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RESEARCH ARTICLE

COMPARATIVE ECONOMIC ANALYSIS OF MAIZE SEED AND GRAIN PRODUCTION IN GULMI, NEPAL

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ABSTRACT

Serious hurdles plague maize cultivation in Nepal's mid-hills, which poses many bottlenecks to commercialization and productivity. This study investigates the dynamics of maize production and commercialization in the Ishma, Malika, and Madane Rural Municipalities of Gulmi district, where maize seed and grain production has potential. The findings reveal that, while seed producers are marginally younger, their household heads perform much better than grain producers on all three family size, economic activity, and labor use criteria. Better seed and better inputs (labor and manure) benefit seed producers and increase the production cost. Although they average the same maize yield, seed producers obtain higher returns as their total return is NRs. 140669.2, compared with only NRs. 68,036.42 for grain producers. For Gulmi, maize seed production is more profitable than grain production (1.47: 1.31, respectively) as indicated by the Benefit-to-Cost ratio (B: C). Similarly, seed producers were found to have a higher (1.204) return to scale than grain producers (1.147). Production obstacles include shortages of workers, problems with pests and diseases, poor infrastructure, and lack of technical expertise. These challenges are exacerbated by marketing problems, such as distance to market and low seasonal prices, which make commercialization difficult. According to the Cobb-Douglas production function analysis, the increased cost in intercultural operations, pre-sowing operations, and post-harvest activities leads to higher income for seed and grain producers. The results pinpoint the need for improved access to inputs, technical training, and better infrastructure to enhance the maize production efficiency and commercialization in Gulmi.

KEYWORDS

B: C Ratio, Cobb-Douglas, Gulmi, Profitability, Return to Scale

1. INTRODUCTION

Nepal's economy largely depends on agriculture and more than half of its population is working in agriculture and agrarian activities, directly or indirectly, and it continues to contribute significantly to the national GDP (Chaudhary, 2018). Maize (Zea mays), the second major cereal after rice, is important to the mid-hills and high hills in Nepal (MoALD, 2023). It gives a basic diet, fuel, and fodder, feed to the populations having little resources (Pandey and Koirala, 2017). Irrigation facilitates additional cropping in the Terai and inner Terai, while maize in highland regions is rain-fed from April to August (Shrestha, 2014).

The Gulmi district in Lumbini Province is designated as a maize production zone under the PMAMP in 2075–2076, with an average yield of 3.04 t/ha and annual production of 68,389 t of maize across 22,488 ha (MoALD, 2023). Though yellow maize remains in high demand as animal feed, white maize is more commonly farmed for human food. Notwithstanding advantageous geographic and climatic conditions, traditional methods of maize production persist, which hinders commercialization and productivity (Khanal et al., 2025). The lack of adoption is due to largely farmers making use of stored seeds and having limited access to high-quality and improved varieties (Gairhe et al., 2021; K.C. et al., 2015).

Poor irrigation and limited input availability as well as lack of extension services are some of the obstacles to maize production in Nepal mid hills (Dulal and Marahatta 2020). Farming is expensive and time-consuming due to the absence of modern equipment and tools (Yang and Li, 2023). Factors of the market such as low seasonal price, minimal bargaining power, and restricted market access impede the commercialization of maize (Pokhrel et al., 2018). Inadequate mechanization and limited adoption of modern technologies reduced input efficiency and productivity (*Park* et al., 2018).

The objective of this study is to determine the level of commercialization and productivity of maize production in Gulmi. Overcoming obstacles requires promoting better maize varieties, efficient use of fertilizer, environmentally friendly insect management, and contemporary agronomic techniques. With improved extension services, provision of high-quality inputs on a guaranteed basis, and encouragement of mechanization, maize output will rise (Khatri and Shrestha, 2023). The findings will help guide policymakers and stakeholders to facilitate sustainable agriculture and help transition from subsistence to commercial maize farming in Nepal's mid-hills.

2. METHODOLOGY

2.1 Study area

The survey was carried out in Gulmi district, Lumbini Province, Nepal, specifically in Ishma, Malika, and Madane Rural Municipalities, selected for their potential in maize seed and grain production under the Prime Minister Agriculture Modernization Project. Taking local socioeconomic and geographical variables into account, preliminary field research assisted in designing the questionnaire and sampling strategy.

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2.2 Sample size and data collection techniques

A total of 70 respondents (35 grain producers and 35 seed producers) were selected through simple random sampling. Data were collected via household survey, key informant interviews (KII), focus group discussions (FGD), field observations, and rapid market appraisal (RMA). Both primary and secondary data were analyzed, using surveys, interviews, and institutional reports. The study employed qualitative and quantitative methods for analyzing maize production trends and challenges.

2.3 Statistical analysis

Primary and secondary data from the field survey were entered and coded in Microsoft Excel, and then analyzed using STATA software. Farmers were grouped into grain and seed producers. Descriptive statistics were used to analyze variables such as gender, family size, education, and income sources.

2.4 Cost and return associated with maize production

The cost of production is the sum of fixed costs (land, depreciation, tools, and equipment) and variable costs (labor, inputs). Returns were calculated by multiplying the total quantity produced by the price per unit.

2.5 Gross margin and gross return

Gross margin also known as gross profit or "returns over variable costs" is the difference between the product's overall value and its variable expenses.

Gross margin (NRs. /ha) = Gross return – Total variable cost

Gross return (NRs. /ha) = Price of seed or grain (Rs. Per kg) × Total quantity produced (Kg)

Total variable cost (Rs.) = Summation of cost incurred in all the variable items like seed, bullock, labor, fertilizer, machine, and machine (NRs.)

The above formulae have also been used in many studies (Neupane et al., 2024; Tiwari and Dhungana, 2023; Subedi et al., 2020; Dhakal et al., 2019).

2.6 Benefit-cost ratio

The benefit-cost ratio was estimated as a ratio of gross return and total variable cost by the formula:

Benefit-cost ratio= $\frac{Gross\ return}{Tota\ variable\ cost}$

The above formula has been used in several studies (Neupane et al., 2024; Thapa et al., 2024; Tiwari and Dhungana, 2023; Subedi et al., 2020; Dulal and Marahatta, 2020).

2.7 Regression analysis

The dummy regression technique in Cobb-Douglas form was used to compute the efficiency of maize seed and maize grain farming in the study area. The following formula was used for the purpose:

$$\ln Y = \ln a + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 \quad (1)$$

Where,

Y= Return per ha;

X1 = Pre-sowing and sowing cost per ha;

X2 = Intercultural operation cost per ha;

X3 = Harvesting and post-harvest cost per ha;

bi = Regression coefficient of respective inputs.

This technique was also used to estimate the efficiency of maize seed and maize grain farming in Rolpa (Pokhrel et al., 2018).

2.8 Problem ranking

A forced ranking scale was used to prioritize key challenges, with weighted indexing determining the severity of issues faced by maize grain and seed producers. The formula used for indexing is:

Index value = $\sum S_i f_i / N$ (Subedi et al., 2024; Shrestha and Shrestha, 2017)

Where,

Si = Ith scale value (I = 1, 0.75, 0.50, 0.25, 0.00)

Fi = Frequency of ith importance given by the respondents

N = Total number of respondents

3. Results and Discussions

3.1 Household characteristics

According to the study, the average age of seed producers is somewhat lower than that of maize grain producers, though the difference is statistically insignificant. Seed producers had somewhat statistically bigger families than grain producers with significance at a 5% level, and the research area's average family size was higher than the national average. Compared to grain producers, seed producers have a substantially lower dependency ratio because they have a greater proportion of economically engaged members. The total land owned and maize cultivated area was higher for seed producers, with the difference at a 1% level of significance. Between the two categories, grain producers have a higher livestock holding. The average landholding of seed producers, on the other hand, is greater.

Table 1: Socio-demographic information (Continuous variables) of Maize seed and grain producers in Gulmi

Variables	Farmers category		Mean difference	t-value	p-value
	Grain producers	Seed producers			
Household head age (years)	51.91	49.05	2.85	1.423	0.159
Family size	4.57	5.22	-0.65	-2.063**	0.042
No. of dependents	1.79	1.24	0.55	1.813*	0.075
No. of independents	3.15	4.00	-0.85	-2.47**	0.016
Dependency ratio	0.75	0.44	0.31	1.68*	0.099
Total land owned	0.30	0.45	-0.15	-3.043***	<0.001
Maize cultivated area (ha)	0.25	0.33	-0.08	-2.920***	<0.001
Livestock holding unit (LSU)[1]	10.62	9.22	1.4	1.399	0.166

Note: *, **, *** indicates significant at 10%, 5%, and 1% level respectively and [1]LSU: 1.5 (no. of buffalo) + 1 (no. of cow/bull) + 0.6 (no. of swine/pig) + 0.4 (no. of sheep/ goat) + 0.2 (no. of poultry) (Bist at al., 2024)

3.2 Other social characteristics of household

The association between socioeconomic characteristics and farmer groups was examined using the Chi-Square test. The findings demonstrate no significant difference in the gender of the household head ($p > 0.05$), but there are significant connections for ethnicity, education, cooperative participation, training, and credit access ($p < 0.05$). These results imply that socioeconomic traits and institutional support are important factors in distinguishing between grain and seed producers.

Table 2: Socio-demographic information (Categorical variables) of Maize seed and grain producers in Gulmi

Variables	Farmers category		Chi-square value	p-value
	Grain producers	Seed producers		

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Table 2(cont): Socio-demographic information (Categorical variables) of Maize seed and grain producers in Gulmi				
Ethnicity (Brahmin)	17 (48.57)	28 (80.00)	8.210**	0.016
Gender of household head (Female)	27 (77.14)	24 (68.57)	0.650	0.420
Education of household head (Primary)	13 (37.14)	20 (57.14)	11.192**	0.011
Membership in co-operatives	9 (25.72)	35 (100.00)	41.364***	<0.001
Access to credit	9 (25.72)	35 (100.00)	41.364***	<0.001
Access to training	0 (0.00)	35 (100.00)	15.984***	<0.001

Note: Figures in the parenthesis indicates percent and ***, ** indicates 1% and 5% level of significance respectively

3.3 Characteristics of maize production in Gulmi

While grain producers in the Gulmi district employ a mix of local and composite varieties, seed producers mostly utilize improved seeds like Manakamana-3 and Arun-2, which are supplied through local cooperatives. While grain producers mostly sell to local people and adjacent markets, seed producers sell directly to retailers and agro-vets.

Despite the district's distant location, the process of production and marketing maize is not very complicated in Gulmi. Farmers in Gulmi primarily choose improved maize varieties, followed by hybrid and local seeds, as per a study (Khanal et al., 2025). According to a study, local and Manakamana-3 maize were the most common maize varieties cultivated in Gulmi (Adhikari et al., 2024).

Table 3: Seed type, source of seed, and market channels used by Maize seed and grain producers in Gulmi

Variables	**Farmers category**	
	Grain producers	**Seed producers**
Seed type		
Improved	3 (8.57)	35 (100)
Hybrid	3 (8.57)	0 (0.00)
Local	29 (82.86)	0 (0.00)
Variety of seed		
Arun-2	6 (17.14)	6 (17.14)
CP-900	2 (5.72)	0 (0.00)
Manakamana-3	3 (8.57)	29 (82.86)
Deuti	2 (5.71)	0 (0.00)
Local	22 (62.86)	0 (0.00)
Market		
Retailers	5 (14.29)	24 (68.57)
Agro-vets	3 (8.57)	11 (31.43)
Haat baazar/ Local people	19 (54.29)	0 (0.00)
Home consumption	8 (22.86)	0 (0.00)

Note: Figures in the parenthesis indicates the percent

3.4 Production economics for maize production

3.4.1 Inputs used for maize production

Farmyard manure, chemical fertilizers (Urea, DAP, and MOP), and labor are essential inputs in the production of maize. The amount of seed used by grain and seed producers was 18.40 kg/ha and 23.59 kg/ha, respectively, and the differences were statistically significant at the 5% level. Grain producers used 174.18 kg/ha of manure, but seed producers used 742.79 kg/ha, which was significantly higher at the 1% significance level. There was no discernible variation in the amounts of urea and MOP utilized by grain and seed producers but there were differences in DAP. Seed producers use more amount of DAP and their difference was statistically significant at a 1% level. Nonetheless, in line with a study, the labor needs for seed producers were greater, requiring 125.71 man-days as opposed to 105.17 man-days for grain production (Dulal et al., 2020). This difference was statistically significant at the 5% level. Similarly, a group researchers also found that in the mid-hills of Nepal, seed producers utilized more inputs such as seed, manures, DAP, and urea than grain producers (Dulal et al., 2020).

Table 4: Inputs used for Maize seed and grain production in Gulmi

Inputs	**Farmers category**		**Mean difference**	**t-value**	**p-value**
	Grain producers	**Seed producers**			
Seed (kg/ha)	18.40	23.59	-5.18	-3.507***	<0.001
Manures (kg/ha)	174.18	742.79	-568.48	-7.410***	<0.001
Urea (kg/ha)	75.72	87.68	-11.95	-1.356	0.179
DAP (kg/ha)	29.82	65.82	-35.99	-4.063***	<0.001
MOP (kg/ha)	3.80	3.78	0.02	0.008	0.993
Labor (MD/ha)	105.17	125.71	-20.54	-10.829***	<0.001

Note: MD represents man days and *** indicates 1% level of significance.

3.4.2 Variable cost of maize production

Mostly because they used more inputs, seed producers had a higher total variable cost (NRs. 95073.42) than grain producers (NRs. 58,398.53). The difference in variable cost was statistically significant at a 1% level. Pre-sowing and sowing, intercultural activities, and harvest/post-harvest operations were the three categories into which the production costs were divided. At the 1% level, the average cost of pre-sowing and sowing activities for seed producers was NRs. 69,002.22, which was much higher than the average cost of NRs. 42,565.59 for grain producers, which accounted for 72.78% and 71.52% of the total expenditures, respectively. For grain and seed producers, the intercultural operating cost was NRs. 10,289.07 and NRs. 14,610.35, respectively, with statistically significant variations at the 1% level. Similarly, seed producers incurred a larger percentage (11.82%) than grain producers (11.18%), with harvest and post-harvest expenses totaling NRs. 11,201.06 vs. NRs. 6,656.55 for grain producers. The difference in harvest/post-harvest costs was statistically significant at the 1% level. In the mid-hills of Nepal, research by found that the overall variable cost was greater for seed producers than for grain producers (Pokhrel et al., 2018).

Table 5: Variable cost (NRs./ha) incurred during maize seed and grain production in Gulmi						
Duration of activities	**Farmers category**				**t-value**	**p-value**
	Grain producers	**% share**	**Seed producers**	**% share**		
Pre-sowing operation and sowing	42565.59±29088.16	71.52	69002.22±33722.94	72.78	-3.511***	<0.001
Intercultural operations	10289.07±5431.87	17.3	14610.35±6634.01	15.40	-2.981***	<0.001
Harvest and post-harvest operation	6656.55±4548.71	11.18	11201.06±5264.08	11.82	-3.864***	<0.001
Total variable cost	58398.53±37226.73	100	95073.42±41069.89	100	-3.914***	<0.001

Note: *** indicates 1% level of significance and figures after ± represents standard deviation.

3.4.3 Yield from maize grain and seed production

Maize cultivation primarily produces quality seeds (used for planting in the next cycle) and grains (harvested for consumption or processing). Straw, husks, and barren cobs are the main byproducts, and they also help maize farmers generate revenue. The fresh weight of these byproducts is determined based on the harvest index, with straw priced at 75 Paisa. per kg and nubbin at 60 Paisa. per kg (Dulal et al., 2020). Grain producers yielded 1,578.57 kg/ha of maize on average, while seed producers yielded 1,884.90 kg/ha; the difference was not statistically significant. With a statistically significant difference at the 10% level, the fresh stover yield for grain and seed producers was 438.57 kg/ha and 524.57 kg/ha, respectively.

Table 6: Yield and byproducts from maize seed and grain production in Gulmi					
Outputs	**Farmers category**		**Mean difference**	**t-value**	**p-value**
	Grain producers	**Seed producers**			
Grain (kg/ha)	1578.57±974.47	1884.90±837.86	-306.33	-1.410	0.163
Fresh Stover (kg/ha)	438.57±251.30	524.57±208.38	-86	-1.558	0.123

Note: Figures after ± represents standard deviation.

3.4.4 Total return from maize grain and seed production

The total amount received by grain producers is NRs. 68,036.42, which includes NRs. 67,882.92 from maize grain, NRs. 153.50 from stover, and no revenue from maize seed. The overall return for seed producers is NRs. 140,669.2, which includes NRs. 140,485.6 from maize seed, NRs. 183.60 from stover, and no return from maize grain. More returns were also seen by from seed-for-seed producers than grain-for-grain producers in Rolpa (Pokhrel et al., 2018).

Table 7: Returns (NRs. /ha) from Maize seed and grain production in Gulmi			
Farmers category	**Return of maize grain (NRs.)**	**Return of maize seed (NRs.)**	**Return of Stover (NRs.)**
Grain producers	67882.92±29011.28	0.00	153.50±87.95
Seed producers	0.00	140485.6±79979.4	183.60±72.93

Note: Figures after ± represents standard deviation.

3.4.5 Benefit Cost analysis of maize seed and grain production

Income from maize grain, quality seed (for seed producers), and by-products including maize straw, nubbin, and husk were all included in the returns for producers of maize grain and seed. By deducting the whole cost from the total returns, profitability was calculated. The average return for seed producers was NRs. 140669.2, but the average return for grain producers was NRs. 68,036.42. Total returns between the two categories were statistically significant at a 1% level. The greater price of seeds is thought to be the reason for the better return for seed producers. Grain producers' Benefit-to-Cost (B: C) ratio was 1.31, but seed producers' was 1.47. This suggests that seed producers are more profitable, which may encourage grain producers to switch to seed production. B: C ratio was higher for maize seed producers than grain producers in previous studies (Dulal and Marahatta, 2020; Pokhrel et al., 2018).

Table 8: Cost-benefit analysis of maize seed and grain production in Gulmi				
Attributes	**Farmers category**		**t-value**	**p-value**
	Grain producers	**Seed producers**		
Total variable cost (NRs.)	58398.53±37226.73	95073.42±41069.89	-3.914***	<0.001
Total return (NRs.)	68036.42±29034.26	140669.2±80006.7	-5.048***	<0.001
B:C ratio	1.31±0.397	1.47±0.520	-1.487	0.141

Note: *** indicates 1% level of significance and figures after ± represents standard deviation.

3.5 Estimation of resource use efficiency of maize grain and seed producers

The efficiency of maize grain producers was estimated using the Cobb-Douglas production function, which examined the impact of different inputs on overall income. The F value of 77.25, significant at the 1% level, and an R-square value of 0.888 indicate that 88.8% of the variation in income was explained by the considered variables. The study was well-fitted by the model. According to the analysis, income was positively and statistically significantly impacted by the cost of all pre-sowing activities, intercultural operations, and harvesting and post-harvest activities. At a 1% significance level, an increase of one unit percent in pre-sowing costs resulted in a 0.57% increase in income. Likewise, an increase of one unit percent in the cost of harvesting/post-harvesting activities and intercultural activities results in increases of 0.21% and 0.36% of total revenue, respectively.

The Cobb-Douglas production function was used to analyze the relationship between various production factors and the income of maize seed producers. The F value of 27.47 was statistically significant at the 1% level, and the R-square value of 0.726 indicates that 72.6% of the variation in income was explained by the variables under consideration. According to the research, income was positively and statistically significantly impacted by pre-sowing, intercultural operation, and harvesting/post-harvesting costs. At a 1% significance level, an increase of one unit percent in pre-sowing costs resulted in a 0.37% rise in income. Likewise, an increase of one unit percent in the cost of harvesting/post-harvesting activities, and intercultural activities results in increases of 0.42% and 0.39% of total revenue, respectively. A group researcher also observed the return to scale higher for maize seed producers than for grain producers in Rolpa (Pokhrel et al., 2018). Similarly, a study by a group researchers on maize seed found that intercultural operation cost (management cost) and pre-sowing and sowing cost (seed, labor, and farmyard manure) have a positive impact on total return (Neupane et al., 2024).

Table 9: Resource use efficiency of Maize seed and grain production in Gulmi

Grain producers					Seed producers				
Variables	**Coefficient**	**Standard error**	**t-value**	**p-value**	**Variables**	**Coefficient**	**Standard error**	**t-value**	**p-value**
Log pre-sowing cost	0.577***	0.099	5.82	<0.001	Log pre-sowing cost	0.378**	0.146	2.58	0.015
Log intercultural cost	0.210**	0.078	2.68	0.012	Log intercultural cost	0.427***	0.122	3.50	0.001
Log Harvesting and post harvesting cost	0.360***	0.061	5.86	<0.001	Log Harvesting and post harvesting cost	0.399**	0.172	2.32	0.027
Constant	0.069	0.807	0.09	0.932	Constant	-0.218	1.321	-0.17	0.870
Number of observations			33		Number of observations			35	
F statistic (3,29)			77.25****		F statistic (3,31)			27.47***	
Prob>F			0.0000		Prob>F			0.0000	
R square			0.888		R square			0.726	
Adjusted R square			0.877		Adjusted R square			0.700	
Root MSE			0.121		Root MSE			0.297	
Return to scale			1.147		Return to scale			1.204	

Note: ***, ** indicates 1% and 5% level of significance respectively.

3.6 Major production and marketing problems of maize in Gulmi

The most serious problem of maize production in the peak seasons was the shortage of skilled labor (index value 0.82) and diseases and pests (0.67). Lack of infrastructure/irrigation came in third (0.42), while input scarcity (0.32) and technical expertise deficiencies (0.25) came in fourth and last respectively. Very seriously these challenges affect efficiency and cost of production. A group researchers state the main issues in maize production in Nepal's highlands are a lack of farm labor, inadequate infrastructure, and input shortages (Dulal et al., 2020). Similarly, a group researchers noted that the main issues with maize production were disease and pests, poor input quality, and transportation (Pokhrel et al., 2018). In Gulmi, fall armyworms and black smut are serious pests and diseases (Khanal et al., 2025).

Marketing issues have a strong effect on the commercialization of agriculture. The market's distance (index value 0.60) was the serious marketing problems. The second issue was low seasonal prices (index value 0.53), followed by a lack of marketing knowledge (index value= 0.50). The fourth problem was the low volume of production (index value=0.46), and the fifth was low bargaining power (index value=0.39), limiting farmers' ability to secure favorable terms with buyers. It affects farmers' profitability as well as the market access. Major problems related to maize marketing in Nepal's highlands include low seasonal prices, low production volumes and absence of marketing expertise (Dulal et al., 2020).

Table 10: Major production and marketing problems of Maize in Gulmi

Production problems	Index value	Rank	Marketing problems	Index value	Rank
Disease and pests incidence	0.67	II	Distant market	0.60	I
Inadequate infrastructures	0.42	III	Inadequate marketing knowledge	0.50	III
Inadequate technical knowledge	0.25	V	Low bargaining power	0.39	V
Shortage of farm labor	0.82	I	Low seasonal price	0.53	II
Unavailability of inputs	0.32	IV	Low volume of production	0.46	IV

4. Conclusion

This study highlights the opposing dynamics between maize seed and grain production in Gulmi region, which depict that although outputs of both seed and grain production are approximately the same, seed producers often get better economic results. Strategic application of improved seeds and inputs and targeted operating procedures are critical for increasing profitability and expanding output in seed-based systems. Nevertheless, the research identifies a few structural barriers that prevent achieving overall profit from maize farming in Gulmi. Key marketing barriers are distance from markets and adverse seasonal pricing, labor shortages; pest and disease threats, poor infrastructure; and lack of technical expertise. For a more sustainable, economically viable maize industry in Nepal's mid-hills, improving access to high-quality inputs, developing knowledge and expertise, and upgrading infrastructure are critical steps to improve production efficiency. The findings are a useful framework for policymaking and stakeholder involvement in promoting agro-development in such agro-ecological settings of the country.

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Authors' Contributions

The research plan and methodology were conceptualized by P. Neupane and N. P. Devkota. P. Neupane collected the data from the respondents and performed the formal analysis and investigation. Resources for the preparation of this manuscript were collected by N. P. Devkota. The original draft of this manuscript was prepared by P. Neupane. The revision and editing were carried out by N. P. Devkota. Additionally, N. P. Devkota and P. Neupane provided comments and suggestions to finalize this manuscript. The final form of the manuscript was read and approved by both authors for publication.

Conflict of Interest

The author(s) declare no conflict of interest.

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