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A Comprehensive Assessment of Apple Production in Jumla District, Nepal: Status, Economics, Marketing and Challenges

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ABSTRACT

Apple production is a vital sector of agriculture in Nepal, significantly impacting local livelihoods and the regional economy. This study, conducted in Jumla District, Nepal, from January to July 2022, aims to comprehensively assess apple production, including its existing conditions, economic implications, marketing and challenges. The research hypothesizes that while apple production in Jumla District contributes significantly to the local economy, it faces challenges related to pest and disease management, marketing, and adoption of modern practices. Using Statistical Package for Social Science (SPSS), descriptive statistics were computed based on data collected from a sample of 80 respondents selected through simple random sampling. The result revealed that agriculture constituted the primary source of income for 73.75% of the population, with an average landholding size of 0.3428 ha and an apple-growing land area of 0.3164 ha. Income from apple production, along with vegetables and fruits, was a major income source. The average annual sales of apple production were 7.291 t/ha. Labor costs accounted for 45.67% of the total cost of apple production, with an average total production cost of NPR 238,097.2 and average gross returns of NPR 485,500. Apple productivity was 9.71 t/ha, demonstrating its economic viability with net returns of NPR 247,402.80 per ha and benefit cost ratio of 2.039. However, the study found that farm produce only sufficed for 6-9 months, with pest and disease incidence and marketing issues as major challenges. Interventions should address pest and disease management, marketing strategies, and modern practices adoption to enhance sustainable and profitable apple production in Jumla. Efforts to extend farm produce sufficiency should also be explored, highlighting apple production's potential and the need for targeted support to overcome challenges and foster sector development.

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Introduction

Agriculture, the backbone of Nepal's economy, is not only the primary source of livelihood for approximately three-quarters of the population but also contributes significantly to the Gross Domestic Product (GDP) at 24.1% and employs 50.4% of the total population (MoF, 2022). Horticultural commodities play a pivotal role in Nepal's agricultural landscape (Ghimire et al., 2023a; Ghimire et al., 2023b). Among these fruits, apple (*Malus domestica*) holds a distinct and indispensable position. Globally recognized as the fourth most extensively produced fruit crop, apples are not only a vital source of nutrition but also an engine of growth for rural economies (Musacchi & Serra, 2018). Apple cultivation alone has contributed approximately 0.3470% to the national agricultural GDP of Nepal (MoALD, 2023). Studies have highlighted the remarkable antioxidant properties of apples, contributing to their value in promoting human health (Groth et al., 2020; Pandey et al., 2020). Furthermore, the cultivation of niche-specific fruits, including apples, presents an opportunity to meet the substantial demand in neighboring markets like India and China (Paudel, 2016). Jumla, Mugu, Mustang, Dolpa, Solukhumbu, Rukum, and Rolpa are among the leading apple-producing districts (Devkota et al., 2017).

Jumla district, situated in the western part of Nepal, offers an ideal setting for apple cultivation. It is the most important district for apple production in Nepal (MoALD, 2022). Its elevation ranges from 915 to 4679 m above mean sea level (masl), with temperature variations from 18-30°C in summer and -14°C to 8°C in winter, accompanied by an annual average rainfall of approximately 1300 mm (Khadka & Øivind Solberg, 2020). These climatic conditions, characterized by high altitude, low humidity, and abundant sunshine during the fruiting period, create an

ideal environment for apple farming. In Jumla, apple production varies from semi-commercial to commercial scale, with Red Delicious, Royal Delicious, and Golden Delicious constituting approximately 80% of total apple production, complemented by varieties like Jonathan, Chocolate, and Macintosh (Atreya & Kafle, 2016). Despite the immense potential for commercial apple production in Jumla, apple farmers face numerous challenges that hinder them from realizing the full benefits of their efforts. The remoteness of farms, lack of proper transportation and marketing facilities, absence of modern technologies for processing and storage, and insufficient knowledge among farmers regarding best practices all contribute to the struggle. Many farmers are unaware of subsidized inputs provided by government offices, and they lack technical expertise in cultivation methods, crop protection against pests and diseases, and post-harvest handling techniques (Ghimire & Chhetri, 2023b). Additionally, the fragmented nature of apple production, coupled with inadequate access to markets and low bargaining power among farmers, further exacerbates the difficulties. Rising production costs, harvesting expenses, transportation fees, and diminishing returns for small-scale producers have led some farmers to switch to more profitable alternative crops or migrate to lower-lying areas (Amgai et al., 2015; Khadka & Øivind Solberg, 2020). The challenges encompass traditional cultivation practices, limited access to technical guidance, shortages of cultivation materials, inadequate transportation networks, lack of market information, and fragmented production (Atreya & Kafle, 2016).

As the leading district in apple production in Nepal, Jumla offers an opportunity to enhance income generation and create employment, especially considering its organic certification (Lewison, 2022). Therefore, it is essential to assess the cost of production for both certified and non-certified apples, examine the price of the produce, and gauge consumer perceptions. Additionally, understanding whether certification schemes offer extra benefits to farmers is vital. The objectives of this study is to analyze the existing scenario of apple cultivation, economics of production, production scale, farmers' knowledge status, adoption of modern technologies, effectiveness of government programs and subsidies, commercialization levels, and challenges that impede sustainable and profitable apple production. The findings can serve as valuable feedback for formulating and implementing effective plans and programs within the district. Furthermore, this research benefits readers interested in understanding the state of apple production in Jumla District and aims to provide insights into economic aspects, challenges, and opportunities, delves to contribute to the sustainable growth of apple production. Assessing economic indicators like the benefit cost (BCR) ratio and marketing cost margins can provide insights into associated risks and assist in developing business plans for apple production in Jumla District.

Materials and method

Study Site and Sub-Sector

The present research study was conducted in Chandanath Municipality, as well as in three rural municipalities namely, Tatopani, Guthichaur, and Patarasi—within the Jumla district of Nepal (Figure 1). The geographic extent of the Jumla district ranges from approximately 25˚58' to 29˚N latitude and 81˚51' to 82˚35'E longitude. Furthermore, it exhibits an elevation gradient, ranging from 915 masl at its lowest point to 4679 masl at its highest elevation. This elevation variation contributes significantly to the suitability of the region for apple production, as it meets the requisite conditions for minimum chilling and vernalization. The study was carried out over a period spanning from January 2022 to July 2022. The selection of the study areas within the Jumla district was deliberate, as these areas are renowned as major hubs for apple cultivation. Moreover, these regions serve as pivotal sites under the Prime Minister Agriculture Modernization Project (PMAMP) – Project Implementation Unit (PIU), Jumla, further underscoring their significance in the context of this research endeavor.

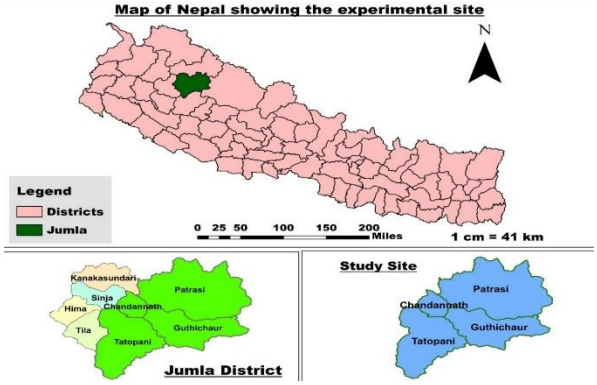


Figure 1. Map of Nepal depicting Jumla and the study sites

Sample and Sampling Technique

The roster of apple-growing farmers within the designated study area was acquired from the PIU located in the apple super zone, Jumla. From an initial list comprising 1152 apple-producing farmers who possessed orchards with more than 50 apple trees, a total of 80 respondents were selected to participate in the research study. The selection of respondents was a two-step process. Initially, the study sites were purposefully identified, and within these sites, a random sampling method was applied to select the 80 respondents. The utilization of this combined approach aimed to enhance the diversity and representation of apple growers within the research sample.

The Rao Soft software was employed to ascertain the suitable sample size for the study, considering several key statistical parameters. These parameters included a margin of error of 10%, a confidence level of 90%, a response distribution of 35%, and a population size of 1152 apple-producing farmers within the study area. This rigorous approach was adopted to ensure that the research sample size would be statistically robust, providing a balance between precision and reliability in our study findings.

Research Instruments

Preliminary field visit and pretesting of the questionnaire

Prior to conducting the main survey, a preliminary study was undertaken to gather crucial socio-economic, demographic, and geophysical data pertaining to the study sites. This preliminary information played a pivotal role in the formulation of questionnaires and the development of the sampling framework (Ghimire & Chhetri, 2023b; Ghimire & Kandel, 2023). Additionally, a pretesting phase

was conducted to evaluate the feasibility of the survey process, identify potential obstacles, and rectify any technical errors that may have arisen during data collection. Notably, this pretesting phase involved the examination of 10% of the total sample population, and the results from this subset were not included in the main report to ensure the accuracy and reliability of the final findings.

Questionnaire survey and Key Informant Interview (KII)

A comprehensive household survey was carried out within the designated target site, during which a set of pre-tested questions were systematically administered to farmers with the objective of collecting valuable data. The primary sources of information were the farmers themselves, as well as key stakeholders and relevant officers with expertise in the field. These key informants were subjected to a structured series of inquiries pertaining to the current state of apple cultivation and various economic aspects related to apple production, aimed at gathering qualitative data of significance.

Key informants were interviewed utilizing specifically designed checklists tailored to the research objectives to ensure data accuracy and validation. This meticulous approach was adopted to enhance the quality and reliability of the data acquired during the survey process (Ghimire & Chhetri, 2023b; Ghimire & Gyawali, 2023).

Data and Data Types

The dataset utilized in this study encompassed both primary and secondary data sources. Primary data were acquired directly from the apple-growing farmers through a multi-stage process that included preliminary field visits, pretesting of questionnaires, and household surveys conducted through interviews. On the other hand, secondary data sources were tapped to complement the primary data. These secondary data were gathered from a variety of reputable sources, including the annual progress report of the PIU, in Jumla, journal articles, books, and information available on the internet. The integration of primary and secondary data sources allowed for a comprehensive and well-rounded analysis.

Data Analysis Technique

Both qualitative and quantitative data obtained from the survey were subjected to a rigorous analysis using statistical software. The quantitative data analysis was conducted using Statistical Package for Social Science (SPSS; IBM Statistics 28; New York, USA). Additionally, Microsoft Excel 2010 (Microsoft Corp., Washington, USA) was employed as a complementary tool for certain analytical tasks. A diverse array of statistical tools, graphical representations, diagrams, charts, and graphs were skillfully employed to examine and interpret the results derived from the survey. Descriptive statistics, including measures such as frequency, mean, and standard deviation, were utilized to characterize the distribution of the study variables.

Operational variables

The selected characteristics of the farmers were considered as operational variables. These included age, gender, level of education, family size, primary income source, and training received by the farmers, as they were the potential parameters affecting the economic aspects of the family. Similarly, information on landholding, farm sufficiency, organizational involvement, and information related to processed or post-harvest products were also considered and analyzed.

Statistical tools such as mean and standard deviation were applied to categorize the age of the respondents. The respondents' ages were divided into three distinct groups: 20-39 years, 40-60 years, and above 60 years, allowing for a more nuanced understanding of the demographic distribution. Gender differentiation was based on whether the respondents were male or female. This categorization was pertinent, as it was expected that gender might impact economic status due to variations in exposure to opportunities, training, extension support, and participation in various economic activities, especially for females. The level of education among the respondents was categorized into four groups: primary, secondary, higher secondary, and Bachelors (university) (Ghimire & Chhetri, 2023b). This classification aimed to capture the potential influence of education on economic factors. Family size, defined as the number of individuals residing together and sharing living arrangements, including kitchen and eating arrangements, was used to classify respondents into three groups: small (less than 4), medium (5-8), and large (greater than 9). This classification allowed for the exploration of the impact of family size on economic aspects. Respondents were categorized based on their primary sources of income, with three categories identified: agriculture, public service, and private business. This classification aimed to assess the influence of income sources on economic conditions. The study considered whether respondents had received training from various governmental and non-governmental organizations (PIU, District Agriculture Development Office, Nepal Agricultural Research Council, NGOs/INGOs) in the context of apple production. Respondents were categorized as either trained or non-trained, providing insights into the potential impact of training on economic aspects.

Economic analysis (Cost of production and benefit cost analysis)

The assessment of apple production costs involves the consideration of multiple components. These encompass the rent of land, tillage expenses, labor costs associated with various inter-cultural operations (such as pit digging, planting, fertilizer application, training, pruning, harvesting, and post-harvest processing), expenditures on fertilizers, the cost of Bordeaux mixture, expenses related to manure, and the costs associated with tools used in the cultivation process (TVC: Equation 1). In the analysis of production costs, only variable costs were taken into account.

$$TVC = C_{land} + C_{till} + C_{labor} + C_{sap} + C_{bdx} + C_{tool} + C_{manure} \quad (1)$$

Where, C_{land} = Cost of rent of land, C_{till} = Cost of tillage, C_{labor} = Cost of labor, C_{sap} = Cost of saplings, C_{bdx} = Cost of Bordeaux mixture, C_{tool} = Cost associated with tools used in cultivation, and C_{manure} = Cost of manure.

Gross return would encompass the total revenue generated from selling apples. This revenue includes the proceeds obtained from the sale of apples in various forms, such as fresh fruit, processed products, or by-products.

Gross return serves as a critical financial metric, providing a measure of the potential revenue or income generated by the activity without considering the associated production costs or deductions.

The net returns were then determined by subtracting the total production cost from the gross returns (Equation 2). Net returns represent the profit or loss resulting from apple cultivation.

$$\text{Net return} = \text{Gross return} - \text{Total production cost} \quad (2)$$

Benefit-cost ratio (BCR) is a critical metric in assessing the economic feasibility and efficiency of the apple production venture. It provides a ratio of the benefits derived from apple cultivation compared to the total cost incurred (Equation 3).

$$\text{BCR} = \frac{\text{Gross returns}}{\text{Total variable cost}} \quad (3)$$

Indexing

Scaling procedures were employed to gauge the direction and intensity of the respondents' attitudes toward specific propositions. Respondents were presented with a range of options that represented various levels of agreement and disagreement. Each of these options was assigned a numerical score. By selecting these options, respondents conveyed their attitudes, and their individual scores were aggregated to calculate their overall scores. These overall scores, which represented the cumulative assessment of respondents across different responses, were indicative of their position along the attitude continuum. The farmers' perceptions of various problems were assessed by ranking them using a scale with values denoting the severity of the issues. The scale points ranged from 1.0, representing the most serious problems, to 0.2, signifying the least serious problems as 1.0, 0.8, 0.6, 0.4, and 0.2. This scaling approach allowed for a structured and quantitative evaluation of the perceived severity of different issues, aiding in the prioritization and analysis of the challenges faced by the farmers (Dawadi et al., 2023).

The index of problem was computed by using Equation (4).

$$I_s = \sum \frac{S_i f_i}{N} \quad (4)$$

Where, I_s = index of importance, $\sum$ = summation, S_i = i^{th} scale value, F_i = frequency of i^{th} importance given by the respondents, and N = total number of respondents.

Results and discussion

Socio-demographic Characteristics

Gender distribution of respondents in the surveyed area

A clear gender distribution was observed, with the majority of respondents, accounting for 65%, being male, while only 35% of the respondents were female (as indicated in Table 3) within the sampled population. In accordance with the research findings of Khadka and Øivind Solberg (2020), the male population in Jumla comprised 63% of the total sample population, aligning with the observations made in our own study. The percentage of men engaged in the surveyed area surpassed the national average male population proportion of 48.87% (National Statistics Office, 2023). This skew in gender representation may be attributed to the prevailing socio-economic dynamics within the study area. One plausible explanation for this distribution is that a significant number of males were actively engaged in income-generating opportunities and various income sources, while females were primarily occupied with household activities (Dawadi et al., 2023). This division of labor reflects traditional gender roles often found in many societies. Additionally, this gender distribution sheds light on the decision-making dynamics within households. The predominance of males among the respondents suggests that, in many cases, males held the role of primary decision-makers within the households (Poudel Chhetri & Ghimire, 2023).

Age of respondents

It was notable that the largest proportion of respondents, constituting 50.0% of the total, fell within the age range of 40 to 60 years. Following this group, respondents in the age bracket of 20 to 39 years accounted for 30.0% of the sample. Lastly, 20.0% of the respondents were found to be above 60 years of age (Table 3). The mean, range and standard deviation of the age of respondents are shown in Table 1.

Table 1. Average age of the respondents of sample household

Variable	Age of respondent
Minimum	22
Maximum	84
Mean	45
Std. deviation	14.20

Ethnicity of the respondent's household

The majority of the sampled households belonged to the Brahmin group, constituting 46% of the total. Following closely behind were the Chhetri households, representing 33% of the sample. Additionally, there were households from the Dalit group, accounting for 15% of the sample, and from the Janajati group, which made up 6% of the total (Table 3). Significantly, when juxtaposed with the outcomes of Ghimire and Kandel (2023) study, distinct disparities in ethnic composition emerge, as Brahmin/Chhetri emerge as the predominant ethnic group at 61%, followed by Janajati at 13%, and Dalits at 6% in the Surkhet region. These variations emphasize the significance of taking into account regional and contextual nuances in ethnic and religious demographics when conducting research. In comparison to the findings of Khadka and Øivind Solberg (2020), which reported 13% Brahmins, 64% Chhetri, 10% Janjati, and 13% Dalit engagement in apple production in Jumla district, the disparities in these percentages might be attributed to several factors. These differences could potentially arise from variations in the sampling methodology, regional demographics, or shifts in the composition of agricultural activities over time.

Educational status of the respondents

The educational background of the respondents in this study displayed a diverse range of educational attainment levels. The distribution of respondents across different education levels is presented in Table 3. Notably, a

significant portion of the respondents, comprising 43.25% of the total, reported being illiterate, is indicating that they had not received formal education. Following this group, respondents with a secondary level of education, ranging from class five to ten (S.L.C.), constituted 23.75% of the sample. The remaining respondents were distributed across various educational levels, including primary, higher secondary, and university education. Within the study site, it is noteworthy that the proportion of literate individuals stood significantly lower at 56.75%, than the national literacy rate of 76.2% as reported in the 2021 census by National Statistics Office (2023).

Family size and economically active members of the respondent's household

The findings revealed that 47.0% of the respondents reported having a medium-sized family. Interestingly, an equal percentage of respondents belonged to both small and large-sized families (Table 3). This distribution suggests a diverse range of family sizes within the sample. It is noteworthy that the majority of respondents (47.50%) had medium-sized families, and this proportion appeared to be higher (7.08) than the national average of 4.5 (CBS, 2016), as shown in Table 2. This observation implies that the study area might have a higher prevalence of medium-sized families compared to the national average. To analyze the economically active population within the households, family members falling in the age group of 15 to 60 were categorized as economically active, while those below 15 and above 60 were considered economically inactive, as shown in Table 2. On average, each respondent had approximately 2.38 economically active family members. This information is valuable for assessing the labor force within the households, which is crucial for understanding the economic dynamics of the community.

Major source of household income

The findings of the study reveal significant insights into the occupational structure of the study area. Notably, agriculture emerges as the dominant occupation, with a staggering 73.75% of households relying on it as their primary source of livelihood (Table 3). This figure surpasses the national average of 65.6%, as reported by CBS (2016), underscoring the region's heavy dependence on agriculture. Several factors likely contribute to this prominence, including favorable geographic and climatic conditions, deep-rooted cultural and historical ties to farming, limited alternative job opportunities, and potential government support for the agricultural sector. In addition to agriculture, public service emerges as the second most common occupation, with 16% of households engaged in this sector. This diversification in the local economy suggests the presence of government offices, educational institutions, healthcare facilities, or other public institutions that provide employment opportunities. Stability in income, job security, and associated benefits often make public service jobs attractive to a significant portion of the population. Moreover, the region's high education levels and skillsets may be aligned with public service roles, further explaining its prevalence. Private business also plays a notable role, accounting for 10% of households' income sources. This entrepreneurial activity reflects economic diversification and reduces dependency on a single sector like agriculture. It signals the presence of individuals with an entrepreneurial spirit who are willing to invest in various businesses, responding to local market demand and contributing to the area's economic development. Understanding the significance of agriculture, public service, and private business in the study area is essential for policymakers and community leaders. They must leverage this knowledge to support sustainable economic development, create job opportunities, and ensure the well-being of the local population while considering the unique dynamics at play in this particular region.

Table 2. Socio-demographic characteristics (continuous variables) of the respondents.

Variables	Mean	SD
Family Size	7.08	2.17
Economically active family members	2.38	1.03

SD: Standard deviation

Table 3. Socio-demographic characteristics (categorical variables) of the respondents.

Variables	Frequency	Percentage
Age (in years)		
20-39	24	30
40-60	40	50.0
Above 60	16	20.0
Gender		
Male	52	65.0
Female	28	35.0
Caste/Ethnicity		
Brahmin	37	46.25
Chhetri	26	33.50
Janajati	5	6.25
Dalit	12	15.0
Level of education		
Illiterate	35	43.75
Primary level	12	15.00
Secondary level	19	23.75
Higher Secondary level	9	11.25
University level	5	6.25
Major source of income		
Agriculture	59	73.75
Public Service	13	16.25
Private Business	8	10.00
Family size		
Small (below 4)	21	26.25
Medium (4-8)	38	47.50
Large (above 9)	21	26.25

Income of the respondents from apple and other sources

The respondents participating in the survey predominantly engaged in apple production, which constituted their primary agricultural activity. The average annual income derived from apple production among these respondents amounted to NRs 87,046, which is 26.41% of total income generated from various income sources (Table 4). Comparable findings were observed in the study conducted by Sapkota et al. (2022), wherein apple production contributed to 20.32% of the total income in Jumla. This suggests a significant contribution of apple production and marketing to the rural household economy. In addition to apple production, a portion of the

respondents, numbering 48, also practiced vegetable and fruit cultivation, yielding an average annual income of NRs 44,575. The study also encompassed respondents involved in various other farming activities. Among these, those engaged in cereal cultivation, totaling 46 respondents, reported the lowest average annual income, amounting to only NRs 3,100. On the contrary, a smaller group of respondents, specifically 3 individuals, were involved in the cultivation and trading of medicinal plants. This group reported the highest average annual income, totaling NRs 1,25,075. In contrast, when comparing these results to Khadka and Øivind Solberg (2020), it is evident that apple production served as the primary income source for 45% of the sampled population. This variation in income sources could be attributed to a range of factors, such as agricultural practices, or variations in sample composition.

Livestock information of the respondents

Nearly every household among the respondents was found to be actively involved in livestock rearing, which complements and supports agricultural activities. The distribution of livestock among the surveyed households revealed some interesting trends. Cows and bullocks were reported in relatively higher numbers (31.37%), primarily due to their essential roles in various farm operations, such as ploughing and transportation. Following cows and bullocks, sheep (21.33%) and poultry (19.65%) were also kept, primarily for meat production purposes (Table 5). Horses (4.50%) were another livestock category present in the households, serving both as riding animals and for their transformative benefits in terms of transportation. The diversity of livestock within the households underscores their multifaceted roles in supporting livelihoods and agricultural activities in the region.

Land status of respondents

The results provided in Table 6 offer a comprehensive perspective on land-related data within the surveyed area. Notably, the total cultivated land shows substantial variation among respondents, ranging from a minimum of 0.06 hectares to a maximum of 1.53 hectares, with an average (mean) of 0.3428 hectares and a moderate standard deviation of 0.218 hectares, indicating some dispersion in the data. In contrast, total uncultivated land exhibits a lower mean of 0.0758 hectares, with a range from 0 to 0.76 hectares and a standard deviation of 0.128 hectares, signifying less variability. The leased out and leased in land categories reflect limited involvement among respondents, with means of 0.0106 hectares and 0.0066 hectares, respectively, and relatively low standard deviations of 0.051 and 0.044 hectares. When examining the net owned land, which accounts for cultivation and leasing, the data indicates a wider range, varying from 0.06 to 1.98 hectares, with an average of 0.4227 hectares and a standard deviation of 0.310 hectares.

Lastly, apple production land exhibits variation, ranging from 0.05 to 1.02 hectares, with an average of 0.3164 hectares and a standard deviation of 0.215 hectares. These results underscore the diversity in land ownership and cultivation practices among respondents, providing valuable insights for further analysis and decision-making in the study area. Our research findings indicate that the total apple production area in Jumla, which amounts to 0.3164 hectares, aligns with the results reported in Mustang by Gayak et al. (2020).

The similarity in total apple production areas between Jumla and Mustang, two prominent apple-producing districts in the country, may be attributed to a convergence of factors. These include shared geographic and climatic conditions, longstanding agricultural traditions, preferences for specific apple varieties suited to the local environment, stable market demand, economic considerations, access to agricultural research and extension services, and limited land availability. These factors collectively encourage farmers in both districts to allocate a comparable area of land to apple cultivation, resulting in a consistent total production area for apples in both regions.

Table 4. Income of the respondents from apple and other sources.

Income sources (NRs)	Frequency	Minimum	Maximum	Mean
Apple production	80	12500	250000	87046.88
Cereals	46	0	12000	3100.00
Vegetables and fruits	48	0	560000	44575.00
Live animal and product sell	8	0	150000	6437.50
Services, business and remittances	34	120000	1000000	320975.00
Government services	18	96000	480000	58987.50
Pension, old age and other allowances	23	48000	480000	30525.00
Medicinal plant	3	85000	200000	125075.00
Total income	80	52000	1207000	329521.88

Table 5. Livestock information of the respondents in the study area.

Livestock status	Minimum	Maximum	Mean	Percentage
Cow/ox	0	15	4.53	31.37
Buffalo	0	5	0.92	3.53
Horse	0	9	0.34	4.50
Sheep	0	125	3.12	21.33
Goat	0	17	1.78	19.62
Poultry	0	25	2.15	19.65
Total			12.84	100

Table 6. Land status of the respondents in the study area.

Land information (hectare)	Frequency	Minimum	Maximum	Mean	Std. deviation
Total cultivated	80	0.06	1.53	0.3428	0.218
Total uncultivated	40	0	0.76	0.0758	0.128
Leased out	4	0	0.30	0.0106	0.051
Leased in	3	0	0.38	0.0066	0.044
Net owned land	80	0.06	1.98	0.4227	0.310
Apple production	80	0.05	1.02	0.3164	0.215

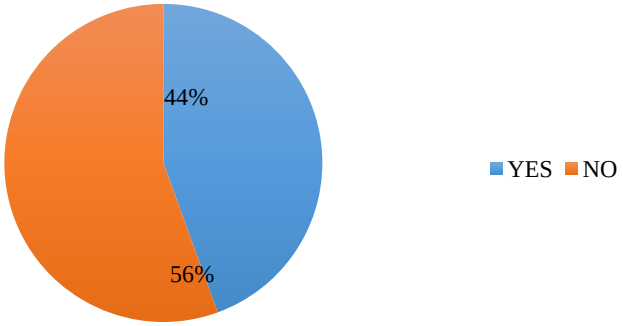


Figure 2. Status of members migrated of the respondents in the study area.

Status of members migrated

Among the total respondents engaged in apple cultivation, a significant portion, comprising 44%, reported having at least one member from their family who had migrated. Conversely, the majority of apple growers, accounting for 56% of them, did not have any family members who had migrated, as illustrated in Figure 2. The reasons for migration varied, with the majority of migrating family members seeking better job opportunities, improved access to education, and access to public services. This migration pattern suggests that individuals from these households sought opportunities and services beyond the local region, likely driven by a pursuit of improved economic prospects and educational access.

Apple Farming Information

Number of apple trees

From an agricultural perspective, the study on the number of apple trees provides insights into economic considerations, influencing decisions related to agricultural practices and crop diversification. Monitoring the health of apple trees aids in pest and disease management strategies, as their condition can be indicative of prevalent issues within the surveyed sites. The study's findings revealed that the majority, specifically 64.28%, of the total number of trees in the respondents' orchards were in the fruiting stage, indicating that a significant portion of their orchards had trees bearing fruit. In contrast, 35.71% of the trees were in the non-fruiting stage, likely indicating younger trees or those not currently producing fruit. In the results by Sapkota et al. (2022), it was observed that 61.83% of the total fruits were in the fruiting stage. This similarity could be attributed to the shared geographical context and the season of the study. The range of trees in the respondents' orchards varied significantly, with the smallest orchard containing 60 trees and the largest orchard comprising a substantial 1200 trees with average tree count of 354.7, as presented in Table 8. This wide range in orchard size reflects the diversity of apple cultivation practices within the surveyed population, with some households managing relatively small orchards while others oversee much larger-scale apple production operations.

Age of orchard

The age of the orchards belonging to the respondents was categorized into four distinct groups, as detailed in Table 7. The largest proportion of apple orchards, accounting for 51.25%, was in the age range of 11 to 15 years. Following this group, orchards aged between 5 and 10 years constituted 28.75% of the total. Orchards in the 16 to 20-year age bracket represented 15% of the surveyed orchards. A smaller percentage, 5.0%, of the orchards was more than 21 years old. The mean age of the respondents' orchards was calculated to be 5 years, with the range spanning from a minimum of 5 years to a maximum of 35 years, as indicated in Table 8. This age distribution provides insights into the maturity and development stages of the apple orchards within the study area, which can have implications for factors such as productivity and maintenance practices (Goossens et al., 2017). The age of the plant indeed has a significant impact on the productive capacity of the tree. As highlighted in the study by Bhandari and Aryal (2016), this influence is reflected in the decreasing trend of the BCR, which occurs as the returns from the older fruit trees diminish over time.

Production status

Table 8 presented below offers a comprehensive snapshot of an orchard's key characteristics and production

metrics. The orchard is shown to consist of a varying number of trees, with a minimum of 60 and a maximum of 1200, averaging at 354.70 trees. Similar findings were reported by Sapkota et al. (2022), who documented 331.04 trees/ha (16.82 trees/ropani) in Jumla. The average production cost of apple crops decreases with an increase in the number of plants. Among these trees, the number of fruiting trees ranges from 10 to 1000, with an average of 163.73. The orchard's age spans from 5 to 35 years, with a mean age of 15.00 years. In terms of productivity, the orchard produces apples at a rate between 2.0 to 20.0 tons per hectare, with an average of 9.710 tons per hectare. The productivity aligns with the data published by the Ministry of Agriculture and Livestock Development (MoALD) in 2022, which indicated a productivity rate of 9.55 tons per hectare in the Jumla district (MoALD, 2022). Additionally, it experiences post-harvest losses ranging from 0.1 to 5.0 tons, with a mean loss of 2.119 tons. Family consumption of apples from the orchard varies from 0.2 to 5.0 tons, averaging at 1.858 tons, while the quantity sold ranges from 1.0 to 23.0 tons, with an average sale of 7.291 tons. These findings offer valuable insights into the orchard's characteristics and production dynamics, aiding in informed decision-making and agricultural management. Our research findings indicate that the productivity in the surveyed area of Jumla is comparatively higher than that reported by Gayak et al. (2020) for Mustang. According to their study, the productivity of Mustang was documented as 8.57 tons per hectare, while our research revealed that Jumla's productivity stands at 9.71 t/ha. Orchards in the two regions may be subjected to different management practices, including irrigation, fertilization, and pest control, impacting overall productivity. Additionally, topography and slope orientation, as well as microclimatic variations, could play pivotal roles in shaping the observed differences. Understanding disease and pest incidence, along with phenological differences in flowering and fruiting times, is crucial for a comprehensive assessment.

Variety grown and preferred by the respondent farmers

Among the 80 respondents surveyed, the predominant apple variety cultivated in their orchards was Golden Delicious, with a substantial presence among 74 respondents, as depicted in Figure 3. This finding is in alignment with the research conducted by Sapkota et al. (2022), who reported that approximately 70% of the total plantation was dedicated to three apple varieties: Red Delicious, Royal Delicious, and Golden Delicious. These varieties are known for their popularity among consumers due to their taste, appearance, and versatility, making them preferred choices for growers. Following closely behind were Red Delicious and Royal Delicious, grown by 72 and 69 respondents, respectively. Together with Golden Delicious, these three varieties constitute a significant 75% of the total orchard plantation. This dominance can be attributed to their market demand, long shelf life, and relatively stable cultivation practices, which provide a sense of security for growers. However, it's worth noting that a variety of other apple cultivars, such as Jonathan, Chocolate, Rich-a-red, Spur, and Fuji, were also cultivated, albeit by fewer respondents. Fuji and Spur, in particular, were mentioned as requiring intensive management and entailing higher input costs. This observation aligns with the documented fact that certain apple varieties demand more meticulous care, including pest control and climate management, which can deter some farmers from adopting them (Herz et al., 2019).

The preferences for different apple varieties were assessed based on discussions with farmers visiting the PMAMP office in Jumla. Seven distinct apple varieties were assigned numerical rankings, ranging from 1 to 7, with 1 indicating the most preferred variety and 7 indicating the least preferred one. Table 9 provides insight into the preferences of the respondents, showing the frequency of respondents who ranked each variety as their top preference and their least preference, respectively. Interestingly, in terms of preference, Golden Delicious was found to occupy the third position, following Red Delicious and Royal Delicious. This preference ranking can be attributed to the fact that delicious is a pollinating variety. As a result, a significant number of farmers have this variety in their orchards, which likely influenced its ranking. The presence of pollinating varieties like Golden Delicious is essential for facilitating cross-pollination and enhancing fruit production in apple orchards, contributing to its overall popularity among farmers.

Table 7. Age of orchard of the respondents in the study area.

Age of orchard (years)	Frequency	Percentage
5-10	23	28.75
11-15	41	51.25
16-20	12	15.0
>21	4	5.0

Table 8. Production status of apple of the respondents in the study area.

Description	Minimum	Maximum	Mean
Number of trees	60	1200	354.70
Number of fruiting trees	10	1000	163.73
Age of orchard	5	35	15.00
Total productivity (t/ha)	2.0	20.0	9.710
Post-harvest loss (t)	0.1	5.0	2.119
Family consumption (t)	0.2	5.0	1.858
Quantity sold (t)	1.0	23.0	7.291

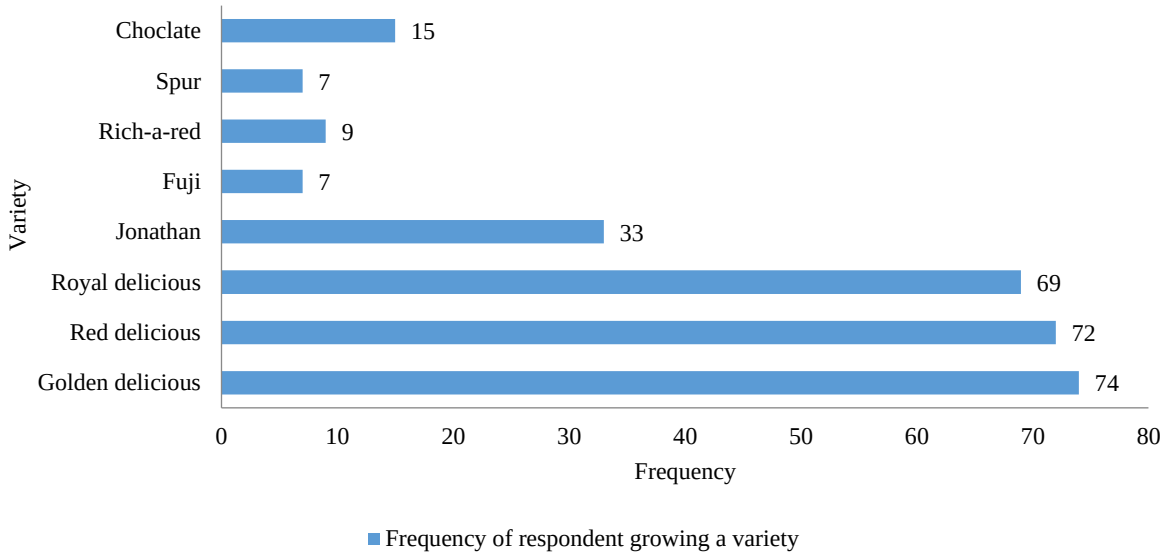


Figure 3. Variety grown by the respondents and their frequency.

Table 9. Variety preferred by the respondents and their ranking in the study area.

Variety	1st	2nd	3rd	4th	5th	6th	7th
Royal delicious	22	27	19	6	4	1	1
Red delicious	42	23	8	6	0	1	0
Golden delicious	6	20	30	10	6	6	2
Fuji	3	5	10	13	22	23	3
Jonathan	1	2	6	20	16	15	20
Rich-a-red	6	2	6	19	23	13	12
Spur	1	2	2	5	7	20	43
Rank	Red	Royal	Golden	Jonathan	Rich-a-red	Fuji	Spur

Table 10. Factors influencing apple production in the study area.

Factors	Responses	Percentage
Land and climate suitability	Yes	100
	No	0
Good returns and market demand	Yes	100
	No	0
Government subsidies and extension services	Yes	22
	No	78
Other crops uncultivable	Yes	34
	No	66
Influences of neighbors	Yes	33
	No	67

Factors influencing apple production

The data presented in Table 10 provides a comprehensive view of the factors influencing the decision-making process of the respondents in their agricultural practices. It is notable that two factors, land and climate suitability, and good returns and market demand, received unanimous agreement among all respondents, with 100% of them recognizing these factors as crucial. This underscores the paramount importance of environmental factors and economic viability in shaping farming choices. In contrast, the influence of government subsidies and extension services was acknowledged by only 22% of respondents, suggesting that such support systems might not be universally accessible or impactful in the surveyed area. Similarly, approximately one-third of respondents (33%) considered the influences of neighbors as relevant to their decision-making, indicating the potential role of social factors and peer practices in guiding their choices. Furthermore, about 34% of respondents mentioned other crops uncultivable as an influencing factor, signifying those certain limitations, such as unfavorable soil or climate conditions, restrict their crop options. These findings collectively highlight the multifaceted nature of agricultural decision-making, encompassing environmental, economic, social, and practical considerations. Understanding these factors can aid policymakers and agricultural support organizations in tailoring their strategies to better meet the diverse needs and challenges faced by local farmers, ultimately contributing to more informed and sustainable agricultural practices.

Number of expected trees in coming year

The findings regarding the relationship between the number of apple plants and production costs, as noted by Gayak et al. (2020), reveal an interesting trend. It was observed that as the number of apple plants increases, the average production cost tends to decrease. This phenomenon can be attributed to economies of scale, wherein larger orchards often benefit from cost savings in various aspects of cultivation and management. This insight suggests a potential incentive for farmers to expand their apple orchards.

Among the 80 respondents surveyed, a notable 49 expressed their intention to expand their apple orchards by adding more apple trees. This indicates a positive outlook towards apple cultivation and a willingness to invest in its expansion. On the other hand, 31 respondents indicated that they were not interested in increasing their apple production any further, which might be due to various reasons such as limited resources, land constraints, or other agricultural priorities. For those respondents keen on expanding their orchards, the data reveals that they are planning to add an average of 87 trees in the upcoming year, as illustrated in Figure 4. This figure signifies a tangible commitment to the expansion of apple cultivation and hints at the potential growth in apple production in the surveyed region. The positive intentions of a significant portion of respondents to invest in the expansion of their apple orchards align with the observed trend of decreasing production costs with increased plant numbers. This optimism bodes well for the growth and sustainability of apple cultivation in the region, potentially benefiting both the farmers and the local apple industry.

Problem in apple production

A five-point scaling technique was employed to assess the severity of problems in apple production, with scores assigned as follows: 1 (most severe), 0.8, 0.6, 0.4, and 0.2 (least severe) (Poudel Chhetri et al., 2023). Respondents were asked to score various problems related to apple production in the study area. The analysis revealed that the incidence of diseases and pests received the highest index value of 0.90, indicating that it was perceived as the most significant and major problem among the surveyed respondents (Table 11). This suggests that disease and pest management are critical challenges in apple production that farmers face in the study area, which is similar to the findings of Khadka and Øivind Solberg (2020) with index value 1.5. Conversely, the lack of technical knowledge was identified as the least serious problem, with a score value of only 0.28. This implies that while technical knowledge may be a concern, it is not perceived as severely problematic compared to other issues. Understanding the severity and perception of these problems is essential for developing targeted interventions and strategies to address the challenges faced by apple growers in the region effectively. According to Gayak et al. (2020), unavailability of input materials was identified as the primary problem in apple production with a high index value of 0.81 in Mustang, while incidence of disease and pests ranked third with an index value of 0.73. In contrast, the current analysis presents different findings, with incidence of diseases and pests receiving the highest index value of 0.90 and unavailability of input materials ranking as the fourth problem with a lower index value of 0.40. This discrepancy suggests that perceptions of the main challenges in apple production may vary among different studies or over time, possibly due to changes in local conditions, management practices, or awareness.

Economics of Apple Production

Cost analysis

The expenses incurred by respondents in apple production were primarily directed toward labor and land rental, reflecting the significant cost components of apple cultivation in the study area. Due to a shortage of labor in the study area and the absence of modern tools and machinery for various inter-culture operations, farmers had to allocate a substantial portion of their budget to labor costs. Specifically, labor costs accounted for 45.67% of the total expenses incurred in apple production, signifying the heavy reliance on manual labor for orchard management. The cost of renting land for apple production was the second-largest expenditure, constituting 30.66% of the total cost. This reflects the importance of access to suitable land for apple cultivation and the associated expenses. On the other hand, respondents spent a relatively smaller proportion, only 1.18%, of their annual budget on tools and equipment such as secateurs, saws, and other tools. This lower expenditure can be attributed to the durability of these tools, which can be used repeatedly over multiple years, as well as subsidies provided by Non-governmental organization (NGOs) and government offices operating in the region.

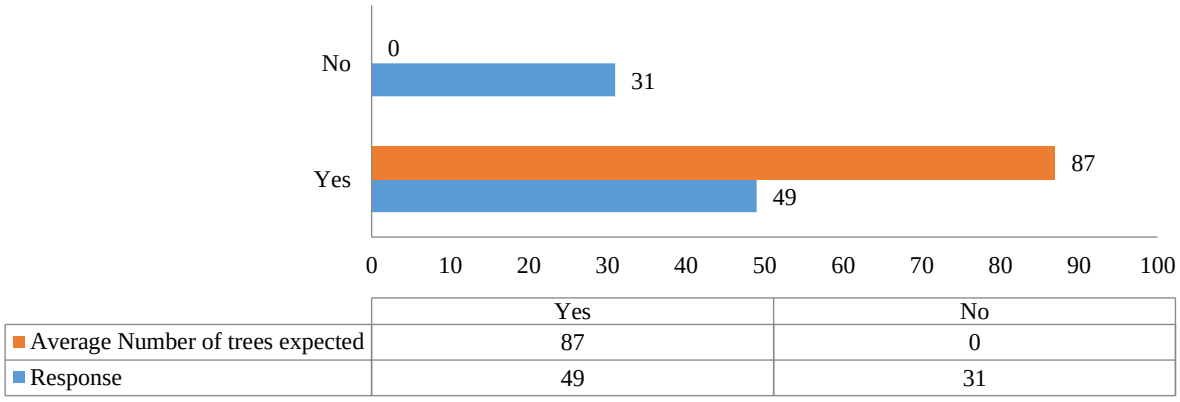


Figure 4. Average number of trees respondents expected to plant in the coming year.

Table 11. Major problems in apple production in the study area based on farmer's response.

Factors	Index	Rank
Incidence of diseases and pests	0.90	I
Occurrence of natural calamities	0.79	II
Unavailability of input materials	0.40	IV
Lack of technical knowledge	0.28	V
Lack of irrigation	0.63	III

Table 12. Various costs incurred in apple production by the respondents.

Input	Mean	Percentage
Labor cost (NRs/ha)	108738.99	45.67
Manure (NRs/ha)	13595.35	5.71
Bordeaux paste (NRs/ha)	16714.40	7.02
Rental cost (NRs/ha)	73000.60	30.66
Sapling cost (NRs/ha)	5238.13	2.20
Tillage cost (NRs/ha)	18000.14	7.56
Secateurs/Saw (NRs/ha)	2809.54	1.18
Total	238097.2	100.0

The breakdown of operating costs in apple production, as presented in Table 12, provides insights into the financial aspects of apple cultivation in the study area, highlighting the key cost components that farmers need to manage to sustain their orchards successfully. Our findings align with those of Sapkota et al. (2022), who also highlighted that rental costs, labor expenses, and manure represented significant expenditures in apple production. Notably, while in Jumla, rental costs emerged as the primary expense (Sapkota et al., 2022), our study identified labor costs as the major contributor. This divergence in cost allocation may be attributed to the fact that the majority of respondents in our survey possessed sufficient self-owned land for apple production (as indicated in Table 6), potentially reducing the need for rental expenses. Moreover, over time, labor costs have experienced an increase, which is reflected in our findings illustrating labor as the major contributor to production costs.

Gross return analysis

The gross return analysis conducted in the study unveils important insights into apple production in the surveyed area. It was found that the average apple productivity stood at 9.71 tons per hectare (Table 8), a significant measure of the agricultural output. However, a notable aspect of this production was that the majority of the apples were sold directly to traders and middlemen at the farmer's farm gate, where they fetched a price of NRs 50 per kilogram. This direct sale model is common in many agricultural regions and has its implications for farmer income. In light of this pricing structure, the mean annual gross returns for apple production in the surveyed area were estimated at NRs 485,500 per hectare. This figure, as detailed in Table 13, represents the overall financial returns generated by apple cultivation among the study's respondents. The data highlights the economic significance of apple farming in the area and underscores the potential for income generation through this crop. However, it's important to note that gross returns represent the total revenue generated before accounting for production costs.

Net returns and benefit cost ratio analysis

It is essential to analyze net returns by subtracting production expenses from the gross returns to gain a comprehensive understanding of the economic viability of apple cultivation. Following the findings, with gross returns of NRs 485,500 per hectare and total costs amounting to NRs 238,097.20 per hectare, the net returns were calculated to be NRs 247,402 per hectare. This implies that for every hectare of apple production, the respondents gained NRs 247,402 in profit (Table 13).

Moreover, the BCR of 2.039 suggests that apple production is indeed advantageous for the respondents, yielding nearly double the returns compared to the costs incurred. The BCR of approximately 2.039 indicates that for every unit of cost invested, you are getting approximately 2.039 units of gross returns, suggesting a favorable economic outcome for apple production. The BCR of apple cultivation is found to be higher than that of food crops, primarily owing to the apple's high market value and superior production and productivity. This indicates that the investment in apple production is economically favorable, reaffirming its benefits for the respondents. In the research conducted by Sapkota et al. (2022), the BCR for apple production in Jumla was reported to be 2.03. In contrast, the study by Khadka and Øivind Solberg (2020) documented a higher BCR of 2.44 for apple production in the same region. These varying BCR values suggest potential differences in factors such as production methods, market conditions, or other variables that influence the economic viability of apple cultivation between the two studies. In the study conducted by Bhandari and Aryal (2016), BCR of apple orchards in Mustang exhibited a range of values, starting at 1.19 in the fifth year after orchard establishment and reaching its peak at 2.68 in the ninth year. However, it was noted that the BCR started to decline beyond this point. Similarly, in Jumla, the same authors reported a BCR of 1.30 in the fifth year, which reached its highest point at 1.96 in the nineth year. Subsequently, the BCR showed a decreasing trend as the returns from the old fruit trees diminished, as observed in their study (Bhandari & Aryal, 2016). In Solukhumbu, the BCR was documented at 1.11 during the fifth year, reaching its peak at 2.22 in the eighth year (Bhandari & Aryal, 2016). The lower BCR observed in our findings may be attributed to the fact that approximately 71.25% of the

trees were over 10 years old, as indicated in Table 7. Moreover, it may be due to higher production cost. The BCR for the fruit crops ranged from 1.86 to 3.66, indicating a notably high level of profitability relative to the investment (MoAD, 2015), which is in accordance to our findings.

Farm self-sufficiency of farm produce

The findings regarding the sufficiency of farm produce to meet the food needs of the surveyed households shed light on the complex food security situation in the area (Ghimire & Chhetri, 2023a). It's evident that there is a considerable variation in the duration for which farm produce can sustain the households, with different respondents experiencing varying levels of food self-sufficiency.

Remarkably, only a small fraction, constituting 7.04% of the respondents, reported that their farm produce was adequate to cover their food requirements for a full 12 months or more, indicating a relatively high level of food security among this minority. However, a striking majority, comprising 66.56% of the respondents, stated that their farm produce could sustain their food needs for a period ranging from 6 to 9 months (Figure 5). This suggests a significant reliance on alternative sources for food during the remaining months when agricultural yields fall short. The fact that a substantial portion of the respondents depends on sources other than their farm produce to meet their food requirements highlights the need for diversified livelihood strategies and food security interventions in the area (Chhetri & Ghimire, 2023b). These non-farm sources could involve purchasing food from the market or accessing alternative food resources, such as government programs or community initiatives. Understanding these dynamics is crucial for policymakers and development organizations when designing programs and policies aimed at enhancing food security and improving the overall well-being of the surveyed households. It underscores the importance of not only boosting agricultural productivity but also addressing the broader spectrum of factors that influence food access and availability throughout the year.

Organizational involvement to financial institution and groups

All of the respondents surveyed in the study were found to have bank accounts and were actively engaged in banking transactions as part of their involvement in apple production. This reflects the financial inclusivity and the integration of banking services within the farming community, allowing them to manage their financial resources effectively. A substantial 75% of the respondents reported being associated with farmers' groups, which are essential for knowledge sharing, collective decision-making, and resource mobilization among farmers. Approximately 53% of the respondents were affiliated with co-operatives, which play a crucial role in providing financial and agricultural services to farmers, including access to credit and market linkages. A smaller percentage of people (13%) were associated with forest committees (Table 14).

Among the respondents who were associated with financial institutions, only a small percentage, specifically 6%, reported taking loans from these institutions to support their apple production activities. This indicates that a relatively limited number of respondents relied on formal financial institutions for credit and financial support in their apple cultivation endeavors, as illustrated in Figure 6. The low utilization of loans from financial institutions suggests that many respondents may have alternative sources of financing or may not require significant external financial assistance to sustain their apple production activities.

Table 13. Return from apple production of the respondents.

Measuring parameters	Value
Apple productivity (t/ha)	9.55
Farm gate price (NRs/kg)	50
Gross returns (NRs/ha)	485500
Total cost (NRs/ha)	238097.20
Net return (NRs/ha)	247402.80
BCR ratio	2.039

Table 14. Involvement of respondents in various organizations and groups.

Types of organization	Frequency	Percentage
Bank (with bank account)	80	100
Farmers group	60	75
Co-operatives	43	53
Forest committee	11	13

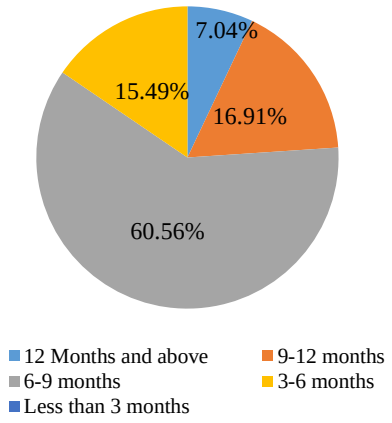


Figure 5. Farm sufficiency of the farm produce of the respondents

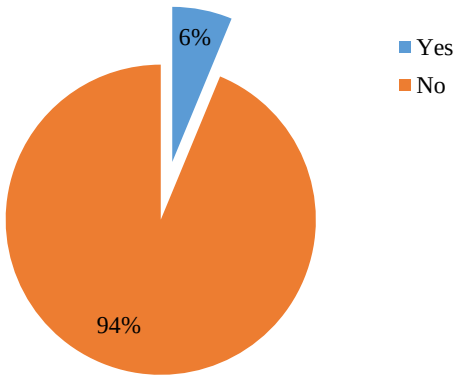


Figure 6. Percentage of the respondents taking loan from any financial institution for apple production

Post-harvest products and their sales

In the study area of Jumla, respondents engage in the production of various post-harvest products from apples, with dried apple and cider being the most popular among them. A majority of the respondents, totaling 56, reported preparing dried apple as a post-harvest product. Cider production was also common, with 34 respondents engaged in making this apple-based beverage (Figure 7). In addition to dried apple and cider, some respondents also prepare other post-harvest products, such as, jam and jelly. A smaller number of respondents, specifically 9, were involved in making jam. Similarly, only 9 respondents prepared jelly. Interestingly, dried apple and cider were not only popular among respondents but also had market importance. These products were sold at a rate of 1000 Nepalese rupees per kilogram for dried apples and 150 Nepalese rupees per liter for cider (Table 15). This suggests a potential avenue for income generation and market expansion for apple growers in the region, offering an additional layer of economic sustainability beyond primary apple production. On the other hand, respondents who prepared jam and jelly primarily did so for personal consumption and did not sell these products. The inclusion of jam and jelly production, primarily for personal use, reflects the multifaceted role of apple cultivation in meeting both economic and nutritional needs within the local community. This differentiation in production purposes highlights the diverse ways in which post-harvest apple products are utilized by the community, encompassing both economic and personal consumption motives.

Sales, Marketing and Related Activities Involved

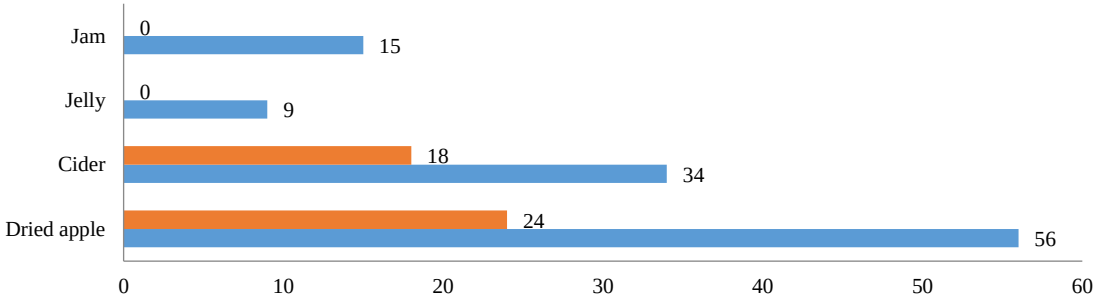
Selling parties of the respondents

The study's examination of the distribution channels for apple products in the surveyed area provides valuable insights into the dynamics of the local apple market. Four distinct categories of parties involved in the sale of apple products were identified, namely local traders, wholesalers, individuals engaged in self-driven sales, and direct-to-consumer channels.

Surprisingly, a substantial majority of the respondents, accounting for 60 out of the total 80, chose to collaborate with local traders for the distribution of their apple products, as depicted in Figure 8. This preference for local traders as a distribution channel highlights the role of intermediaries in the local apple supply chain and their significance in connecting producers with broader markets. This is a common practice in many agricultural regions, where traders act as intermediaries to aggregate and distribute products to various markets. Conversely, a smaller number of respondents, comprising 11 individuals, opted for self-driven sales, while 9 respondents engaged with wholesalers. Notably, none of the respondents in the study reported directly distributing their apple products to end consumers, which is a departure from the more efficient marketing channels described in previous research. Research, such as the marketing channel involving transactions from the producer to primary and secondary wholesalers, retailers, and consumers as outlined in Chand et al. (2017), suggests a streamlined approach to apple distribution. However, the study's findings indicate that such a marketing channel is not widely practiced in the surveyed area. This observation suggests a departure from this efficient marketing model and reflects the existing complexities and realities of the local apple market.

Methods of grading

The evaluation of apple quality is a crucial aspect of the apple production and marketing process, as it directly impacts pricing and consumer satisfaction. The assessment of apple quality is conducted based on the size and shape of the fruits (Zhang et al., 2021). Survey participants were queried regarding their practice of grading apples according to these criteria and whether they established the price based on this grading before selling. Figure 9 illustrates that a mere 71% of the survey respondents were observed to employ hand grading as their chosen method for apple quality assessment, while no respondents indicated the utilization of machine grading methods. This manual grading process involves visually inspecting apples and categorizing them based on their size and shape. Hand grading is a widely practiced method in many agricultural settings, allowing for a more nuanced evaluation of fruit quality (Poudel Chhetri et al., 2023). Consequently, it can be inferred that hand grading constitutes the sole method employed for grading purposes, with the remaining 29% of respondents abstaining from any form of grading methodology.



	Dried apple	Cider	Jelly	Jam
No of people selling	24	18	0	0
No of people making	56	34	9	15

Figure 7. Different post–harvest product practiced by the respondents.

Table 15. Price of post-harvest product prepared and sold by the respondents.

Product	Price (NRs/kg)
Dried apple	1000/kg packet
Cider	150/liter

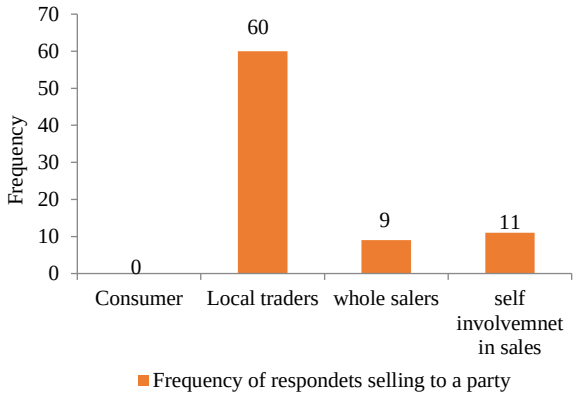


Figure 8. Selling parties of the respondents

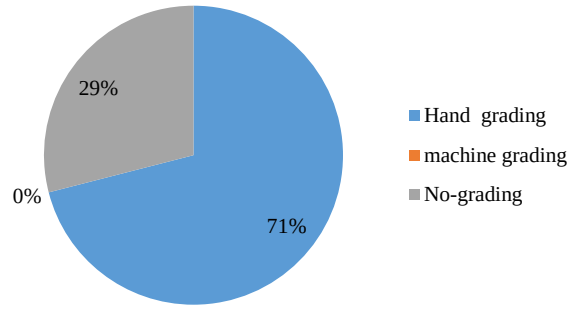


Figure 9. Different methods of grading used by the respondents.

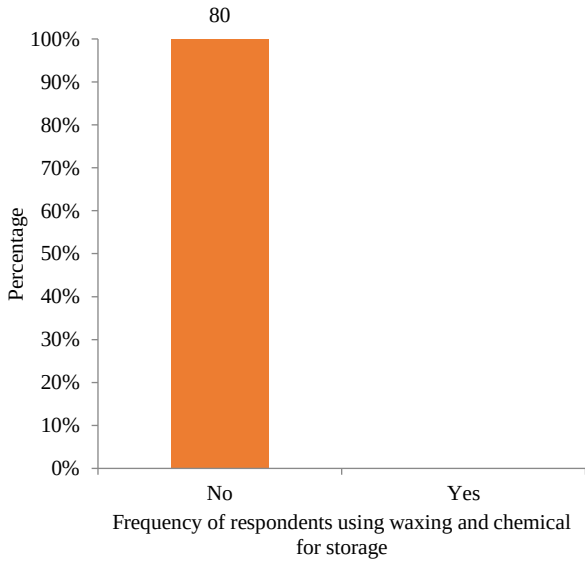


Figure 10. Frequency of the respondents using chemicals and waxing during storage.

Waxing and chemicals used

The significance of studying waxing and postharvest chemicals lies in their potential to enhance the shelf life and quality of harvested apples, providing insights into effective postharvest management practices for maintaining fruit freshness, minimizing decay, and meeting market standards (Chhetri & Ghimire, 2023a). The study's findings shed light on the post-harvest practices of apple growers in the surveyed area, specifically regarding the use of waxing or chemical treatments to extend the storage duration and prolong the post-harvest shelf life of apples (Chhetri & Ghimire, 2023a), as depicted in Figure 10.

Remarkably, none of the surveyed respondents reported employing waxing or chemical treatments on their apples following harvest. This suggests that such post-harvest treatments are not commonly practiced in the area. This observation aligns with the prevailing practice among the majority of respondents, who primarily sell their products to local traders, often directly at the farm gate. The absence of waxing or chemical treatments can be attributed to the immediate sale of apples to local traders. When apples are destined for nearby markets and consumers shortly after harvest, there may be less emphasis on implementing post-harvest preservation techniques like waxing. These treatments are typically employed when apples are intended for longer storage periods or distant markets, as they help protect the fruit from moisture loss, decay, and external damage (Ghimire et al., 2023c; He et al., 2017; Zhang et al., 2022).

Packaging materials used

Figure 11 illustrates the distribution of packaging materials used by the respondents. Remarkably, the majority of respondents, comprising 65 out of the total 80, opted for cartons as their preferred packaging material for apples. Cartons are a common and versatile choice for packaging fruits and vegetables, offering protection, ease of handling, and stacking capabilities (Ambaw et al., 2021). This widespread use suggests that cartons are well-suited to the needs of apple growers in Jumla. Following cartons, plastic containers were the second most chosen packaging material, with 23 respondents utilizing them. Plastic containers provide a degree of durability and visibility, allowing for the showcasing of the fruit, which may appeal to consumers (Kamuni et al., 2022). Doko, a traditional woven basket often used for carrying agricultural produce, was selected by 11 respondents as their packaging choice. While less common than cartons or plastic containers, the use of doko may reflect cultural and regional preferences, as well as a sustainable and eco-friendly approach to packaging (Ghimire & Chhetri, 2023b). A smaller number of respondents, specifically 4, used net bags as their packaging material. Net bags offer breathability and visibility, which can be advantageous for certain fruits, although they are less common in apple packaging. The presence of plastic containers, doko, and net bags highlights the range of options available to meet different packaging needs and preferences in Jumla, catering to both traditional and modern practices in apple packaging and marketing.

Transportation involved in marketing and sales

The study's exploration of transportation methods used in apple marketing and sales provides valuable insights into the logistical aspects of getting apples to market.

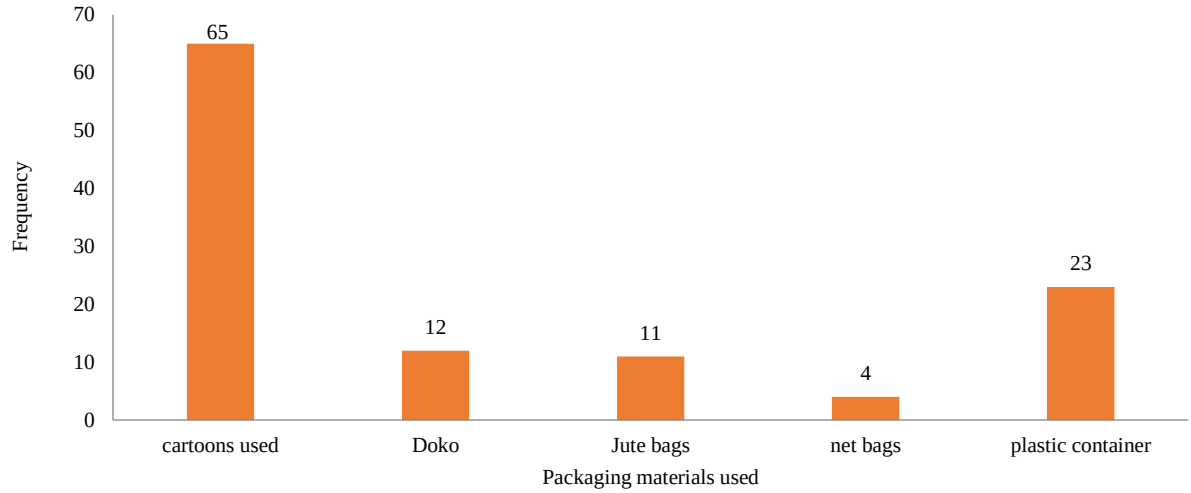


Figure 11. Frequency of respondents using different packaging materials

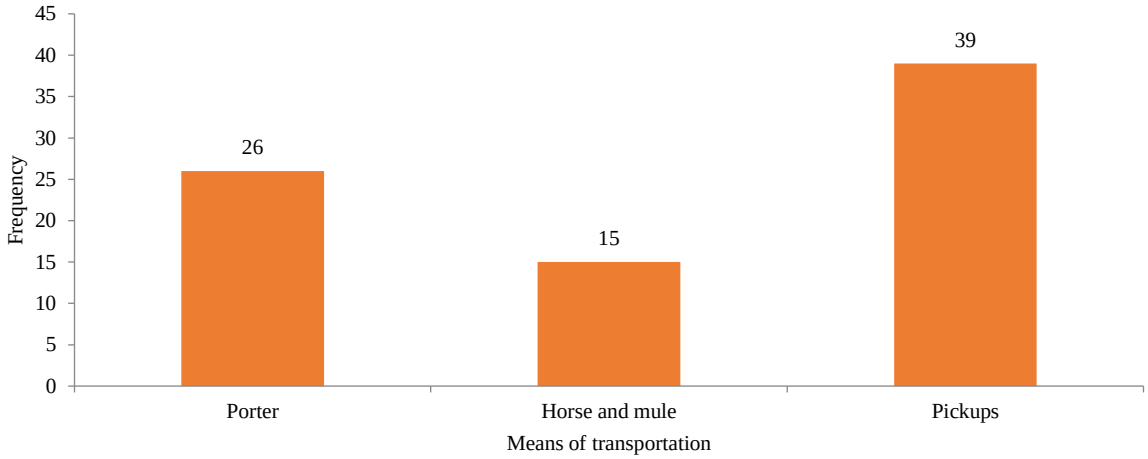


Figure 12. Transportation involved during marketing and sales of apple production

The primary mode of transportation, chosen by the majority of respondents, involved local traders who utilized pickup vehicles for the collection of apples. A significant 39 respondents relied on this mode, indicating a well-established practice in the area (Figure 12).

Pickup vehicles offer a convenient means of transporting apples in larger quantities, streamlining the movement of produce from the farm gate to market (Wani & Mishra, 2022). Additionally, respondents were observed to use porters for transportation, with 26 respondents opting for this method. Porters are valuable for navigating more challenging terrains or when access to vehicles is limited (Tade, 2022). This choice suggests the adaptability of transportation methods based on local conditions and resources. Furthermore, 15 respondents employed their own horses and mules for transportation. This traditional mode of transport can be particularly well-suited to hilly or remote regions, where animals can access areas inaccessible to vehicles (Kumaravel et al., 2022). It also reflects the resourcefulness of respondents in utilizing available assets for apple transportation. The prevalence of pickup vehicles signifies efficient market connectivity, while the use of porters and animals like horses and mules highlights the adaptability of transportation methods to suit the specific needs and geographical challenges of the region. Understanding these transportation practices is crucial for optimizing logistics and ensuring that apples reach their intended markets efficiently.

Nearness to market

Table 16 provides a comprehensive overview of the distances to the nearest market within the study area, spanning a range from 1 km to 15 km. Notably, Khalanga Bazzar, situated within the Chandanath Municipality, stands as the principal market serving the Jumla region. Importantly, the distances to Khalanga bazzar vary across the four distinct study areas considered in this research, signifying the relevance of these variations in the context of the study. The minimum distance indicates that the closest point is 1 kilometer away from Khalanga Bazar, while the maximum distance reveals that the farthest point is 15 kilometers away. On average, the distance to Khalanga Bazar is approximately 6 kilometers when considering all the surveyed locations. A study conducted in the Mustang district has established that apple farmers experience a significant increase in profit when the region is connected by road transportation (Sachs, 2017).

Problems in marketing of apple

In the initial phase of the study, a range of issues pertaining to the marketing of apples were identified and subsequently presented to the respondents for assessment. These problems were categorized into five primary domains, and respondents were requested to score them using a five-point scaling technique. The analysis of these scores revealed that the most prominent issue in apple marketing was the prevalence of middlemen, followed by challenges associated with poor transportation and market inaccessibility, insufficient storage and processing facilities, lack of market information, and lower-quality apple production (Table 17). The study by Gayak et al. (2020) identified price variation as the primary issue of apple marketing in Mustang, while our research highlighted the prevalence of middlemen as the primary marketing problem, leading to price fluctuations. These findings demonstrate a notable similarity between the two studies in terms of the challenges faced in the respective regions. The marketing system for apple crops is relatively straightforward. In a study, it was observed that the majority of the farmers prefer to utilize commission agents for the distribution of their products in the market (Gayak et al., 2020). However, issues related to the absence of marketing intelligence information were identified as the primary challenges in the marketing of apple fruits, as reported by Mehta et al. (2013).

SWOT Analysis

The respondents were tasked with evaluating five distinct prelisted factors, encompassing strengths, weaknesses, opportunities, and threats, as determined during the preliminary visits to apple farmers. The analysis of their responses revealed that the primary strength in apple production is the abundant availability of land suitable for apple cultivation, whereas a significant weakness lies in the limited investment capacity among farmers (Table 18). Furthermore, the study identified climate suitability and the rising price and demand for apples as the principal opportunities, while the incidence of insect pests and diseases emerged as the predominant threat to apple production.

Extension Activity on Research Area

Frequency of respondents receiving training and extension support

A significant majority, accounting for 77% of the respondents, reported benefiting from extension support provided by organizations offering extension services within the study area (Figure 13). This suggests that a substantial portion of the surveyed farmers actively engages with and benefits from the knowledge, training, and resources provided by agricultural extension organizations. These services can play a crucial role in disseminating best practices, new technologies, and relevant information to improve agricultural productivity and sustainability (Olorunfemi et al., 2020; Takahashi et al., 2020). Conversely, a noteworthy 23% of the respondents did not receive any form of support from these organizations. This indicates that there remains a segment of the farming community in the research area that may not have access to or engagement with extension services. Understanding the reasons behind this lack of engagement can be valuable for extension providers and policymakers to ensure that knowledge and support are accessible to all farmers, fostering equitable agricultural development.

Table 16. Distance to near market (Khalanga bazzar) of respondents in the study area.

Descriptive statistics	Minimum	Maximum	Mean
Distance to market	1 km (from Chandanath)	15 kms (from Guthichaur)	6 kms

Table 17. Ranking of problems in marketing of apples based on farmers response

Problems	Index	Rank
Prevalence of middle man	0.82	I
Poor transporation and market inaccessibility	0.79	II
Lack of storage and processing facility	0.58	III
Lack of market information	0.42	IV
Lower quality of apple	0.39	V

Table 18. SWOT of the apple production based on farmers responses.

Strength	Weakness
1. Abundant availability of apple producing land	1. Poor investment ability
2. Comparative advantage over other crops	2. High cost of production
3. Availability of farm labor	3. Unavailability of good propagating material
4. Traders at the farm gate	4. Lack of irrigation water
5. Utilization of local resources and indigenous knowledge	5. Weak bargaining power and high transportation charge
Opportunities	**Threats**
1. Climatic suitability	1. Insects, pest and diseases
2. Increasing price and demand of apple	2. Heavy rain, hailstones and waves
3. Increasing support from different government offices and NGOs	3. Stray animals
4. High yielding varieties available in market	4. Unavailability of input required
5. Improving transport accessibility	5. High price fluctuation and trader dominance

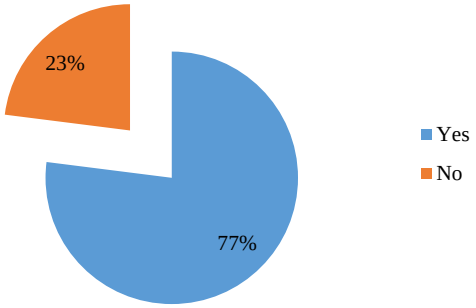


Figure 13. Frequency of respondents receiving training and extension support.

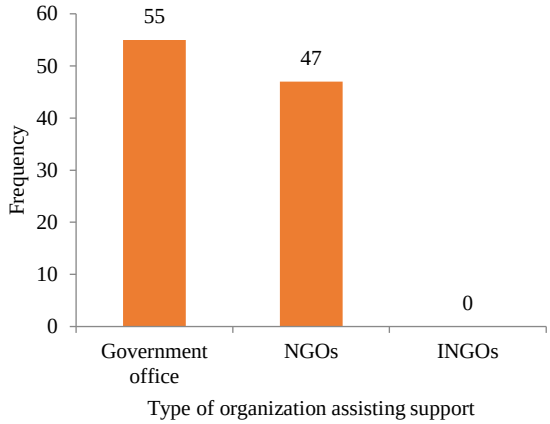


Figure 14. Types of organizations that responders receiving training and supports from

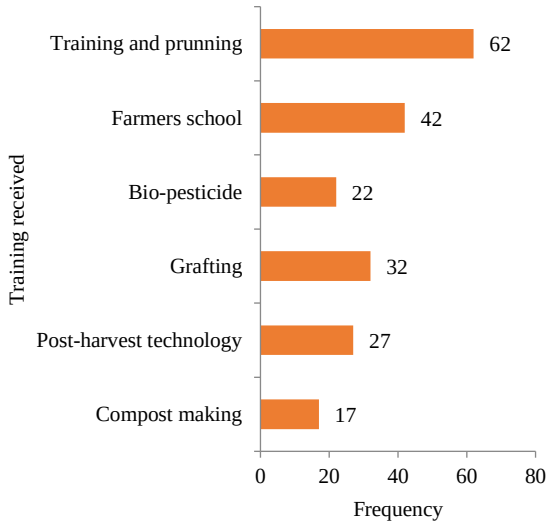


Figure 15. Types of training and services received by the respondents.

Table 19. Visit status of extension workers in the study area

Visit status	Frequency	Percentage
Yes	29	36.25
No	51	63.75
Total	80	100

Types of organization providing extension support

Figure 14 illustrates the dynamic landscape of extension support and services within the research area, with both government offices and non-governmental organizations (NGOs) actively engaged in these endeavors. Notably, the Prime Minister Agriculture Modernization Project (PMAMP) Office and the District Agriculture Development Office (DADO) emerge as key government entities at the forefront of delivering agricultural extension services. These agencies play vital roles in modernizing and enhancing agricultural practices, working closely with local farmers to promote sustainable development. Additionally, NGOs like the Karnali Integrated Rural Development And Research Centre (KIRDARC) Nepal and the Partnership Aid Center (PACE) Nepal are recognized for their significant contributions to extension support within the study area. These NGOs collaborate with communities to address agricultural challenges, offer training, and facilitate capacity-building programs. This multi-faceted approach, involving government and non-governmental entities, reflects a comprehensive effort aimed at improving agricultural practices and enhancing the livelihoods of farmers in the region (Adam & Agegnehu, 2023; Cilliers et al., 2020).

Types of training and extension support received by the respondents

The study's analysis of the types of training and extension support received by respondents reveals a multifaceted approach to agricultural education and skill development in the research area. Among the various categories of support, training and pruning emerged as the most commonly received type of assistance, benefiting 62 out of 80 respondents (Figure 15). This underscores the significance of effective orchard management practices in apple cultivation. Additionally, participation in farmers' field schools (42), grafting technology training (32), post-harvest technology (27), bio-pesticide application (22), and compost-making training (17) were also reported by respondents, reflecting a comprehensive effort to equip farmers with knowledge and skills spanning various aspects of apple farming. This diverse range of training and support categories highlights the commitment of agricultural extension services to empower farmers with the tools and expertise needed to enhance their agricultural practices, improve yields, and promote sustainable farming methods in the region (Kpienbaareh et al., 2020).

Visit of extension workers

Table 19 provides insightful data regarding the visits made by extension workers to households in the study area. The findings indicate that a limited number of households, specifically 29 out of the total 80, received visits from extension workers affiliated with various extension offices. Notably, the frequency of these visits was predominantly confined to once or twice at most, as reported by respondents. This relatively infrequent engagement with extension workers may be attributed to several challenges prevalent in the area, including difficult road conditions that hinder accessibility, dispersed housing arrangements that make reaching households challenging, administrative inefficiencies, and the rugged and uneven topographical terrain that characterizes the study area. These factors collectively contribute to the limited frequency of extension worker visits, potentially impacting the depth and reach of extension services in the region.

Conclusion

In the context of Jumla district, Nepal, where apple cultivation holds significant economic importance, this study has uncovered several vital insights. It revealed the pivotal role of apple farming in the region's livelihoods. The demographic pattern of predominantly male respondents highlights the prevailing gender dynamics in agricultural decision-making. Additionally, farmers' reluctance to cultivate the Fuji variety due to labor-intensive operations and high initial investments calls for the provision of subsidies and financial support. Despite the challenges posed by expensive labor costs, the research highlights the profitability of apple farming, with net returns exceeding production costs and high BCR. However, the sector faces threats from insects, pests, diseases, and natural factors like hailstones and snow. Moreover, despite organic certification, locally produced apples struggle to attain fair prices in the market. Post-harvest losses are substantial due to a lack of adequate knowledge about post-harvest techniques. Equitable distribution and quality of extension services are essential to address these challenges comprehensively. The study also identifies marketing hurdles, such as disease incidence and the prevalence of middlemen. To address these issues, recommendations include providing infrastructure support, ensuring equitable subsidy distribution, establishing clear criteria for nurseries, enhancing extension programs, promoting value chain linkages, improving packaging supply chains, and providing management training. Implementation of these recommendations can empower local farmers and enhance the sustainability and prosperity of the apple production sector in Jumla district.

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Declaration of competing interest

The authors declare no conflict of interest.

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