



Status of Farm Mechanization in Maize Farming at Deukhuri Valley of Nepal

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ABSTRACT

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Farm mechanization plays a pivotal role in increasing productivity. It helps to enhance efficiency, reduce labour costs and optimize resource use in agricultural operations. A field survey was conducted in the Dang district of the Lumbini province in Nepal to assess the current state of mechanization in maize cultivation and its profitability. Using a simple random sampling technique, 95 maize cultivators were personally interviewed to collect primary data. Focus group discussions (FGD) and key informant interviews (KII) were also conducted for primary data collection. Secondary data were obtained through a review of the relevant literature. Data were collected and meticulously entered and analysed using MS Excel and the Statistical Package for the Social Sciences (SPSS 23.0) employing descriptive statistics. The study revealed that farm mechanization was prominent in land preparation (97% of farmers using machinery) and threshing (77% of farmers using machinery), although only 48% of farmers used machinery for seed sowing and 11% for intercultural operations. Importantly, maize harvesting is entirely manual, as no efficient harvesting machinery is available. The cost of operations was significantly reduced by mechanization, with farmers using machinery spending less on land preparation, sowing, intercultural operations, and threshing than those relying on manual labour. This study also highlighted the strengths of mechanization, such as time savings, reduced labour costs, and ease of operation. However, challenges such as the high cost of machinery, limited access to credit, and insufficient availability of custom hiring centres are major barriers. Overall, this study underscores the need for better financial support and the development of suitable technologies to increase mechanization efficiency, particularly in harvesting, and improve the livelihoods of maize farmers in the region.

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Introduction

Maize (*Zea mays L.*) is known as the queen of cereals and is one of the most versatile emerging crops with a wide range of adaptability (Sravani, et al., 2021; Khanal et al., 2019). Following rice and wheat, maize is the third most important crop in the world and the second most important crop after rice in the Dang district (Barali et al., 2019; Khanal et al., 2019). In the world, it is cultivated on nearly 203 M ha and the USA has the highest productivity i.e. 10.88 mt/ha. Maize is a traditional crop grown for food, feed, and fodder. In Nepal, maize is cultivated over an area of 940,256 ha and has a production of 2,976,490 mt with a productivity rate of 3.17 mt/ha. It contributes approximately 7.6% of the total agricultural GDP (AGDP) in the fiscal year 2022/23. In the 1960s, agricultural mechanization began in Nepal with the introduction of four-wheel tractors, and it is the urgent need of Nepal to reduce the cost of production and increase the benefits/revenue. In 2014, the Directorate of Agricultural

Engineering of the Ministry of Agriculture and Livestock Development approved the Agricultural Mechanization Subsidy Mobilization Directives for distributing subsidies. The Agriculture Development Strategy (2015-2035) promotes the four pillars of governance, productivity, competitiveness, and profitable commercialization (Poudel et al., 2023). The Ministry of Agriculture Development (MoAD) has launched the 10 years Prime Minister Agriculture Modernization Project (PMAMP) under national investment to meet the objectives of the Agriculture Development Strategy (2015-2035). Dang is one of the potential districts for maize production; PMAMP has selected Lamahi municipality as the maize super zone in Dang district. The area under maize cultivation is 24,990 ha with a productivity of 3.26 mt/ha in the Dang district (MoALD, 2024).

The main objective of Nepal Agriculture Policy 2004 and thirteenth plan (2013/14- 2015/16) was the commercialization of agriculture. However, before the 2014 agricultural mechanization promotion policy was enacted, agricultural mechanization was not mentioned in any of the policy or plan documents. This includes, the Agriculture Policy 2004, the Agriculture Perspective Plan (APP) 1995-2015, the periodic plans (5/3 yearly plans), and the annual budget programs (Poudel et al., 2023; Shrestha S., 2022). The following are the four main goals of this policy.

- The aim is to enhance productivity through appropriate agricultural mechanization that aligns with regional and socioeconomic conditions, thereby making the agricultural sector sustainable, competitive, and marketable.
- To increase farmers' and entrepreneurs' access to agricultural machinery and equipment by developing agricultural mechanization services as a business.
- Establishing agricultural mechanization-related organizations for the purpose of standardizing, regulating, researching, monitoring, and promoting high-quality agricultural machinery and equipment.
- Promoting women-friendly agricultural machinery and equipment.

Although the Terai region of Nepal is called the food basket of Nepal, insufficient production and low productivity of maize have resulted in a serious problem in food security due to the increasing population, as the demand and supply are not proportional to each other (Srivani et al., 2021). A huge gap exists between the global average yield (5.72 mt/ha) and the attainable yield of Nepal (3.15 t/ha) (FAOSTAT, 2023; MoALD, 2023). For the success of farm mechanization, quality machinery and after-sales services of farm machines are very important (Fuad & Flora, 2019). There are various problems in maize production in the Dang district. Poor cropping practices, incorrect cropping patterns, land fragmentation, inefficient use of manure and fertilizers, delays in weeding, poor seed sowing or broadcasting, incidence of disease and pests, ineffective marketing, and price fluctuations (Poudel et al., 2023). Labor shortages during the peak period of land preparation, seed sowing, intercultural operations, and harvesting are also the main cause of the delay in farm operations. An increase in labour wages leads to an increase in the cost of cultivation, thereby decreasing the profitability of maize farming. Farm mechanization is one of the best options for addressing these issues (Bamboriya

et al., 2020). Increased mechanization is positively linked to higher productivity levels .

According to Taiwo and Kumi (2015), farm mechanization is the process of creating and implementing mechanical support for agricultural output at any level of sophistication to increase labour and time efficiency. The degree of mechanization varies depending on farmland size, cropping system, and location. However, compared to rice and wheat, maize mechanization is less common (Bamboriya et al., 2020). The intervention of mechanization in all agricultural processes of crops is the utmost to increase yield and production. The different options for maize mechanization are listed in (Table 1) as below.

Farm mechanization plays an influential role in commercialization of agriculture sector (Barman & Deka, 2019). Determination and documentation of the agronomic and economic feasibility of farm mechanization would motivate the farmers to participate in Custom Hiring Centre's activities (Jha & Marahatta, 2023). To improve the sustainability of agri-food systems, it is crucial to adopt agricultural mechanization, which tackles a range of economic and social issues, such as enhancing labour efficiency, reducing poverty, ensuring food security, and promoting overall health and well-being (Daum, 2023). Mechanization aids in raising farm productivity and output by lowering labour costs, workloads, and operating times. It includes farming and processing at every level, and technology ranges from basic hand tools to sophisticated motorized machinery (Kandel et al., 2021). The likelihood of male family members engaging in farm work increases with the use of water-lifting equipment, draft power, and tractors. Conversely, all farm machinery, except for tractors, positively influences the participation of female labor on farms. Additionally, as farm size grows, the impact of mechanization on the need for hired labor diminishes (Rajkhowa & Kubik, 2021). The assessment of farm mechanization and profitability might be a good approach to assess various factors and existing bottlenecks and solve them effectively. The concerned stakeholders can plan and act in a package in a holistic manner for the overall benefit. This study is believed to be the basis for planning and extension for authorities such as PMAMP, MOALD, and other GOs, NGOs, institutions, and other concerned stakeholders to develop and implement programs that would help improve the income and livelihood of maize farmers in the study area. Socioeconomic, demographic, and educational factors, as well as government interventions, affect the adoption of mechanization in maize cultivation.

Table 1. Options of mechanization in maize

Operations	Equipment
Tillage and seed bed preparation	Disc plough, Cultivator, Harrow, Rotavator
Sowing/ Planting	Seed drill, Push row, Jab planter
Fertilizer application	Seed cum fertilizer drill, tractor operated fertilizer band placement
Intercultural operations (earthing up, thinning, weeding)	Power tiller, Mini tiller, Cultivator
Irrigation	Shallow or deep tube well, Solar irrigation pumps
Plant Protection	Knapsack sprayer, Hand compression sprayer
Harvesting and threshing	Maize dehusker cum sheller, electric corn sheller, pedal operated corn sheller, multi-crop thresher

(Khatri & Shrestha, 2023; Bamboriya et al., 2020)

This study also assessed the profitability, strengths, weaknesses, opportunities, and threats of agricultural mechanization in maize cultivation. Mechanization in maize cultivation not only saves time but also reduces labour costs or the overall cost of production, and hence increases the profitability of maize cultivation.

There are different factors i.e. socio-economic, demographic and educational factors, and government interventions affecting adoption of mechanization in maize cultivation.

Materials and Methods

Study Site

The research was conducted in the Maize Super Zone, Dang district of Lumbini Province, located in the Inner Terai of midwestern Nepal. The Deukhuri Valley of the district is the capital of the province and is the second largest valley in Asia. The Deukhuri Valley consists of three rural municipalities (Rajpur, Gadhawa, and Rapti) and one urban municipality (Lamahi). It has latitude of 27.8771°N and longitude of 82.5727°E. Dang valley is considered to have been inhabited by the indigenous Tharu people.

Sample and Sampling Technique

A total of 95 samples were drawn using the simple random sampling technique (SRS). The sampling frame of maize-growing farmers was obtained from the record of the PMAMP maize super zone, Dang. Farmers associated with cooperatives and farmers organizations were the target population for this study. Of the 95 samples, 20 samples were chosen from each rural municipality and 35 samples from the urban municipality. The sample size was calculated with a 10% margin of error, 95% confidence level, and a response distribution of 50%, by using Raosoft software.

Where,
Population Size (N) = 2000

Data Collection

Primary data were collected through household surveys, focus group discussions and key informant interviews. Face-to-face interviews were conducted at the convenience of the respondents by visiting their homes. A total of 95 households were surveyed using a personal interview schedule (PIS). Focus group discussions were conducted to target groups to ensure that the information collected was accurate. Farmers from all cultural, gender, and ethnic backgrounds were included in the discussion as far as possible. The major key informants were progressive farmers, custom hiring centers, and maize super zone officers. They were asked a series of questions about the status of maize production, farm mechanization in maize production, and its profitability. To supplement the data from primary sources, various published and unpublished sources of data, reports of the Agriculture Knowledge Centre, reports of the maize super zone, PMAMP profile, National Statistics Office (NSO), MOALD, NARC, and various related reports, journals, and books were consulted.

Data Analysis

Both qualitative and quantitative data were analyzed. The information collected from both primary and secondary sources was coded first and entered into the computer. Data entry was performed using the Statistical Package for the Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics, such as frequency counts, percentages, charts, and diagrams, and t-test were used.

Scaling and Indexing

The SWOT analysis suggests a framework for assisting researchers or planners in identifying and prioritizing corporate goals and further identifying the tactics for accomplishing them. SWOT analysis is a method for evaluating a business's strengths, weaknesses, opportunities, and threats. Scaling and indexing were performed to analyze the strengths, weaknesses, opportunities, and threats of agricultural mechanization in maize production. Scaling techniques provide the direction and attitudes of the respondents toward propositions. Based on direct field observations and discussions with the site supervisor and farmers, the major strengths, weaknesses, challenges, opportunities, and threats of agricultural mechanization in maize farming were identified and included in the interview schedule.

Indexing was computed using the following formula:

$$I_{imp} = \sum (S_i * F_i / N)$$

Where, I_{imp} = Index of Importance, S_i = Scale value at i^{th} priority, F_i = Frequency of i^{th} priority, N = Total number of respondents, \sum = Summation

Results and Discussion

Socio-economic and Demographic Characteristics of the Respondent Households

All information regarding socioeconomic and demographic characteristics, such as age, gender, ethnicity, total owned land, and maize cultivated land of respondents, was collected and is described here.

Age of the Respondents

The age of respondents was classified into three categories i.e. >15-39 years, 40-59 years and >59 years. 40-59 years was the major age group of respondents found in the study area, followed by the >15-39 years. In the study area, the middle-aged group was mainly involved in agricultural activities compared to the young and old age groups, as illustrated in Figure 1. Here, the household respondents are farmers.

Gender of the Respondents

The collected information showed that more than half of the respondents were male, with 68 of the total respondents being male and 27 being female. Table 2 reveals that males were mainly involved in agricultural activities compared to females in the study area.

Table 2. Description of the gender of respondents

Gender of the respondents	Frequency (Percentage)
Male	68 (72)
Female	27 (28)

Table 3. Land holding of respondents

Category	Total owned land (Hectare/HH)	Total maize cultivated land (Hectare/Farm)
Average	1.27	0.81
Maximum	13.33	13.33
Minimum	0.10	0.06

Table 4. Status of farm mechanization

Category	Response of HHs (n=95)	
	Yes (%)	No (%)
Machine for land preparation	97	3
Machine for seed sowing	47	53
Machine for intercultural operations	11	89
Machine for harvesting	0	100
Machine for threshing	77	23

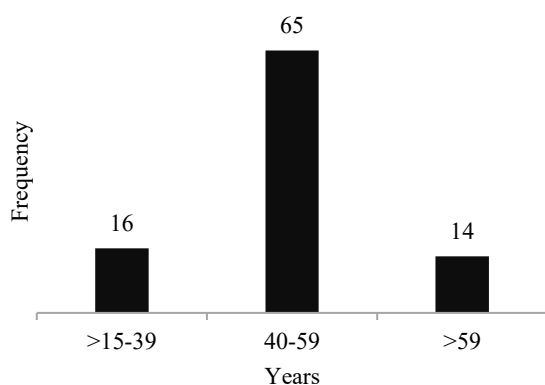


Figure 1. Distribution of age of respondent farmers (n=95)

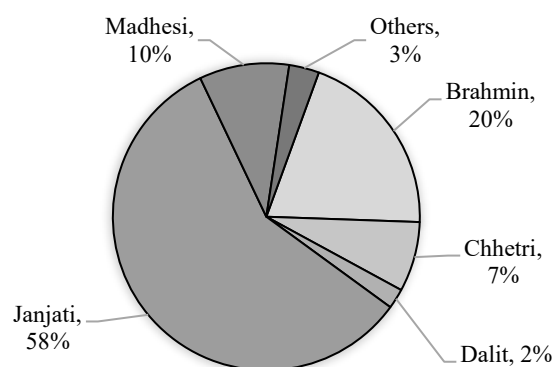


Figure 2. Ethnicity of the respondent households (n=95)

Ethnicity of the Respondents

Ethnicity patterns were categorized into six categories: Brahmin, Chhetri, Janjati, Madhesi, Dalit and others. The data revealed that 58% of the total respondents were Janjati, followed by Brahmin (20%), Madhesi (10%), Chhetri (7%), and Dalit (2%), as shown in Figure 2. In the Dang district, the majority of the people belong to the Tharu community, and they actively participate in agricultural activities.

Education of the Respondents

Education is a pillar of development. The educational status was categorized into four categories: illiterate (0 years of schooling), primary level (up to 8 years of schooling), secondary level (up to 12 years of schooling), and higher secondary and above (above 12 years of schooling). From the data collected, as shown in Figure 3, it was found that 17 out of the total respondents were illiterate, 34 had primary level of education, 39 had secondary level of education, and only 5 of them had higher secondary and above level of education. The data showed that most of the farmers were educated and were well aware of the cultivation practices, cost, and benefits of maize production.

Main Occupation of the Respondents

Nepal is an agricultural nation. The main occupations of the respondents were categorized into four groups: Agriculture, Business, Service and others. According to the data collected, agriculture (94%) was the main occupation of the respondents, followed by business (3%) and service (3%), as shown in Figure 4. Farmers were involved in subsistence and commercial farming of maize and other cereals.

Land Holding of the Respondents

The study revealed that the average land owned by the studied population was approximately 1.27 hectare, with a maximum of 13.33 hectare, and a minimum of 0.10 hectare. The average maize cultivated land by farmers in the studied area was approximately 0.81 hectare, with a maximum of 13.33 hectare, and a minimum 0.06 hectare. The above data is clearly demonstrated by Table 3. Farmers of the study area also preferred land or crop pooling for maize cultivation which helped to produce maize on commercial scale with low cost of production. Maize cultivation occurs in all three seasons i.e. summer, winter and spring season. Rainfed cultivation was usually preferred for summer season by the farmers of study area.

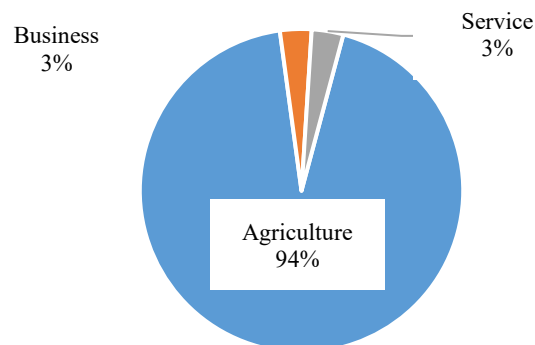
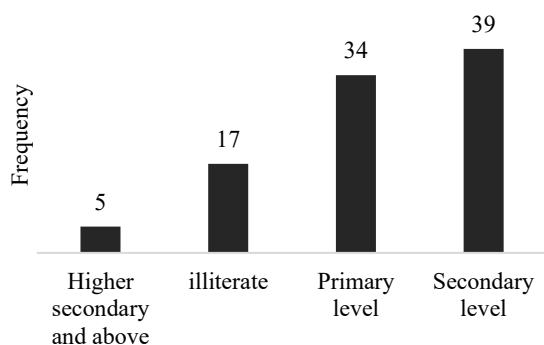


Figure 3. Education level of the respondent households (n = 95) Figure 4. Main occupation of the respondent households (n=95)

Table 5. Farm machinery used for land preparation

Land Preparation	Response of HHs (%)	
	Using machinery	Not using machinery
Disc harrow and Rotavator	26	
Cultivator and Rotavator	21	
Cultivator or Disc harrow and Rotavator	11	
Power tiller and Rotavator	7	
Cultivator	1	
Mini tiller	1	
Power tiller	9	
Rotavator	19	
Draft		3

Assessment of Farm Mechanization of the Study Area

From the studied population (Table 4), it was observed that 97% of farmers utilized machinery for land preparation, 48% for seed sowing, 11% for intercultural operations, and 77% for maize threshing. The data also revealed that all farmers conducted harvesting activities manually. This is attributed to the lack of research in developing a maize harvesting machine. Although trials for a harvesting machine were conducted, it was found to be the least efficient and, therefore, not adopted in farming practices.

Farm Machinery for Land Preparation

Tillage involves turning over the soil to prepare a seedbed, which aids in seed germination and seedling growth. Farmers were offered various machinery options for land preparation, based on their preferences from a pre-testing questionnaire. The study (Table 5) revealed that 26% of farmers used a disc harrow and rotavator as their primary and secondary tillage implements. Meanwhile, 21% opted for a cultivator and rotavator for the same purposes. Similarly, 11% of farmers combined either a cultivator or disc harrow with a rotavator, and 7% used a power tiller alongside a rotavator for land preparation. However, 1% of farmers relied solely on a cultivator, another 1% on a mini tiller, 9% on a power tiller, and 19% exclusively on a rotavator. Additionally, 3% of farmers continued to use draft power for land preparation, primarily due to topographic constraints. Those using only one machine for tillage operations performed both primary and secondary tillage by employing the same machine twice. Nonetheless, most farmers in the study area conducted primary tillage with either a cultivator or disc harrow and secondary tillage with a rotavator.

Farm Machinery for Seed Sowing

Farmers were presented with several options to express their preferences for seed sowing methods. Based on a field survey, it was observed that 8% of farmers used a jab planter, 35% employed a tractor-operated seed drill, and 5% utilized both the jab planter and the tractor-operated seed drill for sowing maize seeds. In contrast, non-mechanized methods included broadcasting, used by 14% of farmers; line sowing with a hoe, chosen by 25%; sowing behind the plough, preferred by 11%; and 2% of farmers used both line sowing with a hoe and sowing behind the plough for maize seed sowing, as represented by Table 6. The use of tractor-operated seed drills and jab planters contributed to a uniform plant stand in the field. The seed rate for both the tractor-operated seed drill and line sowing with a hoe was found to be similar. However, using farm machinery for seed sowing is less labour-intensive and saves farmers time, which can be allocated to other tasks or activities.

Farm Machinery for Intercultural Operations

Intercultural operations encompass the various cultural activities that occur between the sowing and harvesting of specific crops, such as earthing up, weeding, and thinning in maize cultivation. The study revealed that a majority of farmers (Figure 5), specifically 82% in the study area, conducted these intercultural operations manually. Among those utilizing machinery, 9% employed mini tillers, 1% used power tillers, and another 1% utilized cultivators. Additionally, 7% of farmers opted for a combination of manual and mechanical methods for these operations. Women in the study area predominantly participated in intercultural operations, as they were primarily engaged in household activities and had additional time for farming tasks. This approach also reduced the cost associated with hiring machinery.

Table 6. Farm machinery used for seed sowing

Seed Sowing	Response of HHs (%)	
	Using machinery	Not using machinery
Jab planter	8	
Tractor operated seed drill	35	
Jab planter and Tractor operated seed drill	5	
Broadcasting		14
Line sowing with hoe		25
Sowing behind the plough		11
Line sowing and Sowing behind the plough		2

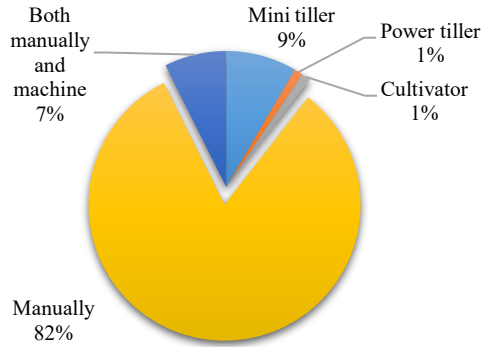


Figure 5. Farm machineries used for intercultural operations (n=95)

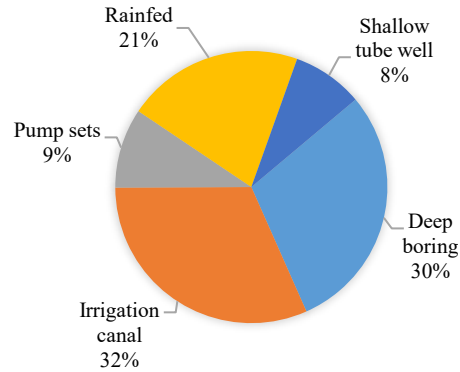


Figure 6. Methods used for irrigation (n=95)

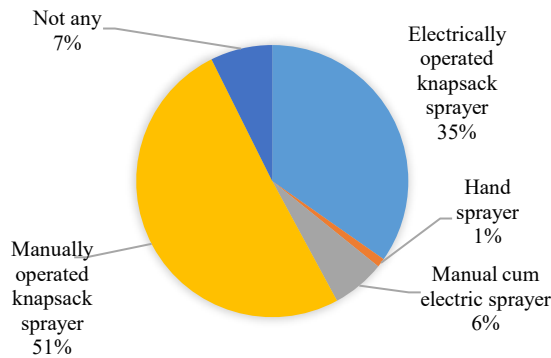


Figure 7. Machineries used for plant protection (n=95)

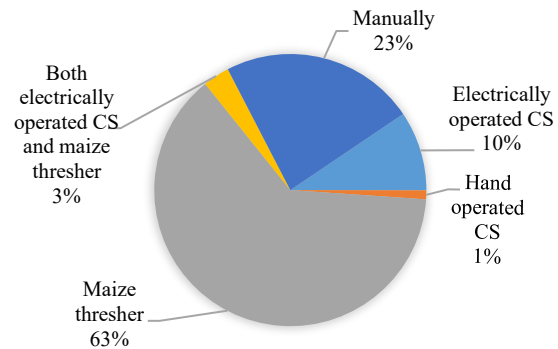


Figure 8. Machineries used for maize threshing (n=95)

Irrigation Methods

The irrigation methods were divided into five categories: irrigation canal, shallow tube well, deep boring, pump sets, and rainfed. According to the survey, 30% of farmers used deep boring, 32% relied on irrigation canals, 9% utilized pump sets, and 8% employed shallow tube wells for irrigating maize fields. Meanwhile, 21% of farmers still preferred rainfed cultivation, particularly for growing maize during the summer season, as shown in Figure 6. Water scarcity also posed a significant threat to maize cultivation in the study area.

Machineries used for Plant Protection

The sprayers used by farmers were classified into five types: manually operated knapsack sprayers, electrically operated knapsack sprayers, manual cum electric sprayers, hand sprayers, and others. The study (Figure 7) revealed that 51% of farmers used manually operated knapsack sprayers, 35% opted for electrically operated knapsack sprayers, 6% used manual cum electric sprayers, and 1% employed hand sprayers for pesticide application in maize cultivation. Additionally, 7% of farmers did not use any

equipment for plant protection, primarily due to the small-scale production of maize and the pest infestation and disease incidence being below the economic threshold level.

Harvesting of Maize

Harvesting methods were categorized into two types: manual and machine-assisted. The study indicated that 100% of farmers preferred manual harvesting, as no efficient machines were available for maize harvesting. Further research in this area is recommended.

Farm Machineries for Maize Threshing Operations

The study found that 63% of farmers favoured maize threshers for threshing, 10% preferred electrically operated corn shellers, 3% used both electrically operated corn shellers and maize threshers, and 1% opted for hand-operated corn shellers. Meanwhile, 23% of farmers still preferred manual threshing, partly due to the small-scale production of maize and the utilization of farmers' excess time. It is illustrated by Figure 8.

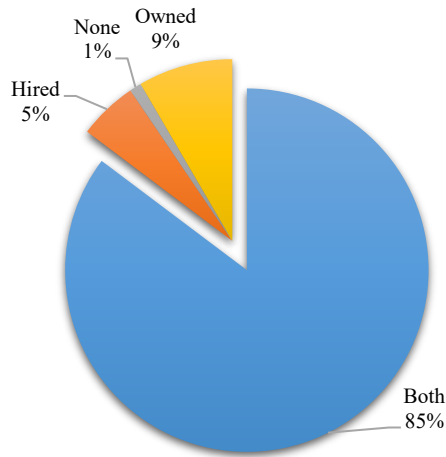


Figure 9. Description about the farm implements (n=95)

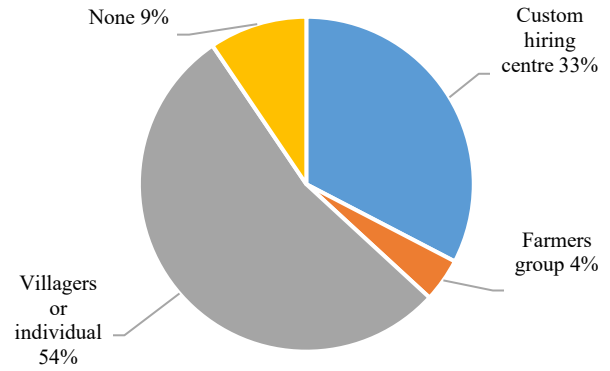


Figure 10. Description about the farm implements (n=95)

Table 7. Cost comparison of adoption of mechanization and non-mechanization in maize farming

Components	Using Machinery (USD/Hectare)	Not Using Machinery (Human Labour Cost) (USD/Hectare)
Land preparation cost	55.10	150.00
Sowing cost	25.99	103.80
Intercultural operation cost	75.54	125.76
Threshing cost	32.00	128.57
Mean	47.1575	127.0325
Variance	515.4875	357.0794
Pearson Correlation	0.477641	
df	3	
t Stat	-7.42647	
P(T<=t) one-tail	0.002526	
t Critical one-tail	2.353363	
P(T<=t) two-tail	0.005052	

Description about the farm implements

Farm implements were categorized into four groups: owned, hired, both, and none. The study (Figure 9) showed that 9% of farmers owned their farm implements, 5% hired them from individuals or organizations, and 85% had both owned and hired implements. Only 1% of farmers did not use any farm implements.

Organization Preferred for Machine Hiring

Among the studied population, 54% of farmers preferred hiring farm machinery from village individuals, 33% opted for custom hiring centres, and 4% choose farmers' groups. Meanwhile, 9% of individuals did not prefer hiring farm machinery, as shown in Figure 10.

Sources of Financing

The sources of financing were divided into five categories: personal savings, remittance incomes, loans, subsidies, and other informal sources. The study revealed that the primary sources of financing for most farmers using farm machinery were personal savings and subsidies from the maize super zone.

Training Related to Agricultural Mechanization

The study also showed that only 18% of farmers participated in training related to agricultural mechanization, mainly provided by the PMAMP, maize super zone, Dang.

Marketing Channel

Only 16% of total respondents sold maize straight to the market, while 84% sold it through middlemen. Farmers selling maize straight to the market were subsistence farmers who wanted to get a decent price. Whereas, maize supplied to middlemen reduces farmers' transportation costs and time, producers also receive a decent market price at home for their commercial production.

Profitability Assessment of Farmers Using Farm Machinery

The average rental cost of land preparation, seed sowing, intercultural operations and threshing using farm machinery was found to be USD 55.10, USD 24.99, USD 75.54, and USD 32.00 per hectare respectively. Similarly, the average labour cost was found to be USD 150, USD 103.80, USD 125.76, and USD 128.57, per hectare for land preparation, seed sowing, intercultural operations and threshing without using farm machinery by the farmers (Table 7). This demonstrates that the use of farm machinery reduces the operational cost (mean difference Table 7), which further reduces the cost of production.

The average seed rate used by the farmers using farm machinery is found to be 22.97 kg per hectare, which is much higher than that of not using farm machinery i.e. 18.58 (Table 8). This result is similar to (Jha & Marahatta, Appraisal of Farm Mechanization and Farmer's Field Practice of Maize Farming at Lamahi Municipality, Dang, Nepal, 2023). Similarly, the productivity of farmers using

machinery was found to be 7.44 mt/ha which was comparatively higher than that of farmers not using farm machinery i.e. 5.58 mt/ha respectively. Different studies showed that the number of plants were found higher in the field where the seeds were sown by tractor operated seed drill than that of broadcasting or other non-mechanized method of sowing.

Hiring cost of Farm Machinery

Through the FGD and KII data were collected and through the data analysis it was found that the average cost of farm machineries was 10% less for cooperative or farmers group member, than that of outsiders (Table 9).

Similarly, the average cost of a job planter was found to be USD 0.71 per day. The cost of farm machinery was found comparatively lower for the cooperative or farmers group member than that of outsiders.

Strengths of Agricultural Mechanization

Different options regarding strengths, weaknesses, opportunities and threats behind agricultural

mechanization were listed for respondents and their responses were taken. Farmers of study area ranked time saving in farm operations as their biggest strength for agricultural mechanization, and reduce human labour cost as their second major strength behind agricultural mechanization. Whereas, farmers ranked increasing production as their least strength, since the production from seed sowing by using a tractor-operated seed drill and line sowing with a hoe was found somehow similar (Table 10).

Weaknesses of Agricultural Mechanization

Farmers of study area ranked low tendency of farmers to invest in farm machineries as the major weakness behind the less agricultural mechanization, and limited access to finances and credit facilities as the second valid reason for less agricultural mechanization. However, farmers ranked the lack of awareness regarding farm machinery at last, as most of them were well known of the advantages of agricultural mechanization, and they also recommend others to adopt it (Table 11).

Table 8. Seed rate and production comparison of the mechanized and non-mechanized methods used by the farmers.

Component	Mechanized	Non-mechanized
Seed rate (Kg/Hectare)	22.97	18.58
Yield(mt/ha)	7.44	5.58

Table 9. Hiring cost of farm machinery

Machineries	Cost for cooperative or farmers group member (USD/hour)	Cost for outsiders (USD/hour)
Cultivator	14.95	15.71
Disc harrow	17.02	17.86
Rotavator	20.48	21.43
Tractor operated seed drill	15.83	17.86
Mini tiller	6.19	6.66
Power tiller	5.00	5.71
Maize thresher	20.71	21.43

Table 10. Ranking of strengths of agricultural mechanization

Strengths	Index	Ranking
Time saving in farm operations	0.85	I
Reduce human labour cost	0.71	II
Makes the work easier	0.61	III
Reduce cost of production	0.58	IV
Reduce drudgery	0.51	V
Saved time utilize for non-agricultural works	0.46	VI
Vast and flat agricultural lands	0.40	VII
Increase production	0.35	VIII

Table 11. Ranking of weaknesses of agricultural mechanization

Weaknesses	Index	Ranking
Low tendency of farmers to invest in farm machineries	0.86	I
Limited access to finance and credit facilities	0.76	II
Small land holding	0.74	III
Feminization in agriculture	0.64	IV
Insufficient number of farmer's group	0.57	V
Frequent maintenance and repairing	0.53	VI
Inability to buy maintenance and spare parts	0.41	VII
Lack of training on use of farm machineries	0.32	VIII
Lack of awareness regarding the use of farm machineries	0.21	IX

Table 12. Opportunities of agricultural mechanization

Opportunities	Index	Rank
Availability of subsidy to farm machinery	0.98	I
Agricultural facilities and loans to farmers	0.68	II
Existence of farmers group and cooperatives	0.56	III
High incentives for farmers to use agricultural machinery	0.28	IV

Table 13. Threats to agricultural mechanization

Threats	Index	Rank
High cost of farm machinery	0.81	I
Less attention by officials to agricultural mechanization	0.81	II
Increase in Agri-startups in providing technology- based input services	0.44	III
Water scarcity for irrigation	0.44	IV

Opportunities of Agricultural Mechanization

The government interventions via. Subsidies in agricultural mechanization had encouraged farmers to use agricultural machinery in maize cultivation. However, the incentives were not enough for 100% mechanization in maize farming. Farmers ranked the availability of subsidies as the major opportunity for agricultural mechanization, and high incentives for farmers to use agricultural machinery as the least opportunity for agricultural mechanization (Table 12).

Threats to Agricultural Mechanization

Farmers of the study area ranked the high cost of farm machinery, as their biggest threat to agricultural mechanization, and water scarcity for irrigation was ranked at the lowest (Table 13).

Conclusion

The study successfully provides a detailed understanding of the current status of farm mechanization among maize farmers in Dang district. By examining the prevalent practices, it reveals a concentration of mechanization in specific activities, notably tillage and threshing, while highlighting the limited adoption in other crucial phases of maize cultivation. Mechanization reduces the cost of cultivation thereby increasing the profitability of maize farming. The research effectively identifies the strengths, weaknesses, opportunities and threats of agricultural mechanization among maize growers. This insight is crucial for developing targeted interventions and policies aimed at promoting and sustaining mechanization in maize cultivation in the region. While mechanization has already begun transforming maize farming, significant gaps remain in its implementation across all farming stages. To boost productivity and improve the livelihoods of maize farmers, it is essential to promote the use of mechanized equipment across all farming operations. This can be achieved through better financial support mechanisms, greater access to technology, and a more robust network of custom hiring centres. Addressing these issues would not only increase agricultural efficiency but also contribute to the overall socio-economic development of the region's farming. Research should be carried out on the topics related to the comparison of production efficiency of maize using farmers field practices and advanced technology. The Role of custom hiring centres

(CHCs) to develop farming systems and improve of livelihood of farmers should also be studied.

Declaration

Ethical Statement

The study was conducted under the consent of farmers of study area.

Author Contribution Statement

Priyanka Kumari Chaudhary Kalwar: Site selection, sample size determination, data collection, analysis and interpretation of data, involved in paper writing

Anushka Bista: Data collection and involved in paper writing.

Samarth Bista: Involved in paper writing

Sachita Bista: Analysed and interpreted the data

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Conflict of Interest

The author declares no conflict of interest.

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References

- Bamboriya, S. D., Jat, S. L., Sreelatha, D., Mahala, D. M., & Rakshit, S. (2020). Mechanized maize production for enhanced productivity and profitability. *I*, 4-46. doi:https://iimr.icar.gov.in
- Barali, S., Jha, R. K., Karn, R., & Regmi, M. (2019). A case study on soil fertility status and maize productivity in Dang District, Nepal. *Malaysian Journal of Sustainable Agriculture*, 3(2), 56-59. doi:http://doi.org/10.26480/mjsa.02.2019.56.59
- Barman, S., & Deka, N. (2019). Effect of farm mechanization in human labour employment. *International Journal of Agricultural Science*, 4.
- Daum, T. (2023). Mechanization and sustainable agri-food system transformation in the Global South. A review. *Agronomy for Sustainable Development*, 43(16). doi:https://doi.org/10.1007/s13593-023-00868-x
- FAOSTAT. (2023). Retrieved from www.fao.org/faostat/en/#data/qc

- Fuad, M., & Flora, U. (2019). Farm mechanization in Bangladesh: a Review. *International Journal of Research in Business Studies and Management*, 6(9), 15-29.
- Jha, P., & Marahatta, S. (2023). Appraisal of Farm Mechanization and Farmer's Field Practice of Maize Farming at Lamahi Municipality, Dang, Nepal. *Journal of Agriculture and Environment*, 24, 29-37.
- Kandel, S., Poudel, R., Saru, M. T., & Parajuli, T. (2021). Status of farm mechanization and its impact on maize production in Jhapa District, Nepal. *Archives of Agriculture and Environmental Science*, 6(3), 290-294. doi:<https://doi.org/10.26832/24566632.2021.060304>
- Karn, R., Khanal, P., Chhetri, P. B., Karki, S., & Sah, S. K. (2019). Response of Maize Varieties To Sowing Dates In Inner Terai Region, Dang, Nepal. *Malaysian Journal of Halal Research Journal*, 2(2), 27-31.
- Khanal, A. P. (2020). Impacts of Agricultural Mechanization: A case study of Palpa district of Nepal. *Acta Mechanica Malaysia*, 3(1), 16-19. doi:<http://doi.org/10.26480/amm.01.2020.16.19>
- Khatri, S., & Shrestha, S. (2023). Emerging Technological, Insights, Hotspots Challenges and Future Driving Pathways for Whole Process Maize Mechanization in Nepal. *Big Data in Agriculture (BDA)*, 5(2), 77-88. doi:DOI: <http://doi.org/10.26480/bda.02.2023.77.88>
- MoALD. (2023). Statistical Information on Nepalese Agriculture in the FY 2022/23. Ministry of Agriculture and Livestock Development (MoALD), Planning and Development Cooperation Coordination Division, Government of Nepal. Singhadurbar, Kathmandu, Nepal.
- MoALD. (2024). Statistical Information on Nepalese Agriculture in the FY 2023/24. Ministry of Agriculture and Livestock Development (MoALD), Planning and Development Cooperation Coordination Division, Government of Nepal. Singhadurbar, Kathmandu, Nepal.
- Poudel, P. S., Yadav, P. K., Bhujel, P., & Subedi, A. P. (2023). Assessment of Economics of Production and Marketing of Maize in Shantinagar, Dang, Nepal. *Agribusiness Management in Developing Nations (AMDN)*, 1(2), 59-71. doi:<http://doi.org/10.26480/amdn.02.2023.59.71>
- Rajkhowa, P., & Kubik, Z. (2021). Revisiting the relationship between farm mechanization and labour requirement in India. *Indian Economic Review*, 56, 487-513. doi:<https://doi.org/10.1007/s41775-021-00120-x>
- Shinde, G. U., Mandal, S., Ghosh, P. k., Bhalerao, S., Kakade, O., Motapalukula, J., & Das, A. (2023). Farm Mechanization. In *Trajectory of 75 years of Indian Agriculture after Independence*. Singapore: Springer. doi:https://doi.org/10.1007/978-981-19-7997-2_18
- Shrestha, S. (2022). An overview of agricultural mechanization in Nepal. *Kathmandu University Journal of Science, Engineering and Technology*, 16(2).
- Sravani, D., Guddeti, M., & Rajanikanth, E. (2021). Boquet Ears in Maize. *Biotica Reasearch Today*, 3(1), 70-71.
- Taiwo, A., & Kumi, F. (2015). Status of agricultural mechanization in Ghana: A case study of maize Producing Farmer's in Ejura/Sekydumase district, Ashanti region. *International Research Journal of Engineering and Technology*, 2(9), 36-43.
- Takeshima, H., & Justice, S. E. (2020). Evolution of agricultural mechanization in Nepal. In IFPRI book chapters. Kathmandu, Nepal: Government of Nepal. Retrieved from <https://www.researchgate.net/publication/347517304>