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ECONOMICS OF POTATO PRODUCTION IN MUSTANG DISTRICT OF NEPAL

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ABSTRACT

Potato possesses a huge potential for production in Nepal and is a major source to ensure food and nutritional security among people of mountainous region. The study was carried out in four rural municipalities of Mustang district to assess the economics of potato production. A pre-tested semi-structured questionnaire was administered randomly to 90 different farmers. The collected data was tabulated and analysed using STATA. Potato production was identified as a profitable farming business with an average productivity of 18.95 t/ha with benefit-cost ratio of 1.59. The average per hectare total cost of production of potato was found to be Rs 660774.8 on mustang district. The study reveals that expenditure on labour wage and organic manure contributed more than three-quarters of total production cost of potato. There were no any significant differences between the different rural municipalities in terms of the total cost of production but a significant difference (1% level of significance) was observed over the production of potato per hectare. An increment in 1% cost of seeds was found to result in increase in 0.27% of income from potato production, however a diminishing return to scale (0.232) was revealed in the study. Incidence of disease and pest and price fluctuation were identified as a major constraint for potato production and marketing respectively. Timely availability of inputs, mechanization to reduce labour cost, training on advanced technology, wide coverage of agriculture extension service, and adoption of climate smart farming technologies is recommended to ensure profitability of potato production in Mustang.

1. INTRODUCTION

Potato (*Solanum Tuberosum*), an herbaceous annual plant that belongs to the family Solanaceae of the flowering plants (Reddy *et al*., 2018) is one of the important food crops of Nepal. In hilly and mountainous regions potato is regarded as a staple crop. Potato is the fifth most important crop grown in Nepal after rice, maize, wheat, and millet whereas it is the fourth major crop of the world (Kloos *et al*., 1991; Reddy *et al*., 2018). It ranks second in terms of production and ranks first in productivity in Nepal (Sapkota *et al*., 2019). Potato possesses huge potential for production in Nepal and it can be cultivated from the lower belt of terai to higher elevations of 4400 metres above sea level (Kharel, 2022). The production of crops goes on decreasing whereas the period required for maturation keeps on increasing with the increase in the altitude above sea level (MoALMC, 2020). Low productivity of cereal crops coupled with low access to food items due to physical and financial barriers results in food and nutrition insecurity in the high Himalayan region of Nepal (FAO, WFP, MoALD, 2019). In this scenario, potato can be grown as a major staple crop substituting rice, maize, wheat to ensure food and nutritional security. Potato is considered an important cash crop as well. The area under potato cultivation in the fiscal year 2020/21 was 1,98,788 ha whereas the national production of potato was 33,25,231 mt. (Figure 1) (MoALD, 2022).

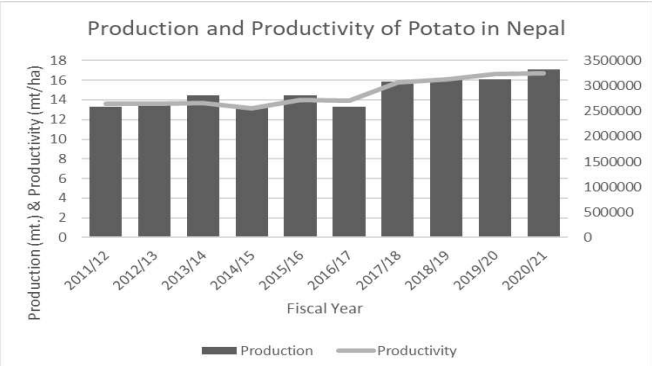

Figure 1. Production and Productivity of Potato in Nepal

Source: (MoALD, 2022)

Although the food security situation in Nepal has improved over the years, still 4.6 million people are food-insecure. Among this 20% of the households are moderately food-insecure and 10% are severely food insecure (Ministry of Health, Nepal; New ERA; and ICF, 2017). Households in rural communities and mountainous regions where food production is comparatively low is and price of food items is high are more likely to be food insecure. Mustang district falls under the category of food deficit region of Gandaki province where the annual production is insufficient to meet the demand of food requirement (NPC and WFP, 2019). Mountainous topography, the cold climate at a higher altitude above sea level makes it challenging for the cultivation of cereals and other food crops. Potato is the only crop that can be grown at the altitude of 3000 m in a short duration of 4-5 months. It gives good production even up to the altitude of 4000 m. Hence, potato serves as an important substitute for any other staple crop in this region. Development Vision Nepal Pvt. Ltd. (DVN), 2018 has identified value chain development in potato and its linkage to the regional and global value chain as a source of better income for farmers of Gandaki Province. Kunjo, Lethe, Kujjo, Pangling, Falyak, Tukuche, Marpha, Jomsom, Kagbeni, Muktinath have been mentioned as pocket areas for potato cultivation in Mustang district under the Commercial Potato Cultivation Programme (National Potato Development Program, 2017).

In the Mustang district, potatoes are cultivated as a rainy season crop in the months of Falgun to Bhadra. In the fiscal year 2020/21, the total area under potato cultivation of Mustang district was 306 ha, total production is 4,795 mt. and total productivity was 15.67 mt. per ha. The average productivity of potato in Mustang district is above the average potato productivity of Gandaki province (15.09), and below the national productivity of 16.73 mt. per ha (MoALD, 2022). Although potato is grown as a major staple crop, study on economics of potato production in mustang district is limited. Thus, the study was undertaken to assess the economics of potato production in Mustang district with an aim to compute the cost associated with production, productivity and benefit-cost ratio and make a comparison among different rural municipalities and identify the problems associated with potato production. Moreover, the study aims to provide valuable insights into current state of potato production and will help to identify problems associated with production and marketing.

2. MATERIALS AND METHODS

2.1 Study area

Mustang district is one of the eleven districts of Gandaki Province and covers an area of 3,573 sq. km. It is located at the latitude of 29° 04' 60.00" N and longitude of 83° 54' 59.99"E. The district is surrounded by China in the North, Myagdi district in the South, Manang in the East, and Dolpa in the West. The total area of this district is 3,63,958 ha out of which 3,639 ha is suitable for agriculture. The selection of Mustang district for this study is based on its status as a food-insecure region within Gandaki Province, where potato serves as a crucial staple crop and a significant source of income. The study location is shown in the figure 2. The survey was conducted at different wards/villages of four rural municipalities namely Thasang, Gharapjong, Barhagaun Muktikshetra and Dalome.

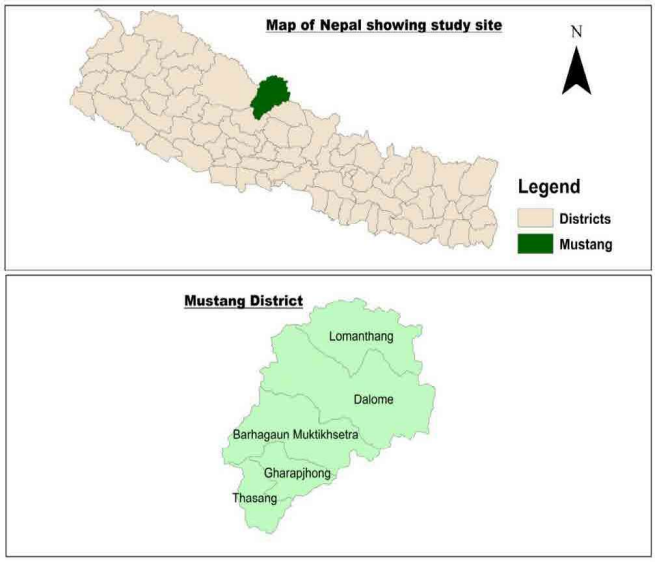

Figure 2. Map showing the study site

2.2 Sampling process

A total of 90 farmers were selected using simple random sampling technique. The sample size was determined by using Cochran's formula at 10% error (Cochran, 1977)

$$n = \frac{\frac{z^2pq}{e^2}}{1 + \frac{\frac{z^2pq}{e^2} - 1}{N}}$$

Where, n is the sample size, z is the selected critical value at desired confidence level (90% confidence level), p is the estimated proportion of an attribute that is present in the population (p=0.5), q=1-p and e is the desired level of precision (e=0.10), N is the population size (3,305 i.e., number of households in Mustang)

2.3 Data collection and analysis

The household survey was conducted using a pre-tested questionnaire to collect the necessary information from April to June 2021. Phone survey was also used for collection of data because of the second wave of Covid-19 and subsequent travel restrictions. Relevant secondary information was collected by assessing various secondary data sources, including annual report, publications, journals from National Potato Development Programme, Nepal Agricultural Research Council and government websites. The collected data was coded and entered into MS-Excel and the analysis was completed through the use of MS-Excel and STATA (version 16). Descriptive statistics (average, frequency, standard deviation) and analytical statistics (multiple regression model) were performed.

2.4 Benefit-cost ratio

The benefit-cost ratio was calculated by dividing the gross return by total variable cost as used by Bajracharya & Sapkota, 2017 using the formula below:

$$\text{Benefit-Cost Ratio} = \frac{Gross\ Return}{Total\ Variable\ Cost}$$

Total Variable Cost = Summation of all variable Costs (seeds, organic manure, chemical fertilizers, pesticides, labour)

2.5 Production Function and Return to Scale Analysis

Cobb–Douglas production function (CDPF) is widely used to represent the technological relationship between the various inputs used and output produced (Bajracharya & Sapkota, 2017). The following form of CDP was used

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}e^u$$

Where Y is the total income from potato production in hectares (NRs.), X_1 is the cost of seeds, X_2 is the expenditure on manure, X_3 is the expenditure on manure, e error term and b_1, b_2, b_3 coefficient to be estimated.

The CDPF in the form expressed above was linearized in logarithmic function for the ease in computation

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + u$$

where ln=natural logarithm, a=constant and u= random disturbance term

The summation of respective coefficients obtained from CDPF was used to calculate the value of return to scale (Ghimire & Dhakal, 2014).

Return to Scale (RTS) = Summation of coefficients $(b_1+b_2+b_3)$

Decision rule:
Return to scale >1: Increasing return to scale
Return to scale =1: Constant return to scale
Return to scale<1: Decreasing return to scale

2.6 Ranking of problems

Based on a review of literature and discussion with farmers and key officials of the Agriculture Knowledge Centre (AKC), major problems associated with potato production and marketing in Mustang were identified and included in the questionnaire. The identified problems were ranked using force ranking technique as used by Subedi *et al*., 2019. The formula given below was used to find the index of importance for problems where the value of score ranged from 0 to 1.

$$I_{imp} = \sum \frac{SiFi}{N}$$

Where, I_{mp} = Index of Importance

$\sum$ = Summation

Si = I^{th} scale value

Fi = frequency of i^{th} importance given by respondents

N = total number of respondents

3. RESULTS AND DISCUSSION

3.1 Socio-demographic characteristics of the respondent:

The average age of the respondent was found to be 47.68 and within the range of 21 to 81 years. The majority of the respondents (76.67%) were male and the remaining 23.33% were female. The majority of the respondent (42.22%) were Thakali followed by Gurung (32.22%), Dalit (14.44%), Brahmin/Chhetri (6.67%), and Magar (4.44%) **(Table 1).**

Table 1. Gender and Ethnicity of the respondent in present survey

Gender	Frequency	Percentage
Male	69	76.67%
Female	21	23.33%
Ethnicity		
Thakali	38	42.22
Gurung	29	32.22
Dalit	13	14.44
Brahmin/Chhetri	6	6.67
Magar	4	4.44

The total population of the study area of 90 households was 524 with an average family size of 5.82 members, which was higher than the national average (4.50) (CBS, 2017). The average household percentage of females was 49.24% and the participation of females in agriculture (both full-time and part-time) was more compared to male. Among the total respondents, 18.89% respondents were found to be illiterate and the remaining 81.11% were literate. The average household income of the respondents was Rs. 4,52,966.7 whereas the average household income from potato production was Rs. 95,788.89. From the survey, the average landholding of the respondent was found to be 0.667 hectares whereas the land used for potato cultivation on an average was 0.1455 hectares. 42.22% of the respondents practiced sole-cropping of potato, 40% of them practiced mixed or intercropping with other crops, and the remaining 16% practiced both sole and mixed cropping. 16.67% of the farmers had attended training whereas 83.33% of the farmers hadn't participated in any sort of training. The majority (82.22%) of the respondents had cultivated local varieties of the potato (Local Rato and Local Seto). The majority (82.22%) of the farmers used organic manure (cattle, poultry, goat or sheep manure) as the only source of fertilizer in the potato field. The majority of farmers (82.22%) employed irrigation systems to cultivate potatoes, while 17.78% relied on rainfall as their source of irrigation. Late blight was considered the most important disease in the study area whereas white grub was the most important insect.

3.2 Economics of potato production

3.2.1 Cost of production of potato

The total cost of production associated with potato farming was found to be Rs. 660,774.8 per hectare for Mustang district. The major cost incurred comprised labor expenses of Rs 269,407.8 per hectare, cost of organic manure of Rs 249,172.2 per hectare and seed tuber expenses of Rs.132,825.4 per hectare (Table 2). A report on production cost of cereal, cash, vegetable and industrial crops in Nepal 2015/16 by Bhandari *et al.* (2016) calculated the average cost of potato production in Myagdi district as Rs 243,687.60 per hectare. The cost of potato production in Achham district was Rs 256,285.293 per hectare (Sapkota *et al*., 2019) Rs. 197,186 per hectare in Baglung district (Bajracharya & Sapkota, 2017) and Rs. 172,292.2 per hectares in Nuwakot district (Dahal & Rijal, 2019). The cost of potato production in Mustang district was found to be much higher than the cost of production as suggested by the existing literature. This could have been because of remote and mountainous topography of the region.

Table 2. Variable Cost of Potato Production in Mustang district

Items	Overall	Thasang	Gharapjong	Baragung-Muktikshetra	Dalome
Seeds	132825.4	125736.4	127813	136192.8	152385.2
Organic Manure	249172.2	226270	243915.2	274249	218478.8
Chemical Fertilizers	1630.6	660	1472.2	4242.8	0
Pesticides	7738.8	9183.2	11589.6	4675.2	0
Labor	269407.8	237856.8	275142	270262.2	305714.6
Total Cost of Production	660774.8	599706.4	659931.8	689622	676578.6

The highest cost of production was associated with labour requirement which amounts to 41% of the total cost of production. Mainly labour was used in land preparation and planting, intercultural operations (earthing up, weeding), and harvesting of potato. Organic manure accounted the second highest cost, 38% of the total cost of production, followed by the cost of seed tuber attributing 20% of the total cost of production. The cost of chemical fertilizers and pesticides was minimal as farmers opted for organic manure (Figure 3). Bajracharya & Sapkota (2017) also identified the cost of farm-yard manure (FYM), seeds and labour as major costs incurred in the potato production. Similarly, Chauhan *et al*. (2022) reported cost of seeds, labour and FYM accountable for the majority of cost of production in Darchula district of Nepal.

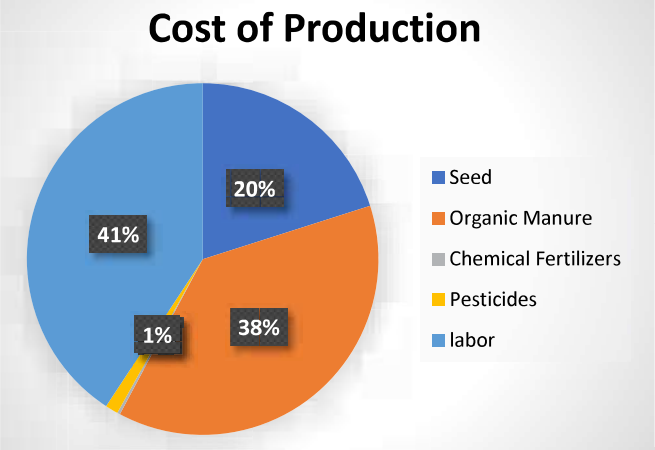

Figure 3. Cost of production of potato farming

There was no any significant difference among different rural municipalities with respect to the total cost of production as observed by the one-way ANOVA test (Table 3).

Table 3. Oneway ANOVA test among different rural municipalities with respect to the total cost of production

Source	SS	df	MS	F	Prob > F
Between group	1.1013e+11	3	3.6712e+10	0.76	0.52
Within group	4.1807e+12	86	4.8612e+10		
Total	**4.2908e+12**	**89**	**4.8612e+10**		

3.2.2 Production, productivity and benefit-cost ratio

Potato was cultivated on an average area of 0.1455 hectares with an average production of 18.95 tonnes per hectare. Among the rural municipalities, Thasang had the lowest production per hectare at 14.13 tonnes, while Dalome had the highest at 26.9 tonnes. Gharapjong and Baragung-Muktikshetra recorded production rates of 19.16 and 18.26 tonnes per hectare, respectively (Table 4). The productivity (18.95) t/ha which is above the national productivity of 16.73 t/ha and the productivity of Mustang district reported in 2020/21 (15.67 ton/ha). However, the productivity was similar to the average productivity of Mustang district in 2019/20 i.e., 19.92 t/ha (MoALD, 2021). High altitude region with longer maturation time is more suitable for potato cultivation, especially for higher tuber yield and higher quality products (Islam *et al*., 2020).

Table 4. Economic Indicators of potato farming in different rural municipalities of Mustang district

Items	Potato grown area				
	Overall	**Thasang**	**Gharapjong**	**Baragung-Muktikshetra**	**Dalome**
Total Variable Cost (NRs. / hectare)	660774.8	599706.4	659931.8	689622	676578.6
Total Production (kg. / hectare)	18954.8	14139.6	19160	18269.6	26900
Total Income (NRs. / hectare)	1052749.6	822783.2	997852.8	1021636	1601096
Total Profit (NRs. /hectare)	391974.8	223076.8	337921	332014	924517.4
Benefit-Cost Ratio (NRs. / hectares)	1.59	1.37	1.51	1.48	2.36

Despite the significantly higher cost of production, the benefit cost ratio was found to be comparable to other regions. This can be attributed to higher potato yield per unit area and higher selling price (Rs. 55.54 per kg) received by the farmers. Potato cultivation was found to be profitable with a B/C ratio of 1.59. The highest B/C ratio was observed at Dalome rural municipality with a value of 2.36, followed by Gharapjong (1.51), Baragung-Muktikshetra (1.48), and lastly Thasang (1.37) (Table 4). The Benefit-Cost ratio of potato production in Nuwakot was 1.71 (Dahal and Rijal, 2019), 1.23 in Okhaldhunga district (Phulara *et al*., 2022), 1.47 in Achham (Sapkota *et.al*., 2019), 1.44 in Baglung (Bajracharya & Sapkota 2017), 1.62 in Darchula (Chauhan *et al*., 2022). Higher production of potato per unit area along with the higher price received by the farmers for their produce (Rs. 55.54 per kg) could have been the reason for a higher B/C ratio in Mustang. The one-way ANOVA test revealed a significant difference at 1% level of significance in potato production per hectare across rural municipalities. Specifically, there was a significant difference at 5% level of significance in production per hectare between Dalome and Baragung-Muktichhetra, as well as between Dalome and Gharapjong. Additionally, the difference in production per hectare between Thasang and Dalome rural municipality was highly significant at a 1% level of significance as shown by the Bonferroni test (Table 5). The difference in productivity between rural municipalities maybe because of increasing incidence of diseases and pests and different environmental constraints such as erratic rainfall, hailstorm in in lower elevation of Mustang district. Bom *et al*. (2023) in his study has reported farmers' perception on an increase in temperature with warmers summers, decreased snowfall and variable rainfall pattern in Lower Mustang region. A study by Adhikari *et al*. (2021) also reported that agriculture has been adversly impacted by climate change with an increase in agricultural diseases, insects and invasive species in Muktinath region of Mustang district.

Table 5. One-way ANOVA test with Bonferroni test among different rural municipalities with respect to production per hectare in Mustang

Source	SS	df	MS	F	Prob > F
Between group	1.4085e+09	3	469512136	8.04	0.0001***
Within group	5.0207e+09	86	58380735.6		
Total	**6.4293e+09**	**89**	**72239097.4**		

Row Mean-Column Mean	Baragung-Muktikshetra	Dalome	Gharajong
Dalome	8649.33		
	0.01**		
Gharapjong	898.238	-7751.09	
	1.00	0.01**	
Thasang	-4129.76	-12779.1	-5028
	0.528	0.00***	0.106

***indicates significant at 5% level*

**** indicates significant at 1% level*

3.2.3 Production function analysis

Table 6 represents the Cobb-Douglas production function analysis of potato production in the study area. It was found that the increase in cost of seeds by 1% would result in increase in total income from potato production by 0.27% and the increment was significant at 5% level of significance. A study by Bajracharya & Sapkota, 2017 also found a positive increment in income from potato production with increase in cost of seeds in Baglung district. In the present survey, it was revealed that labor and manure constitute over three-quarters of total cost of production which might explain the lack of significant relationship of manure and labor with total income from potato production. The mean variance inflation factor (VIF) was 1.05 and none of the variables had VIF higher than 2 indicating the absence of multicollinerity between independent variables.

Table 6. Production function analysis of potato production

Explanatory Variable	Coefficient	Standard Error	T value	P> | *t* |
Seeds (NRs. / ha)	0.277**	0.133	2.08	0.040
Manure (NRs. / ha)	0.000	0.000	0.10	0.919
Labour (NRs. / ha)	-0.045	0.107	-0.42	0.675
Constant	11.032	1.81	6.08	0.000
R^2	0.0493			
Adjusted R^2	0.0162			
F-value	0.2237**			
Return to scale	0.232			

** indicate significance at 5% level of significance

3.2.4 Return to scale analysis

The sum of regression coefficients obtained from CDPF was 0.232 which indicated decreasing return to scale. This implies that increase in cost of variable inputs would return lesser amount of income from potato production. Amgai *et al*. (2011) in his study also reported a decreasing return to scale in apple production in Mustang district.

3.2.5 Problems associated with the production of potatoes

The incidence of disease and pests was identified as the primary concern in potato production, with the highest index value of 0.83. Lack of fertilizers and pesticides ranked second (0.76) followed by shortage of high-quality planting material (0.68) (Table 7). Erratic rainfall patterns and impacts of climate change were an emerging issue at Thasang rural municipality whereas lack of manpower was another additional problem at Dalome rural municipality, Upper Mustang. Upadhyay *et al*. (2020) also reported disease, pest problems as one of the most important problems in his study. Bajracharya & Sapkota (2017) also identified disease infestation in potatoes as a major reason behind low productivity in Baglung district. Similarly, Subedi *et.al*. (2019) also reported lack of improved quality seeds and the incidence of disease and pest as major problems in potato production.

Table 7. Ranking of the problems associated with production of potato

Problems	Index	Rank
Incidence of disease and pest	0.83	I
Lack of fertilizers and pesticides	0.76	II
Lack of quality planting materials	0.68	III
Lack of training and extension service	0.61	IV
Technical Constraints	0.46	V
Lack of Irrigation	0.42	VI
High Cost of Production	0.21	VII

3.2.6 Marketing of the produce

The majority of the farmers (77.78%) were satisfied with the price received whereas 22.22% of the respondents were unsatisfied with the price. Fluctuation in the price of potato and delay in payment resulted in dissatisfaction in the farmers. The farmers received an average of Rs 55.54 per kg of potato produce with price varying from Rs 36.67 to Rs. 90 per kg. The local cultivar of potato is sought out for their superior and excellent taste and has an excellent market demand which is why potatoes fetch such a high price in Mustang. The fluctuation of price can be attributed to several factors including, seasonal variation in production, involvement of marketing channel and intermediaries, weather and road conditions, lack of storage facilities. Traders collected the produced potatoes and were responsible for marketing of the major produce whereas only a small quantity of the produce was sold directly by farmers themselves.

3.2.7 Problems associated with marketing

Price fluctuation was identified as the most important problem with an index value of 0.90. Lack of transport was the second most important problem with an index value of 0.66 followed by high middleman margin with an index value of 0.65 (Table 8). Phulara *et.al*. (2022) also reported more middleman, lack of adequate market information and price fluctuation as major problems in marketing of potato at Okhaldhunga district.

Table 8. Ranking of the problems associated with marketing of potato

Problems	Index	Ranking
Price Fluctuation	0.90	I
Lack of transport facility	0.66	II
High middleman margin	0.65	III
Lack of storage	0.61	IV
Lack of grading and packaging	0.45	V

4. CONCLUSION

Potato is an important staple crop in food-insecure mountainous region of Nepal such as Mustang. According to the study, farmers in this region cultivated potato on an average area of 0.1455 hectares and the average household income from potato production was Rs. 95,788.89. The farmers grew local cultivars of potatoes and preferred organic manures over chemical fertilizers. The total cost of production associated with potato farming was found to be Rs. 660774.8 per hectare for Mustang district which was much higher compared to other regions primarily due to remote topography and lack of infrastructures resulting in high cost associated with labor, organic manure and seeds. However, potato farming was profitable with a B/C ratio of 1.59 because of higher productivity of 18.95 t/ha and higher per unit selling price. A significant difference was observed in production of potato per hectare

between rural municipalities which can be attributed to environmental constraints and increase in disease and pest in lower elevations as an impact of changing climate. It is recommended to prioritize development of local level policies and adaptation strategies aimed at mitigating adverse effects of climate change in agriculture. Production function analysis revealed that an increase in 1% cost of seeds, would increase the total income from potato production by 0.27%. The return to scale was found 0.232, indicating a decreasing return to scale. Incidence of disease and pest, lack of fertilizers and pesticides and lack of quality planting material were identified as major problems associated with potato production whereas price fluctuation and lack of transport were major constraints of marketing of potato. Moreover, a huge proportion of population had not received any training related to potato cultivation. Hence, strengthening agricultural extension activities for dissemination of production technology along with timely availability of inputs is necessary to increase the profitability of potato production.

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