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Research Article

Yield and Cost Benefit Assessment of Lentil (*Lens culunaris*) Differentiated by Scale, Method and Purpose of Production in Nepal

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Abstract

Diverse production system and cultivation methods are followed for lentil crop in Nepal. This study was designed to analyze differentiated yield and cost benefit analysis of lentil by scale, method and purpose of production. Four major lentil producing districts in Nepal was purposively selected and followed multistage sampling. Face-to-face interview method was applied with randomly selected 473 respondents using pre-tested semi-structured interview schedule for primary data collection in 2022. Descriptive statistics, comparative yield analysis, benefit cost analysis methods were adopted and analyzed using MS-excel and STATA software. The average yield (kg/hac.) of lentil was 672.6 in the study area. Yield analysis resulted higher yield with the seed producer (739.1 kg/ha.) followed by improved seed user (706.3 kg/ha.), small scale farms (690.1 kg/ha.), commercial scale farms (658.0 kg./ha.), local seed user and grain producer (652.9 and 653.4 mt/ha.). Again, benefit cost ratio was higher among the seed producer (2.02) indicating lentil seed producing as a higher profitable enterprise followed by improved seed user (1.88), commercial farms (1.79), small scale farms (1.77) and grain producers (1.71). It can be concluded that lentil farming with a purpose of producing seed by the use of improved varietal seed in a commercial scale with good management practices is highly profitable.

Keywords: Lentil; Yield; Cost-benefit; Profitable; Nepal

Introduction

Lentil (*Lens culinaris Medik*) is one of the most important winter legume crops of Nepal which shares 60% area and 65% production of total legumes (Darai et al 2020) and cultivated in a diverse system of scale, purpose, method and types of inputs used. In Nepal lentil is cultivated in 202416 ha, with the production of 246092 ton and yield of 1215.7 Kg. /ha. (MoALD, 2021). Most of the Nepalese farmers follows relay cropping with rice and this crop depend primarily on residual moisture and nutrient (Shrestha et al., 2011), follow mixed farming with mustard, grain production for home consumption and market, seed production as a business using local and improved seed depending upon purpose of production. Nepali lentil with its characteristic of small grain size and bright pink color is highly sought in domestic as well as international markets owing to its taste, good cooking quality and high nutritional value. Lentil is grown almost throughout the country except some Himalayan region, but commercial production of lentil is confined in Terai districts such as Sarlahi, Rautahat,

Bara, Dang, Kailali and Bardiya, which account for nearly 90% of the production (CRS, 2018). With its highly nutritive value, lentil in Nepal is taken as a cheapest and easily available source of protein and significantly contributing for nutrition security, farm and family income and also accounts remarkable share in world export market (Ghimire et al., 2022).

Due to small parcels of land and scattered lentil pockets production and yield is declining due to ineffective management. Such that expansion of area under lentil cultivation with high yielding varieties and improved package of practice is highly recommended in Nepal (Ghimire et al., 2022). Also, lentil pulse crop on account of their vital role in nutritional security and soil ameliorative properties have been an integral part of sustainable agriculture since ages (Zeb et al., 2022), has the potential of fixing free nitrogen up to 107kg per hectare soil (Poudel et al., 2021). Considering the diverse benefit of the lentil in Nepal, this sector should be the most prioritizing ones to address food and nutrition security as well as the livelihood improvement of rural smallholder farmers (Gautam et al., 2022). Although tremendous opportunities of lentil production exist in the country, lentil crop is suffering with different problems and constraints from farm to market which needs innovative solutions to strengthen the production system. While talking to production opportunity, Nepal still holds about 0.24 million hectares of rice-fallows showing great opportunity to incorporate grain legumes in the rice-based cropping system (Gharti et al., 2014). The high price of pulses in the Nepalese market clearly reflects the demand pressure on the pulses showing its production potentiality in the country.

In Nepal different study was found done on benefit cost and profitability analysis of lentil but the adequate study on comparative yield and cost benefit assessment differentiated by production purpose, methods and scale of production has not done. Consequently, the rationality of the pattern of existing methods of production has to be evaluated to find out the best option for farmer that could be suggested to maximize the yield and income. This study is an effort in the direction of yield and cost benefit analysis in diverse system of lentil farming in Nepal. Proper cost estimation analysis helps farmers and development stakeholders to make the proper decisions required for further improvement (Poudel et al., 2021). In this backdrop, the facts revealed by the study would help in assessing the profitability at existing technological level and facilitate lentil farmers to choose their production system and guide related stakeholders to deliver support mechanism accordingly.

Research Methodology

Data

Using Cochran (1977) formula 473 sample size was maintained and thereafter simple random sampling procedure was adopted to collect primary data. The pre-tested interview schedule was used for household survey using face to face interview method with randomly selected 473 farmers in 2022. Four major lentils producing districts Kailali, Bardiya, Dang and Rautahat of Nepal were purposively selected as a research site. Using MS-excel sheet data from the field were edited, cleaned and maintained for further analysis purpose.

Data Analysis

Descriptive statistics using mean, standard deviation, minimum, maximum, two sample t-test were performed using STATA software. Gross margin (GM) and benefit cost ratio were analyzed differentiating purpose, method and scale of lentil production. Among the surveyed farms, the small scale and commercial scale farms were categorized as below and above the average area under lentil production respectively.

Gross Margin (GM) Analysis

Gross margin is the difference between the gross return and the total variable cost (Subedi and Timsina, 2023). In this study, cost of production of lentil was estimated as a sum of major variable costs incurred in production process.

Gross Margin (NRs.) = Gross farm income (NRs.) - Total variable cost (NRs.)

where, Gross farm income (NRs.) = Price of lentil (NRs.) × total quantity sold (Kg.)

Benefit Cost Analysis (BCA)

Benefit cost ratio analysis was done using the total variable cost and gross return from the sell of lentil.

$$\text{B: C ratio} = \frac{\text{Gross return (NRs.)}}{\text{Total variable cost (NRs.)}}$$

Results and Discussion

Socio-Economic Characteristics of Lentil Farmers in The Study Area

In the study area about 68% of surveyed households were headed by male with majority of nuclear family (51.37%). Around 88% of household's major occupation was agriculture. Farmers in the study area mostly following relay cropping (39.96%) with rice followed by sole cropping (33.19%) and mixed cropping (26.85%) with oilseed crop as a lentil production system. Similar to this result, Gautam et al., (2022) resulted majority of farmers (58.33%) followed relay cropping of lentil with rice in their study in Nepal. Majority of farmers were found involved in group cooperatives (51.8%). In the study area 36.78% found using improved seed of lentil and only 22.41% of lentil farmers were growing lentil for seed purpose. Among the farmers, only 21.14% had received training related to lentil

farming. But, Poudel et al., (2021) resulted about 54% of households had received training on lentil cultivation. The average age of household head were 49.12 years with 3.38 mean years of schooling. The total family size was found 7.04 with 4.73 numbers of economically active members. The detail and differentiated figures of socioeconomic profile by commercial and small-scale lentil farmers in the study area is presented in Table 1.

Land characteristics of the surveyed households

Study resulted there were around 66% of farmers under small scale and about 34% of farmers under commercial scale covering total land area of 67.7 hectare and 111.4 hectare with average of 0.2 and 0.7 hectare respectively in the study area. Only 22% of farmers were producing lentil for seed purpose in about 23% of land area (41.15 ha.) with mean area of 0.39 ha. About 37% of farmers were using improved seed of lentil and the area covered by improved seed was 69.23 hectare comprising 38.65% of total land under lentil cultivation. About 63 percent of farmers were using local seed of lentil covering about 61.35% of land area. The land characteristics by method, purpose and scale of production in the study area is presented in table 4 below. The average farm size of lentil in the study area was 0.38 hectare. Similar to this result Poudel et al., (2021) reported an average of 7 kattha (0.23 hectare) land was found allocated for lentil cultivation in their study in Nepal. The result reveled that majority of lentil farms are of small scale with minimum of 0.03 hectare to maximum 3.83 hectare. Taking in consideration to average farm size (0.38 ha.), the study found that 66 percent of farm sizes are of small scale and remaining 34 percent only are of commercial scale (Table 2).

Differentiated Yield Analysis of Lentil in The Study Area

Analysis of yield parameters differentiating by purpose, method and scale of lentil production is presented in Table 3. The average yield (kg/hac.) of lentil was 672.6 in the study area which was far lower than the national average of 1215.7 kg/hac (MoALD, 2021). Higher yield was found with the seed producer (739.1 kg/ha.) followed by improved seed user (706.3 kg/ha.), small scale farms (690.1 kg/ha.), commercial scale farms (658.0 kg./ha.), local seed user and grain producer (652.9 and 653.4 mt/ha.). Higher yield among seed producer and improved seed user may be due to the use of improved seed, technical facilitations and trainings compared to grain producers and local seed users. In this study lower yield was observed among local seed user and similarly Darai et al. (2020) also observed lower productivity of lentil because of poor access to quality seeds, inputs and technology delivery services. In case of commercial farmers low productivity was observed may be because of poor crop management and lack of intercultural operations. In the study area, somehow good management of crop was observed in small scale farms compared to commercial farms. Also, the result revealed that there is a large yield gap in lentil production between different purpose, methods and scale of production in the study area. Minimum 188 kg/hac to maximum 1410 kg/hac of yield was observed in the study area.

Table 1: Socio-demographic and economic characteristics of sampled farmers by farm size (n=473)

Variables	**Frequency**	**Percentage**
A. Categorical variables		
Gender of household head		
Male	322	68.08
Female	151	31.92
Family type		
Joint	230	48.63
Nuclear	243	51.37
Major Occupation		
Agriculture	418	88.37
Non-agriculture	55	11.63
Farming Practice		
Sole cropping	157	33.19
Relay cropping with rice	189	39.96
Mixed cropping with oilseed	127	26.85
B. Institutional and Farming variables		
Involved in groups/cooperatives (yes=1)	245	51.80
Received training on lentil (yes=1)	100	21.14
Use of improved seed (yes=1)	174	36.78
Purpose of lentil farming (seed=1)	106	22.41
C. Continuous variables	Mean value	Std. Dev.
Age of HH head	49.12	12.54
Education (years of schooling) of HH head	3.38	3.41
Total family size	7.04	4.22
Economically active HH members	4.73	2.71

Source: (Field survey, 2022)

Table 2: Land characteristics with farmers category differentiated by method, purpose and scale of production (n=473)

Criteria	Total land area (ha.)	Mean area per farmers (ha.)	Proportion Percentage	Percentage of farmers
Area under small scale lentil farms (n=312)	67.70	0.20	37.80	65.96
Area under commercial scale lentil farms (n=161)	111.40	0.70	62.20	34.04
Area under lentil seed production (n=106)	41.15	0.39	22.97	22.41
Area under lentil grain production (n=367)	138.00	0.38	77.03	77.59
Area covered by local seed user (n= 299)	109.92	0.37	61.35	63.21
Area covered by improved seed user (n= 174)	69.23	0.40	38.65	36.79
Lentil farm size distribution	Value in hectare			
Maximum farm size	3.83			
Minimum farm size	0.03			
Average farm size	0.38			
Scale of lentil production	Frequency/percentage			
Small scale (<0.38 ha.)	312 (66.0)			
Commercial scale (>0.38 ha.)	161 (34.0)			

(Source: Field survey, 2022)

Table 3: Yield of lentil differentiated by purpose, method and scale of production in the study area

Category	Average yield (kg/Ha.)	Std. Deviation	Minimum yield (kg/Ha.)	Maximum yield (kg/Ha.)
Total surveyed farms (n=473)	672.6	321.7	188	1410
Small scale farms (n=312)	680.1	335.5	188	1410
Commercial farms (n=161)	658.0	293.6	200	1380
Local seed user (n=299)	652.9	332.2	188	1380
Improved seed user (n=174)	706.3	300.6	188	1410
Grain producer (n=367)	653.4	327.7	188	1380
Seed Producer (n=106)	739.1	291.8	214	1410

(Source: Field survey, 2022)

Gross Margin and Cost benefit analysis of lentil differentiated by methods, purpose and production scale

Table 4 represents the comparative cost benefit assessment based upon methods, purpose and scale of lentil production in the study area. The production scale was categorized as commercial and small scale with above and below mean area under lentil production respectively. Result revealed that significantly lower cost per hectare (NRs. 35203.14) was found in commercial scale compared to small scale (NRs. 36807.29) farms. Although higher benefit cost ratio was observed in commercial scale farms (1.82) compared to small scale farms (1.78), surprisingly yield was found higher in small scale farms than commercial scale farms (Fig. 1). This may be due to good crop management activities by small scale farmers due to small and manageable farm size.

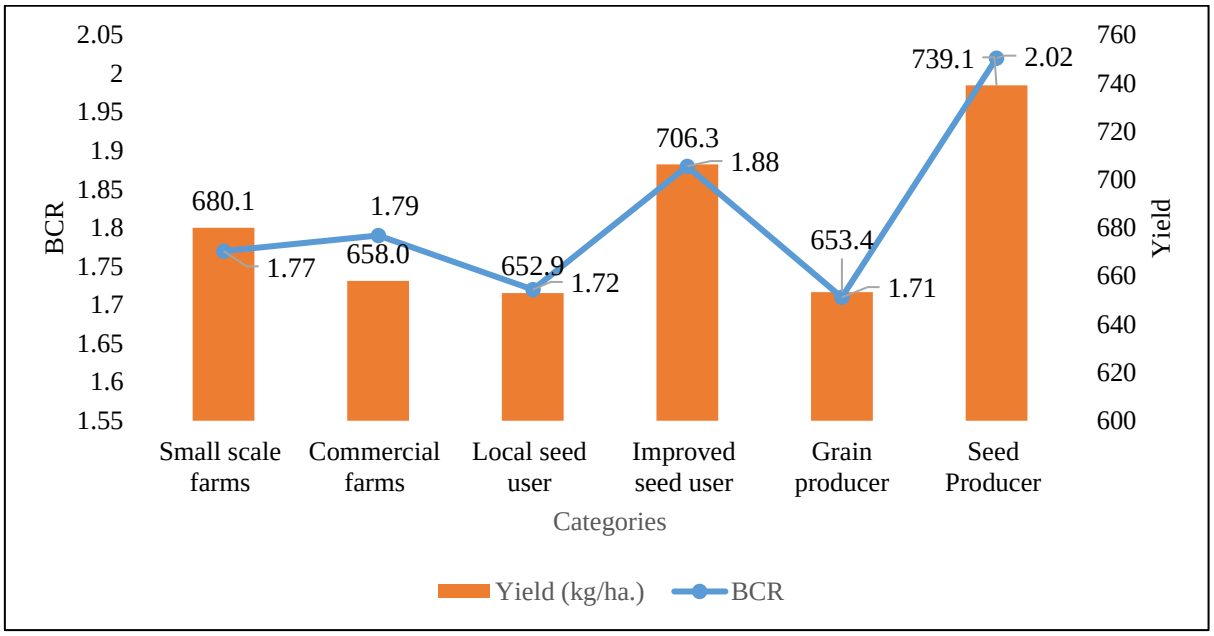

Fig. 1: Benefit cost ratio (BCR) and yield of lentil differentiated by farm size, purpose and types of seed used

Table 4: Per hectare cost and return structure of lentil production differentiated by farm size, purpose and types of seed used in the study area

Measuring criteria	**Commercial farms (n=161)**	**Small scale farms (n=312)**	**Mean diff.**	**Std. error**	**T value**
Total cost (NRs./ha.)	35203.14 (8422.67)	36807.29 (7885.29)	-1604.15**	783.27	-2.048
Yield (kg/ha)	658.02 (293.61)	680.10 (335.50)	- 22.07	31.23	-0.706
Gross Revenue (NRs./ha.)	59951.01 (28171.28)	62214.46 (30297.42)	-2263.45	2871.56	-0.788
Gross Margin (NRs./ha.)	24747.87 (28961.76)	25407.17 (31456.01)	-659.29	2972.40	-0.221
BCR	1.79 (0.90)	1.77 (0.99)	0.014	0.09	0.153
Measuring criteria	**Seed producer (n=106)**	**Grain producer (n=367)**	**Mean diff.**	**Std. error**	**T value**
Total cost (NRs./ha.)	37265.86 (9094.678)	35971.12 (7777.38)	1294.74*	892.01	1.451
Yield (kg/ha)	739.05 (291.84)	653.39 (327.70)	85.66**	35.29	2.427
Gross Revenue (NRs./ha.)	71505.87 (29582.1)	58537.88 (28975.41)	12967.99***	3210.05	4.039
Gross Margin (NRs./ha.)	34240.01 (30620.43)	22566.76 (30132.84)	11673.25***	3334.71	3.500
BCR	2.02 (0.96)	1.71 (0.95)	0.31***	0.105	3.009
Measuring criteria	**Improved seed user(n=174)**	**Local seed user (n=299)**	**Mean diff.**	**Std. error**	**T value**
Total cost (NRs./ha.)	36784.16 (8626.73)	35956.98 (7774.34)	827.183	772.13	1.071
Yield (kg/ha)	706.35 (300.63)	652.93 (332.28)	53.41*	30.60	1.745
Gross Revenue (NRs./ha.)	65749.47 (29730.42)	58938.52 (29251.52)	6810.95**	2805.98	2.427
Gross Margin (NRs./ha.)	28965.31 (30633.11)	22981.54 (30416.61)	5983.766**	2907.82	2.057
BCR	1.88 (0.95)	1.72 (0.97)	0.15**	0.091	1.709

Note: Figure in parentheses indicates standard deviation. *, ** and *** indicates significance level at 10, 5 and 1% level of significance.
(Source: Field survey, 2022)

From the result it was found that per hectare total cost, yield, gross margin and benefit cost ratio was found significantly higher among seed producer compared to grain producer in the study area. Higher in total cost may be due to higher price of improved seed for seed production purpose and use of other inputs like farm yard manure, compost and fertilizers by seed producing farmers. Compared to grain producer, about 18.5% higher benefit cost ratio for seed producer (2.02) was observed may be due to around 13% higher yield and about 15% higher farm gate price for lentil as a seed compared to grain. Similar to this result, Gautam et al., (2023) resulted 13% higher benefit-cost ratio for seed production than for grain production, implying that lentil seed production is more profitable than grain production. From the study, statistically no significant difference was observed in cost and return variables with improved seed user and local seed user but comparatively higher gross margin (NRs. 26323) per hectare and higher benefit cost ratio (1.81) was found with improved seed user compared to local seed user (Table 4). This may be due to higher yield and higher price of the sold lentil as seed producing farmers are also listed under improved seed user category. Based on

these findings, it can be explained that lentil farming with a purpose of producing seed by the use of improved varietal seed in a commercial scale with good management practices is highly profitable.

Conclusion

This study has derived critical results and findings that provide better understanding of the differentiated lentil production system in Nepal. Study resulted that majority of farmers in lentil are small scale, lower yield but higher profit was observed due to higher farm gate price and higher market demand but suffered with low adoption of improved seed and improved varieties, poor crop management practices. Higher yield and profit were found among lentil seed producing enterprises and improved seed user farms. Although the cost was reduced and resulted with higher benefit in large scale farms, poor management and lower yield was found compared to small scale farms such that yield enhancing practices should be focused in major lentil pockets rather than increasing area under cultivation. Based on these findings, it can be concluded that lentil farming with a purpose of producing seed by the use of improved varietal seed in a commercial scale with good management practices is highly profitable and recommended. Implementation of good agriculture practices is recommended with strong agriculture extension system to expedite sustained production system of lentil in Nepal.

Authors' Contribution

Binod Ghimire as a PhD student designed and conducted the research and analyzed and interpreted the data. Dr. Shiva Chandra Dhakal, Dr. Santosh Marahatta and Dr. Ram Chandra Bastakoti guided, advised, suggested, and provided constructive feedback to finalize this manuscript. All the authors reviewed and agreed manuscript for publication.

Conflict of Interest

The authors declare that there is no conflict of interest.

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