha and BK Sapkota. 2020. Profitability and resource use efficiency of rice production in Jhapa district of Nepal. International Journal of Social Sciences and Management **7**(4): 242-247.**DOI**: 10.3126/ijssm.v7i4.32487

Sultana T and A Ghafoor. 2008. Genetic diversity in ex-situ conserved Lens culinaris for botanical descriptors, biochemical and molecular markers and identification of landraces from indigenous genetic resources of Pakistan. Journal of Integrative Plant Biology **50**(4): 484-490. **DOI**: 10.1111/j.1744-7909.2007.00632.x

Sumera A and B Ali. 2020. Pulses: a poor man's meat, importance and ways to enhance the pulses productivity in Pakistan. Department of Agronomy, University of Agriculture Faisalabad. https://www.technologytimes.pk/2020/09/14/

Thapa G, A Kumar and P Joshi. 2019.Agricultural transformation in Nepal. Prospects, and Policy Options: Trends, Prospects, and Policy Options.

Thapa Magar DB, D Gauchan and R Darai. 2014. Varietal Adoption and Marketing of Lentilin the Mid and Far Western Terairegion of Nepal. Advances in Plants and Agriculture Research **1**(5):, 1–6. **DOI**: https://doi.org/10.15406/apar.2014.01.00026

Tithi SM and BK Barmon. 2018. Comparative advantages of lentil (*Lens culinaris*) and mustard (*Brassica nigra* L.) production and their profitability in a selected district of Bangladesh. The Agriculturists **16**(1): 21-33.

Umar ASS and MBA Kadir.2015. Analysis of resource-use efficiency and productivity of residual soil moisture tomato production in Kaduna state, Nigeria.International Letters of Social and Humanistic Sciences **51**: 152-157.

||-------|||-------||