TECHNICAL REPORT

Assessing selected crops for value chain development in Bajura and Jumla districts of Nepal

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Assessing selected crops for value chain development in Bajura and Jumla districts of Nepal

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The report was commissioned by the Renewable Energy for Resilient Agri-Food Systems (RERAS) project, a joint initiative of the Government of Nepal and UNDP funded by the Royal Norwegian Embassy.

RERAS is working to increase food and nutrition security in 20 municipal governments across Sudurpashchim, Karnali, Madesh and Bagmati provinces. RERAS is contributing to the Sustainable Development Goal 2 about creating a world free of hunger by 2030 (SDG 2: Zero Hunger) and Sustainable Development Goal 7 aiming to ensure universal access to affordable, reliable, sustainable, and modern energy by 2030 (SDG 7: Affordable and Clean Energy) in Nepal's most vulnerable regions.

The project aims to increase food and nutrition security by enhancing agricultural productivity by leveraging affordable energy solutions, empowering local farmers through modern technology, and partnering with government bodies and national organisations. The strength of RERAS lies in its diverse partnerships, bringing together expertise in climate resilient agriculture, off-grid renewable energy, home-grown school feeding and community empowerment.

RERAS/UNDP and ICIMOD extends special thanks to the project and ICIMOD teams for their valuable contributions to the production of this report.

On behalf of the Director General of ICIMOD and Resident Representative of UNDP we extend our sincere gratitude to the experts and organisations for their valuable intellectual contributions. Our special thanks are due to the authors, reviewers, and editors who made this report possible.

Foreword

Karnali and Sudurpaschim provinces in the western and far-western part of Nepal are the among the most remote, mountainous and historically underserved regions of the country. Both provinces have diverse agroecological conditions, strong dependence on agriculture for livelihoods, and rich indigenous farming traditions. At the same time, these regions face persistent structural constraints, including fragmented landholdings, labour shortages due to outmigration, difficult terrain, limited infrastructure, and limited market access. These long-standing challenges are further intensified by climate change, with rising temperatures, erratic rainfall, increased frequency of droughts, floods, and landslides, and growing incidences of pests and diseases. Together, these pressures are undermining agricultural productivity, livelihoods, and food security in some of the country's most vulnerable areas.

Food insecurity remains a critical concern in both provinces, with Karnali and Sudurpaschim recording some of the highest levels of vulnerability. Subsistence oriented farming systems, limited adoption of improved technologies, high pre- and post-harvest losses, and weak value chain integration continue to constrain farmers' ability to secure stable incomes and adequate food supplies. Addressing these challenges requires moving beyond isolated production focused interventions toward integrated approaches that strengthen agricultural systems from production to markets, while building resilience to climatic and non-climatic risks.

This report by the Renewable Energy for Resilient Agri-Food Systems (RERAS) project presents an in-depth assessment of the factors shaping agricultural productivity and food systems in the remotest Jumla and Bajura districts of the Karnali and Sudurpashchim provinces, respectively. Drawing on secondary data, including meteorological analysis as well as field-based research, involving key informant interviews and focus group discussions, this report documents observed climate trends and farmers' experiences of climate related and structural constraints. The findings highlight clear warming trends, increasing climate variability, and a range of non-climatic barriers that together limit the performance of local agricultural systems.

The report adopts a value chain development approach to identify opportunities for strengthening climate resilient agriculture in these mountain districts. By focusing on high potential crops, including indigenous varieties well adapted to local conditions, the analysis identifies key bottlenecks and entry points across production, post-harvest handling, processing, storage, and marketing. The study underscores the importance of climate smart practices, community-based seed systems, improved post-harvest infrastructure, stronger market linkages, and supportive policies to enable farmers to move beyond subsistence farming and participate more effectively in higher value markets.

We believe that the evidence and recommendations presented in this report will be valuable for policymakers, development practitioners, and private sector actors working to strengthen food security, rural livelihoods, and climate resilience in the mountainous regions of Nepal. The report highlights the need for coordinated, locally grounded, and inclusive interventions that place farmers and value chain actors at the centre of agricultural transformation.

We extend our sincere appreciation to the Government of Nepal, the Royal Norwegian Embassy in Kathmandu, local communities of Jumla and Bajura districts, our local partners and the research team, whose knowledge and participation made this study possible. We are confident that this report will serve as a useful resource to inform policy dialogue, guide investment, and support action toward building resilient and sustainable agricultural value chains in the mountain regions of Nepal.

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Director General, ICIMOD

Kyoko Yokosuka
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Acronyms and abbreviations

ADO	Agriculture Development Office
AKC	Agriculture Knowledge Centre
CBO	Community-Based Organisation
CRA	Climate-Resilient Agriculture
DHM	Department of Hydrology and Meteorology
FGD	Focus Group Discussion
FMTC	Food Management and Training Corporation
FYM	Farm Yard Manure
HDI	Human Development Index
HKH	Hindu Kush Himalaya
INGO	International Non-Governmental Organisation
IPM	Integrated Pest Management
KII	Key Informant Interview
MOALD	Ministry of Agriculture and Livestock Development
NARC	Nepal Agricultural Research Council
NGO	Non-Governmental Organisation
SME	Small and Medium Enterprise

Executive summary

Karnali and Sudurpaschim provinces in Nepal, are predominantly dependent on agriculture for livelihoods. However, subsistence farming faces significant challenges, including fragmented landholdings, male labour outmigration, complex terrain, poor market access, limited infrastructure, and weak post-harvest management. These constraints, combined with low adoption of modern technologies and traditional farming practices, limit productivity and the potential for commercialisation. Climate change further exacerbates these challenges. Rising temperatures, erratic rainfall, reduced snowfall, frequent droughts, floods, landslides, and increased pest and disease incidence have disrupted agricultural cycles, reduced soil moisture, and affected crop phenology. Current estimates indicate that 21.3% of the population in the mountain regions experience moderate to severe food insecurity, with Karnali and Sudurpaschim provinces showing the highest incidences.

This study focuses on Jumla (Karnali Province) and Bajura (Sudurpaschim Province) districts, selected for their challenging topography, climate vulnerability, high levels of food insecurity, and low human development. The study uses both primary and secondary data collection methods, including secondary data on temperature and precipitation and crop production data, as well as primary data gathered through field visits, Key Informant Interviews (KIIs), and five Focus Group Discussions (FGDs), one in each of the five municipalities across Jumla and Bajura. Meteorological analysis shows statistically significant increases in temperature in both districts, while precipitation patterns remain erratic. Farmers report visible climate impacts, including droughts, irregular rainfall, and increased pest infestations, alongside non-climatic barriers such as labour shortages, limited extension services, and poor infrastructure.

The study applies a value chain development approach to identify opportunities for strengthening climate-resilient agricultural systems. High-potential crops for value chain development are identified through participatory evaluation methods, including Jumli Marshi rice, beans, potato, apple, walnut, vegetables, millet, and buckwheat. Key challenges across these value chains include limited input supply, post-harvest losses, inadequate processing and storage, poor market access, price fluctuations, and dependence on intermediaries. Opportunities include strengthening community seed banks, promoting climate-smart practices, developing processing infrastructure, improving market linkages, supporting direct sales, implementing branding and certification, and leveraging agrotourism.

The findings highlight the need for integrated interventions to boost productivity, food security, and livelihoods, including climate-resilient farming, support for indigenous crops, improved storage and processing, stronger market access, and financial and technical assistance. A holistic value chain approach can help farmers move beyond subsistence, increase incomes, and promote sustainable, high-value agriculture in Jumla and Bajura.

CHAPTER 1

Introduction

1.1 Background

The mountain regions of the Hindu Kush Himalayas (HKH) are predominantly agriculture dependent for livelihood (Tiwari, 2000). But mountain agriculture, especially crop cultivation, encounters several challenges that restrict farming at a subsistence level. The agricultural landscape in the mountain regions of Karnali and Sudurpaschim provinces of Nepal is characterised by diverse topography, heavy reliance on subsistence farming, and traditional farming practices (Khadka et al., 2023).

An intrinsic challenge for agriculture in these regions is the fragmented and small size of land holdings – average landholding size of mountain farmers, estimated at 0.42 ha, potentially constrains the scope and scale of commercialisation (Gauli et al., 2022). Another factor is the high outmigration of the male labour force, which, combined with the increasing feminisation of agriculture, deters agricultural expansion, including shifts to high-value crops. Outmigration and labour shortages have left thousands of hectares of cultivable land barren (Pandey et al., 2019; Tamang et al., 2014).

Disadvantageous geographical location and complex terrain hinder access to marketing and distribution infrastructure, leading to high or prohibitive transportation, transaction, and search costs. These constraints prevent farmers from participating in non-local or distant markets, and when combined with limited extension services, lack of proper storage facilities, and weak post-harvest management, they restrict agricultural productivity and market engagement (K. P. Gautam, 2024). Limited market access and a lack of innovative technology also hinder farmers' ability to increase yields, manage inputs efficiently, adopt new crops, and adapt to climate challenges (Fuglie et al., 2020).

The potential for commercialisation is further weakened by the escalating effects of climate change, including rising temperatures, unpredictable rainfall patterns, more frequent droughts, floods, and landslides, as well as increased pest and disease outbreaks (Khadka et al., 2023; Risal et al., 2022). The changing climate has led to increased incidences of pests and diseases, loss of agro-biodiversity, and soil degradation, diminishing crop resilience, and increasing food insecurity (Kafle, 2022; Upadhyay, 2012). These impacts, along with the decline of agro-biodiversity from a shift away from indigenous crops such as maize, millet, buckwheat, and potatoes, have further suppressed production and productivity (Adhikari et al., 2017; S. Thapa & Hussain, 2021).

In this context, subsistence production often fails to provide reliable and adequate food supply to meet households' basic requirements. In Nepal's mountain regions, for instance, about 21.3% of the population face moderate to severe food insecurity (National Planning Commission, 2021) with the highest incidence of rural food insecurity recorded in the Karnali Province (36%) followed by that in the Sudurpashchim Province (13.2%) (Nepal Demographic and Health Survey, 2023). According to the United Nations (World Food Programme, 2024) Karnali and Sudurpashchim provinces recorded 22.2% and 16.9% of poor to borderline food consumption.

While adverse supply shocks (low productivity and variable yields) are a significant driver of food insecurity, price shocks can worsen the situation. Farmers, who are also food buyers, face a double burden – food price inflation alongside low and uncertain income. In South Asian agricultural markets, asymmetric price transmission is a key driver of low and unstable farm incomes. Market inefficiencies resulting from poor infrastructure, weak or absent market advisory services including

price information, and inadequate governance hinder farm prices from changing proportionately with consumer prices.

Hence, raising agricultural production above subsistence level and increasing farmers' incomes requires interventions at both farm and post-farmgate levels. We have therefore adopted a value chain development approach to identify and recommend holistic intervention actions.

According to the United Nations Food and Agriculture Organisation, a value chain in agriculture identifies the set of actors and activities that bring a basic agricultural product from production in the field to final consumption, where value is added at each stage (such as processing, packaging, storage, transport, and distribution)(Miller et al., 2010). This approach helps assess the distribution of costs and returns across different actors, starting from the producer, and understand price transmission between the upstream (farm sector), midstream (trading, wholesaling, processing), and downstream (retail and consumers) segments. It also allows the identification of opportunities to enhance farmers' participation in the value chain.

Therefore, the value chain approach provides insight into the distribution of costs and returns or margins across the various actors in the chain, starting from the producer. It also helps in understanding the process of price transmission between the upstream (farm sector), midstream (trading, wholesaling, processing), and downstream (retail and consumers) segments of the value chain, while simultaneously identifying opportunities to engage farmers more effectively in the chain.

1.2 Rationale

Karnali and Sudurpashchim provinces are among the most vulnerable regions to food insecurity, making it critical to strengthen existing crop value chains. The overarching objective is to ensure a sustainable and climate-resilient food system that supports the livelihoods of the local population and ensures food security. However, a significant knowledge gap remains in integrating traditional farming practices with modern climate-resilient approaches. Research on the impacts of climate change on indigenous crops and potential adaptive solutions is also limited.

Promoting indigenous crops alongside adaptive farming techniques can help improve food availability and resilience. Yet, challenges such as poor market access, inadequate infrastructure, and high post-harvest losses hinder their full potential. Strengthening agribusiness opportunities and establishing resilient food value chains, along with processing industries, can enable farmers to move beyond subsistence farming, increase incomes, and create local employment, thereby contributing to poverty reduction and improved food security (Adhikari et al., 2017). Additionally, identifying and developing agribusiness opportunities can enable farmers to move beyond subsistence farming, increase their incomes, and reduce poverty and food insecurity. When supported by climate-resilient agricultural practices, such opportunities can contribute to developing sustainable food value chains that drive long-term growth in agribusiness farming, strengthen food security, and create effective pathways for poverty alleviation (Neven, 2014).

Recognising the distinct climatic, agro-ecological, and economic conditions of these mountain regions, this report's value chain development approach prioritizes strengthening indigenous crop varieties for a climate-resilient food system, identifying investment opportunities in agricultural research and post-harvest infrastructure, and shaping policies that support local food systems while empowering value chain actors—especially farmers.

1.3 Objectives

This report aims to assess the climatic and non-climatic factors affecting agricultural productivity in Jumla and Bajura. Its specific objectives are as follows:

1. Evaluate and identify indigenous and other crops for their capacity to develop climate-resilient value chains

2. Conduct a detailed assessment of the value chain for the identified crops

3. Analyse existing storage mechanisms and propose innovative solutions to minimise production and post-harvest losses and enhance value addition

CHAPTER 2

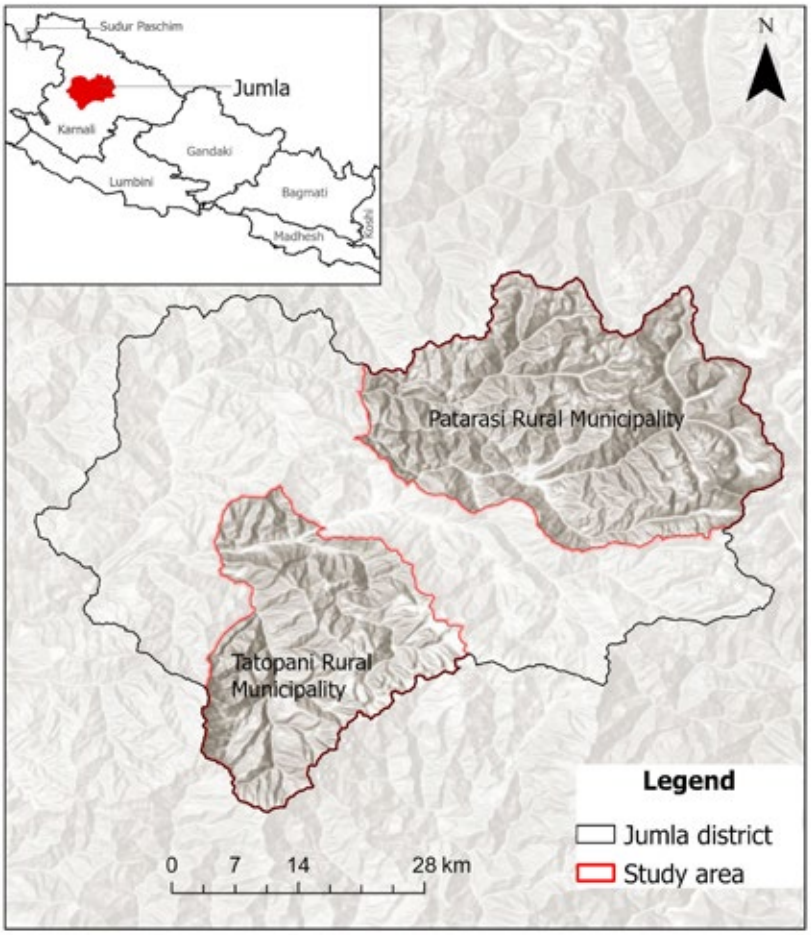
Selection of study locations and research methodology

2.1 Study area

Jumla in Karnali Province and Bajura in Sudurpaschim Province were selected as the focus of this study due to their unique and difficult topography, vulnerability to climate change and food insecurity, and low level of human development in the region. Further, five rural municipalities were identified – with two (Patarasi and Tatopani) from Jumla and three (Budhinanda, Triveni, and Swamikartik) from Bajura districts - as study areas.

Jumla is located in the northwest region of Nepal, at an elevation ranging from 915 to 4679 meters above mean sea level (masl) (National Planning Commission, 2014). It is one of the remotest and least developed districts of Karnali Province, with a human development index (HDI) of 0.409. Around 45% of the population in this district depend on agriculture for income and livelihood, with nearly 90% of the agrarian population practising subsistence farming to support own household food consumption in the main (Thapa & Hussain, 2021). Communities living in Jumla are highly exposed to the vagaries of climate change with the rural municipalities of Tatopani and Patarasi being among the

FIGURE 1 **DISTRICT MAP OF JUMLA**

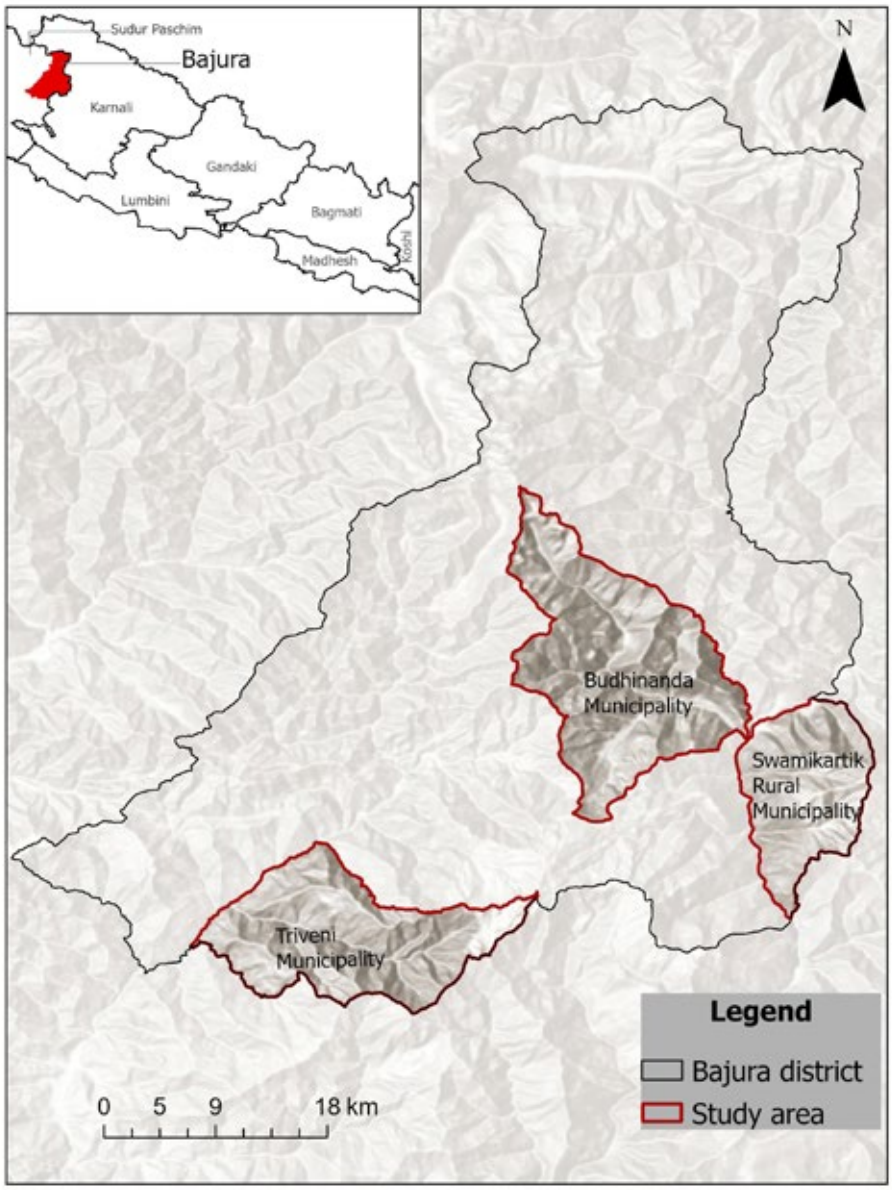


district's hotspots of climate-related disasters extreme events that directly affect agricultural production and food security.

Bajura is in the far-west region of Nepal, in the Sudurpaschim Province, lying between 300 to 6400 masl. The district has an HDI of 0.364 (National Planning Commission, 2014). Despite agriculture being the mainstay of income and livelihood in Bajura given limited alternative income sources due to a lack of access to road and other services, Bajura has one of the highest rates of food poverty in Nepal with 65% –80% of the total population in the district living in food poverty (Bajura - PHASE Worldwide, n.d.).

Bajura has a complex geography and is ranked as the second most vulnerable district in terms of its susceptibility to extreme weather events and lack of capacity to adapt—a challenge that is compounded by its socioeconomic and geological characteristics (MoFE, 2021). Addressing food insecurity is crucial in Bajura. For this study, Triveni Municipality, Budhinanda Municipality, and Swamikartik Rural Municipality were selected based on an initial scoping assessment and pilot activities.

FIGURE 2 **DISTRICT MAP OF BAJURA**



2.2 Data sources and collections methods

The study employed both primary and secondary methods for data collection. Secondary data on temperature and precipitation for the studied districts were collected from the Department of Hydrology and Meteorology (DHM), while the production data for the identified crops was extracted from the "Statistical Information on Nepalese Agriculture" report published by the Ministry of Agriculture and Livestock Development (MOALD) 2023/24.

Primary data was collected through Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and field visits. A total of five FGDs were conducted with one in each of the five municipalities across Jumla and Bajura.

The FGDs were conducted with local farmers where they provided insights on crop cultivation, including the impacts of climatic and non-climatic factors, and local adaptation strategies. The FGDs and KII participants were engaged in a hazard ranking exercise, where they assessed and ranked three hazards based on their impact on the municipalities. A total of 38 KIIs were conducted with a diverse range of stakeholders, such as local farmers, representatives from national and international NGOs, community-based organisations (CBOs), cooperatives, women's groups, government officials, and value chain actors like agro vets, collectors, transporters, producers, wholesalers, traders, and banks. The interviews included in-depth discussions with value chain actors to examine post-harvest losses, storage issues, and the effects of climatic variability on agricultural production.

CHAPTER 3

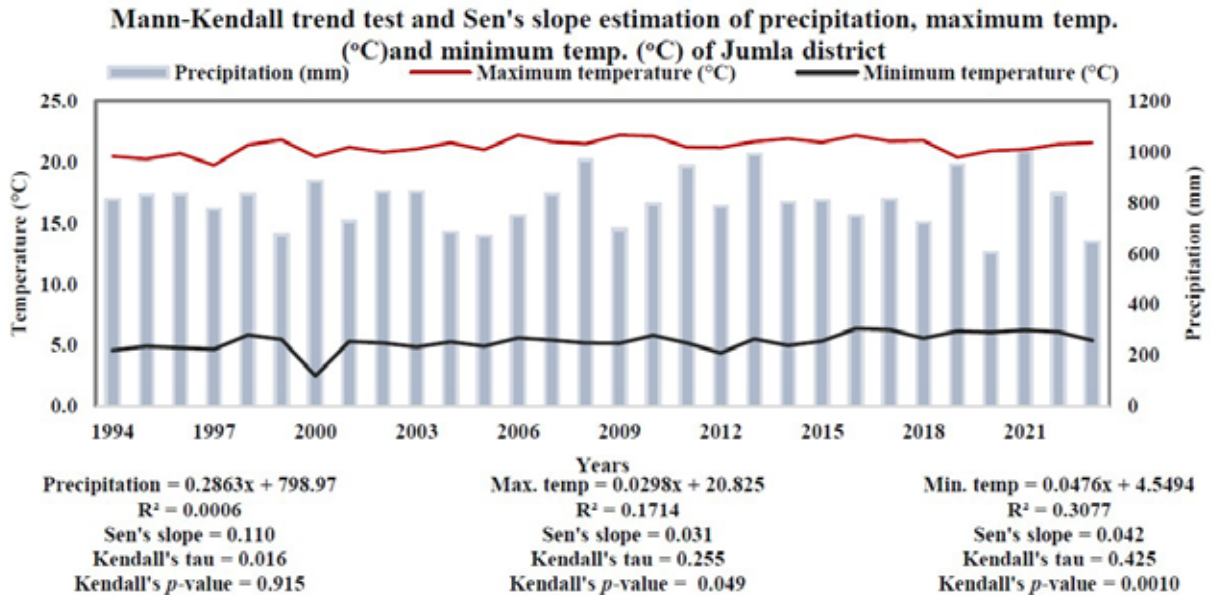
Findings

3.1 Meteorological trend analysis using DHM data

A trend analysis of temperature and precipitation for districts was conducted based on the secondary data received from DHM. To analyse the trends, the Mann-Kendall Trend Test was employed to assess the significance of trends in time series data. The Mann-Kendall test is a non-parametric statistical test commonly used to analyse climatic trends in time-series data (Salami et al., 2014). Sen's Slope Estimator, another non-parametric method, was used to calculate the rate of change in the meteorological data (Sen, 1968).

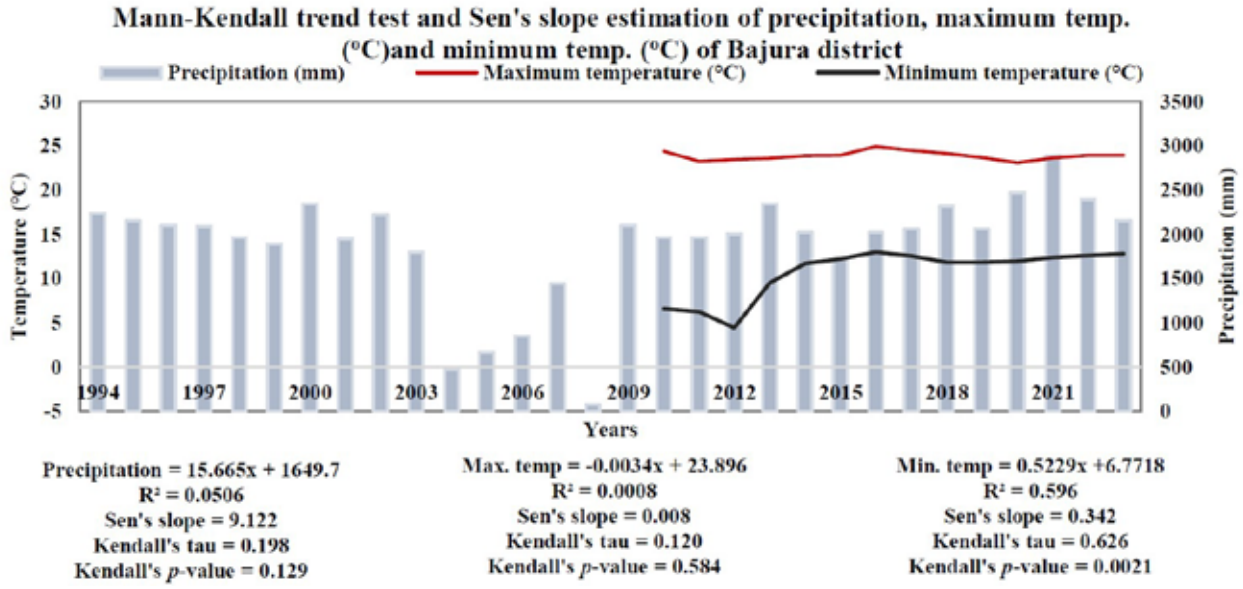
The trend analysis of the maximum and minimum temperatures of Jumla revealed a statistically significant increasing trend in both maximum and minimum temperatures (Figure 3). The maximum temperature showed an increase from 20.4°C in 1994 to 21.6°C in 2023, while minimum temperature rose from 4.6°C in 1994 to 5.4°C in 2023, showing a stronger upward trend in comparison to the maximum temperature. Although precipitation in Jumla shows variability, it does not exhibit a statistically significant trend.

FIGURE 3 **ANNUAL MAXIMUM AND MINIMUM TEMPERATURE, AND PRECIPITATION OF JUMLA**



The maximum temperature recorded in Bajura shows slight variability with a relatively flat trend over time; it was 24.4°C in 2010 and 23.9°C in 2023 with no statistical significance (Figure 4). The minimum temperatures show a significant increasing trend from 6.6°C to 12.7°C, over the same period. There were fluctuations in precipitation over the years, from 1994 to 2023, with an overall increase in recent years (2020, 2021 and 2022). This trend is not statistically significant.

FIGURE 4 **ANNUAL MAXIMUM AND MINIMUM TEMPERATURE, AND PRECIPITATION OF BAJURA**



3.2 Perceptions of climate change

The responses from the FGDs and KIIs were used to conduct a perception-based analysis for visible signs of climate change. The analysis considered the impact of climate change on agriculture systems and identified value chains (see section 4). The perception analysis also considered the impact of non-climatic factors such as government policies, socio-economic conditions, migration, infrastructure, technology accessibility, etc. on agriculture.

Meteorological data indicates rising temperatures and erratic precipitation patterns in Jumla and Bajura. Farmers perceive these changes in shifting agricultural cycles, water availability, and extreme weather events. FGD and KII participants suggested that climate change impacts were visible in the form of extreme weather events and disrupted weather patterns in both Jumla and Bajura. The visible signs of climate change in Patarasi and Tatopani municipalities of Jumla highlight the impact on agriculture, water resources, and weather patterns, closely aligning with the meteorological trends in Jumla. Participants from these municipalities reported that rising temperatures, erratic rainfall, increased drought, and decreased snowfall have led to reduced soil moisture, drying water resources, and stressed agricultural systems.

These observed changes in Jumla correspond with the increase in both maximum and minimum temperatures from 1994 to 2023. With the rise in minimum temperatures, there have been warmer nights and reduced cold extremes, ultimately leading to snowfall disruptions. Farmers reported that they have seen disruptions in the production of apples and various staple crops .

In Bajura, participants reported decreased snowfall, erratic rainfall, and increased drought as visible signs of climate change. There has been a drought in Bajura for the past seven to eight years (Kafle, 2022). Farmers noted that rainfall is irregular, and setting up irrigation facilities is challenging given the difficult terrain. In Budhinanda Municipality, participants reported that drying water resources have disrupted agricultural patterns, and dry landslides have damaged agricultural land. Particularly in Muktikot, reduced snowfall has affected apple tree dormancy. Reduced snowfall and warmer winters reduce the chilling hours and result in apple orchards being less productive (Kumar et al., 2016).

Several wards in Triveni Municipality have experienced increased drought and water scarcity, further hampering agricultural productivity. Despite district-wide data indicating increased precipitation, localised drought conditions and erratic rainfall patterns continue to prevail in specific areas of Bajura and Jumla.

The findings of the hazard ranking exercise conducted during the FGDs revealed that all municipalities in Jumla and Bajura face drought and pest infestations. Irregular rainfall in Patarasi and Swamikartik municipalities has led to disrupted planting schedules, reduced water availability for crops, and increased vulnerability to soil erosion, posing a further challenge to farmers. Floods and landslides in Budhinanda Municipality destroyed agricultural land and disrupted irrigation systems. These hazards severely impact agricultural systems in Jumla and Bajura, highlighting the urgent need for climate-resilient agricultural practices.

TABLE 1 **HAZARD RANKING PER MUNICIPALITY**

District	Municipalities	Top three hazards
Jumla	Tatopani Rural Municipality	Drought, pest infestation, forest degradation
	Patarasi Rural Municipality	Drought, pest infestation, irregular rainfall
Bajura	Budhinanda Rural Municipality	Drought, pest infestation, flood, landslide
	Swamikartik Rural Municipality	Drought, irregular rainfall, pest infestation
	Triveni Municipality	Drought, hailstorm, pest infestation

SNOWFALL IN BUDHINANDA MUNICIPALITY

3.3 Impact of climate change on agriculture

A majority of FGD participants and key Informants reported that climate change has impacted agricultural productivity in the region. In 2015/16, a severe drought burned vegetable seedlings and reduced vegetable production, while intense rainfall caused massive floods that swept away large portions of agricultural land in Patarasi Rural Municipality. Drought has also affected the genetic quality of previously resilient crops like foxtail millet, proso millet, and buckwheat. In Tatopani Rural Municipality, farmers have experienced decreased soil moisture, wilting of crops and appearance of new pests and diseases, and change in the phenology of crops.

Similarly, in Bajura, reduced snowfall led to increased soil insects and diminished winter dormancy in apples. In Budhinanda Municipality, erratic rainfall caused landslides, destroying almost 2 acres of cultivated land across 12 households in ward 1. Swamikartik Rural Municipality features diverse landscapes: lower plains for mangoes and rice, intermediate elevations for onions, bananas, and walnuts, and higher regions for apples and beans. Increased temperatures and erratic precipitation have caused some crops to shift their growing areas from low to high elevations, while others have been lost. Apple-growing areas are being replaced by walnut cultivation due to the walnut's preference for warmer temperatures. In Triveni Municipality, farmers experienced changes in sowing/planting times and increased incidence of pests, diseases, and weeds.

3.4 Impact of non-climatic factors

In both Jumla and Bajura, farmers are unaware of modern agricultural practices and face barriers to market information. Farmers, particularly women, lack access to credit and other financial services. Although cooperatives, microfinance institutions, and banks offer loans and credits to farmers, high interest rates often make loans unaffordable. Additionally, a lack of financial literacy often

makes these facilities inaccessible, especially for smallholder farmers. Limited access to resources and knowledge regarding climate-smart farming makes vulnerable farmers less likely to adopt climate-resilient farming practices (Neupane et al., 2022).

Infrastructure development remains a key challenge in this region. Insufficient supply of high-grid electricity severely affects agricultural activities such as irrigation, processing, and storage. Inadequate road connectivity limits farmers' access to markets and makes internal travel expensive and time-consuming. In Budhinanda Municipality, the local market at Kolti is not connected to a proper road and does not offer competitive pricing, preventing farmers from earning an income from their produce. On the other hand, in Patarasi and Tatopani Rural Municipalities, improvements in road and transportation have aided farmers in accessing and transporting farm supplies and produce. However, the expansion of roadways has led to land fragmentation and damage to irrigation canals.

There is a scarcity of modern technologies and agricultural materials and tools in local markets and agrovets. This results in a knowledge gap, limiting farmers' ability to adopt modern technologies. In the absence of technical assistance and subsidies from the government, it is difficult for farmers to improve productivity and mitigate climate risks.

Outmigration is a common trend across all municipalities in Jumla and Bajura. The youth population is migrating abroad or to urban areas due to the perceived lack of prospects in traditional agriculture (Yogi et al., 2025). Migration of male farmers has also led to increased feminisation of agriculture and shortage of labour. Women face challenges due to limited resources and support, limiting their ability to transition to higher-value crops that could enhance income stability and ensure food security (Slavchevska et al., 2020).

Farmers in this region do not have adequate access to quality fertilisers, seeds and essential agricultural equipment. Due to the geography of these municipalities, there is sparse distribution of agrovets. Irregular availability of agricultural inputs hinders effective farming practices.

3.5 Adaptation practices against climatic and non-climatic factors

After identifying the relevant climatic and non-climatic factors affecting the value chains in the study areas, discussions were held with community members to understand their adaptation practices.

3.5.1 ADAPTATION PRACTICES AGAINST CLIMATIC FACTORS

Farmers' adaptation practices for crops included strategies for improving yield, managing soil and water, and controlling weeds. Each of these areas involved different techniques tailored to specific challenges.

Respondents were found to be more inclined toward practices to optimise yield (29%), followed by practices for integrated pest management (IPM) (28%), practices for soil management (18%), practices for water management (17%), and practices for weed management (8%). Among the highly preferred adaptation strategies are crop rotation, followed by using botanical pesticides and crop diversification under insect management practices.

3.5.2 ADAPTATION PRACTICES AGAINST NON-CLIMATIC FACTORS

Non-crop related adaptation practices consisted of migration for work, buying from food management and trading corporation (FMTC), regular trainings, credit facilities, crop insurance, community investment in renewable energy sources, and following early warning system.

Respondents were found to be more inclined toward migration for work (25%), followed by buying from FMTC (21%), taking regular trainings on different sources of income generation (21%), taking credit facilities (16%), following early warning system (13%), and crop insurance (6%).

CHAPTER 4

Crop identification for value chain development

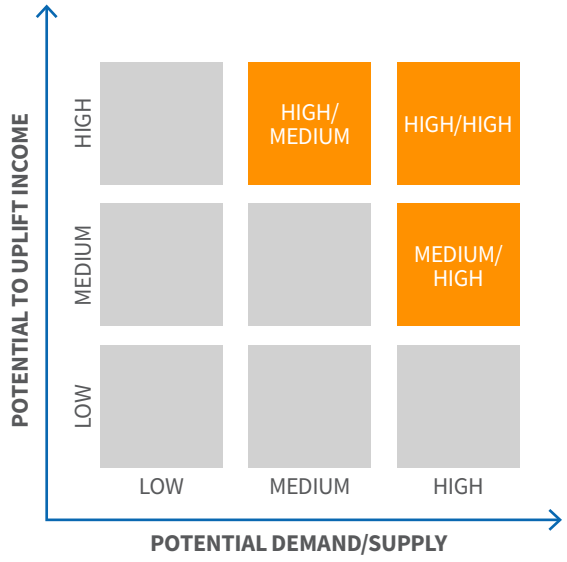
Value chain assessment began with the selection of crops. The process used a participatory approach where participants of the FGDs and KIIs identified major crops cultivated in their municipalities and ranked these crops based on economic value, market demand, and climate resilience.

This approach sought to build a common understanding among participants for identifying potential value chains (M4P, 2008). The longlist comprised of commonly grown crops in the selected municipalities is presented below.

Tubers (potato, yam), **Vegetables** (capsicum, carrot, chilli, cucumber, onion, pumpkin, radish, red pepper, spinach, tomato, turnip) **Grains** (barley, buckwheat, maize, millet, rice, wheat) **Indigenous Crops** (foxtail millet, Jumli Marshi rice) **Soybean**, **Vegetable Seeds**, **Ginger/Turmeric**, **Spices** and **Herbs** (round chilli, cardamom, garden cress, star fruit, perilla seeds, garlic) **Oilseeds** (sunflower, mustard) **Fruits** (apple, apricot, sour citrus, kiwi, lemon, sweet lemon, olive, peach, plum, soapberry) **Nuts and Seeds** (almond, sesame seed, walnut, peanut) **Sugarcane**, **Beans** and **Pulses** (beans, lentils, pea) **Specialty Crops** (wild Himalayan cherry, rhododendron, amaranth, stinging nettle, hog plum, spinach, turnip, mustard greens, wild garlic/ onion, mushroom, tamarind)

The shortlisted crops were selected using two key evaluation tools: the Attractiveness Matrix and the Score and Ranking method.

FIGURE 5 **ATTRACTIVENESS MATRIX**



Source: Joshi & Gurung, 2009

The Attractiveness Matrix evaluated crops as low, medium or highly attractive based on their market demand potential and the potential to raise farmers' income (Joshi et al., 2016; Joshi & Gurung, 2009). Priority was given to crops that fell into high/high or high/medium categories (refer to Fig 5).

The Score and Ranking Method (Joshi et al., 2016; Walker et al., 2021), further evaluated the crops based on five criteria namely, (i) market demand and local supply; (ii) production and productivity; (iii) value addition and impact on the local economy; (iv) consumption behaviour and preferences; and (v) rural employment and value chain linkage. Each criterion was assigned an equal weight of 20%, and the crops were ranked on a scale of 1 (very low) to 5 (very high) (see Table 2). The assessment followed a participatory method (Walker et al., 2021) wherein stakeholders ranked the crops based on their perception of the crop's potential with respect to each of the evaluation criterion.

TABLE 2 **SCORE AND RANKING METHOD FRAMEWORK**

Main Criteria	Weight (wt %)	Sub-criteria	Weight (wt %)	Value chain 1		Value chain 2	
				Score	Weight score	Score	Weight score
Market demand and local supply	20%	Existing and potential market demand	10	5	(wt.%*score) = 0.5	5	0.5
		Production potential to meet the market demand	10	5	0.5	4	0.4
Production and productivity	20%	Potential to increase production areas	10	5	0.5	4	0.4
		Enhancement of productivity	5	4	0.2	5	0.25
		Access and adoption of technology for productivity	5	4	0.2	4	0.2
Value addition and local economy	20%	Local processing and marketability	5	4	0.2	4	0.2
		Economic impact on local communities	5	5	0.25	5	0.25
		Opportunity to deploy energy (for value chain development)	5	3	0.15	4	0.2
		Opportunity for value addition along the VC	5	3	0.15	5	0.25
Consumption behaviour and preferences	20%	Promotion of iIndigenous food diversity	10	4	0.4	4	0.4
		Alignment with consumption trends	10	2	0.2	5	0.5
Rural employment and value chain linkage	20%	Reduction of imported food consumption	10	5	0.5	5	0.5
		Extent of benefit to women and minority communities (employment)	5	5	0.25	5	0.25
		Linking with other value chains (e.g., tourism)	5	5	0.25	4	0.2

Weight (%): Represents the importance of each main criterion and sub-criterion in the overall evaluation.
Sub-criteria: Detailed aspects to be considered under each main criterion.
VC1, VC2, VC3, etc.: These columns will be used to score each value chain against the sub-criteria.

Source: Joshi et al., 2016; Walker et al., 2021

Based on the Attractiveness Matrix and the Score and Ranking responses gathered through the participatory surveys, a short list of five crops per municipality was drawnup based on the market potential, local production capabilities, value addition to the economy, consumption preferences, and value chain linkage of the selected crops (Table 3).

TABLE 3 **SHORTLISTED CROPS FOR VALUE CHAINS**

	Districts	Municipalities	List of value chains
Cluster 1	Jumla	Tatopani RM	Jumli Marshi rice, buckwheat, apple, walnut, beans, potato, vegetables
		Patarasi RM	
Cluster 2	Bajura	Budhinanda RM	Apple, potato, beans, paddy, vegetables, onion, walnut, banana, soybean, millet, maize

Based on stakeholder consultations, the excluded crops were not prioritised because, regardless of farmers' landholding size, they are generally cultivated for household consumption with minimal surplus for market-oriented production. They also have a lower comparative advantage than the shortlisted crops for value chain in in terms of demand, value addition potential, and price competitiveness. The shortlisted crops were selected for their mountain specific qualities such as unique flavor and resilience to high altitude conditions that enhance their competitiveness in niche markets, emphasizing the importance of leveraging the unique agroecological conditions and traditional knowledge of mountain regions to develop high value, climate resilient products. (Joshi et al., 2016). This further screening of value chain commodities was also supported by the four-cell analysis (Annex 12), done as part of developing the Climate Resilient Agriculture (CRA) farming plan, where the selected crops were categorised as potential crops for commercialisation (i.e., cultivated in larger areas by many people and cultivated in larger areas by fewer people).

4.1 Area, production, productivity of the selected crops

In Jumla, high-potential crops such as beans, apples, potato, buckwheat and vegetables have shown several significant trends. Productivity of beans has increased. Apple productivity had an initial drop in 2072/73 B.S . [2015/16], however, it increased and stabilised in 2078/79 B.S. [2021/22]. Walnut production has stabilised with a drop in 2074/75 B.S [2017/18]. Potato cultivation has increased in both area and productivity, while buckwheat and vegetables have shown significant growth in both yield and cultivation area (Statistical Information on Nepalese Agriculture, 2077/78 [2020/21 2022]).

In Bajura, the present status of high potential crops such as beans, apple, walnut, and millet, show both growth and variability. Beans have experienced a decline in both production and productivity in recent years, due to soil degradation and erratic rainfall patterns. Although apple production increased in recent years, there has been a variation in productivity after peaking in 2020/21. Walnut production stabilised with improved productivity. Millet cultivation surged, with a significant increase in both area and production. Potato cultivation continues to maintain high production levels, and vegetable productivity has generally increased, despite some fluctuations (Statistical Information on Nepalese Agriculture 2077/78 [2020/21, 2022]).

4.2 Impact of climate change on selected crops and adaptation practices

Climate change has significantly affected the production of selected crops. Rising temperatures, erratic rainfall, reduced snowfall, and increased incidence of pests and diseases have disrupted crop cycles, reduced yields, and stressed farming systems.

TABLE 4 **IMPACT OF CLIMATE CHANGE ON IDENTIFIED CROPS AND ADAPTATION PRACTICES**

Crops	Observed climate change impacts	Adaptation practice
Jumli Marshi rice	Increased prevalence of rice borers and bugs, with an infestation rate of 15% in Jumla as well as blast fungus disease (Budha, 2023; R. Gautam et al., 2022). Hailstorms during the harvesting period led to lodging and shattering of the tall Marshi rice variety, reducing grain yield (Ghimire, 2017). Delays in monsoon rainfall has disrupted the planting and growing cycles (Sapkota et al., 2010). Development of pest-resistant varieties of rice has led to a shift in preference.	Use of transplanting system Use of herbicide to control weeds Use of urea as fertilizer Use of farmyard manure (FYM) as fertiliser Use of intercropping with soybeans (R. Gautam et al., 2022)
Beans	Bean production has been affected by rust, mildew, mosaic virus, and infestations of spider mites, pod borers, and stem borers. Climate-induced stressors reduce the viability of traditional landrace mixtures, impacting the genetic diversity and resilience of bean crops (Palikhey et al., 2016).	Use of FYM as fertiliser Use of intercropping with maize by some farmers Use of bio mulch to control weeds
Potato	Potato yields have been affected by early and late blight, white grubs, potato tuber moth, and red ants have reduced productivity and quality (Giri et al., 2013). Drought has reduced potato yields due to reduction of soil moisture, affecting tuber formation and size (Luitel et al., 2015). Disrupted weather patterns have led unseasonal frost and snow which has damaged tubers by causing chilling injury or halting growth during the critical developmental phases.	Use of fungicide and pesticide Use of sprinkler irrigation in some places Crop rotation practiced by some farmers Use of raised beds by some farmers
Walnut	Walnut trees have been affected by dieback and blight. Stem borers, and ants target roots, stems, and branches during fruiting.	Use of cross pollinators
Vegetables	Vegetables have been affected by wilting, blight, and powdery mildew. Pests such as aphids and diamondback moth (DBM) are prevalent. Drought has led to reduced yield and production of vegetables.	Use of fungicide, pesticide, chemical fertiliser to control disease and pests and improve soil fertility Use of poly houses and plastic tunnels in some places Use of improved and hybrid seeds Use of intercropping by some farmers Crop rotation practiced in some communities Use of pine leaves as bio mulch
Apple	Apple production has been affected by diseases like papery bark, apple scab, foot rot, and powdery mildew, and pests like woolly aphids and mealy bugs that weaken apple trees by feeding on sap and reducing fruit size and yield. Papery bark disease causes thinning and peeling of the bark, killing branches. Warmer winters have reduced the necessary chilling hours for proper flowering, while sudden spring frosts have damaged blossoms. Reduced snowfall has affected apple tree dormancy.	Regular training and pruning Intercropping with vegetables Bordeaux mixture spray

Indigenous crops (Buckwheat and millet)	Buckwheat has been affected by wilting and plant rot due to steam issues that absorb excess water while millet yield has been impacted by Cercospora leaf spot and downy mildew. Changes in precipitation patterns have disrupted traditional cultivation patterns.	Use of community seedbanks Use of terracing and mulching to prevent soil erosion and conserve moisture

Papery Bark Disease

Rot induced splitting of apple

Infestation of woolly aphids

KEY ISSUES IN APPLE TREES

1. Unseasonal flowering, where flowers and ripening fruits appear simultaneously on different branches, is increasing due to climate change. Warmer winters and sudden spring temperature shifts disrupt natural flowering cycles, affecting pollination and yield.

2. Biennial fruiting, where trees produce a heavy crop one year and little or none the next, is influenced by environmental conditions and resource depletion.

Off season broadleaf mustard cultivation under plastic tunnel

High density apple orchard with drip irrigation system in Budhinanda Municipality

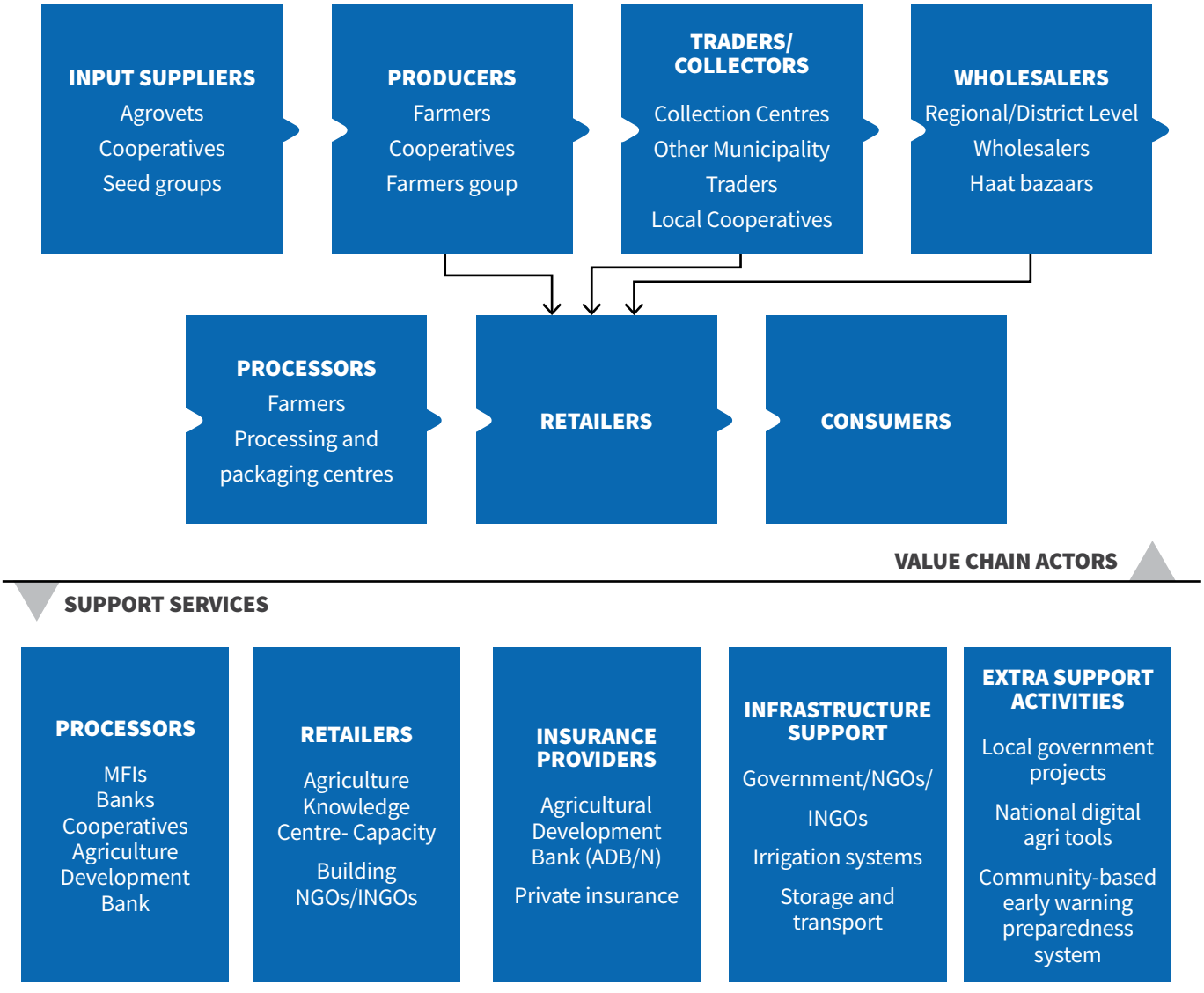
CHAPTER 5

Value chain assessment

The value chain assessment aims to evaluate the steps involved in the production, processing, and distribution of each crop, as well as identify the key actors across the various stages of the value chains. It takes into account the characteristics of Jumla and Bajura while proposing interventions that connect mountain communities with markets and add value to the identified crops.

Based on the insights from the FGDs and the KIIs, we developed a schematic diagram for a representative value chain, which shows the flow of the products across different segments (viz. production, trading, processing, retailing) the value chains, along with the various support services (viz. technical, financial, agricultural extension services etc.) that can potentially improve the forward and backward linkages along the chain and help farmers to participate in and navigate the product markets more effectively (Joshi et al., 2016).

FIGURE 6 **SCHEMATIC DIAGRAM OF A REPRESENTATIVE VALUE CHAIN**



Based on this schematic diagram, we have assessed the value chain of each of the selected (or high/ medium) potential crops in the following sub-sections.

5.1 Jumli marshi rice value chain

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Input supply	Seed selection from grain heaps from threshing or directly through the panicle, seed banks Community seedbanks created by the support of farmers and local associations to preserve and promote local seeds	Smallholder farmers, community seedbanks, Agrovets, Nepal Agricultural Knowledge Centre (NARC), NGO/INGOs	Limited availability of agrovets for quality supply of seeds, fertilizers, pesticides, and farming tools	Establishment of local seed banks Strengthen linkages between farmers and input suppliers through agricultural extension services and a centralised market for agrovets
Production	Field preparation using manual tools, transplanting of seeds according to local climatic conditions (typically May-June) Flooding irrigation, intercropping with soybean varieties	Smallholder farmers, Agriculture Knowledge Centre (AKC), NARC, agricultural extension services	Increased prevalence of rice borers and bugs Cultivation is limited to small areas in specific areas Disruption in monsoon rainfall due to delays in the monsoon Hailstorms during the harvesting period	Capacity building trainings for farmers to improve cultivation and IPM techniques, crop improvement programs with integration of traditional farming techniques
Post-harvest handling	Rice is stacked in small bundles for manual threshing and sundried to reduce moisture Grains are stored using traditional methods in jute bags, wooden granaries, earthen pots, or trenches dug inside houses	Smallholder farmers, agricultural extension services	Loss of harvest during manual threshing Moth and butterfly infestation during storage, leading to grain loss	Use of appropriate harvest machinery
Processing and value addition	Farmers focus on winnowing, cleaning, and packaging	Smallholder farmers, Jumla Organic Group, and agricultural cooperatives	Limited modern equipment, resulting in inefficient processing, and price instability	Training on quality control and food processing, branding, and certification focusing on the unique characteristics of Jumli Marshi Rice
Marketing and distribution	Farmers and cooperatives gather harvested rice, which is then transported to wholesalers and collectors Processed rice is packaged	Smallholder farmers, wholesalers, collectors, cooperatives	Middlemen buy rice at low prices (~ 50 NPR per kg) from farmers and sell it at much higher rates (up to 180 NPR per kg) Farmers have limited direct market access and must rely on wholesalers and collectors.	Enhanced direct marketing channels for producers Improved transport infrastructure to ensure farmers reach regional markets Promotion of eco-tourism through on-site processing and demonstration units with emphasis on 'Taste of Jumla'

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Consumption	Local consumers purchase Jumli Marshi rice from local retailers and wholesalers at a maximum price of 250 NPR per kg (off-season) and a minimum price of 200 NPR per kg (Gautam et al., 2022).	Households, Kathmandu retailers, local residents, tourists visiting Jumla	Jumli Marshi rice experiences significant price fluctuations. While the farm gate price was found to be 50 NPR per kg, distant market prices were 180 NPR per kg (Devkota et al., 2022). Challenges in road connectivity disrupt supply chains, resulting in increased prices.	Jumli Marshi rice has premium branding potential due to its unique characteristics.

5.2 Beans value chain

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Input supply	Farmers cultivate both hybrid and local bean cultivars. Farmers use seeds saved from previous harvests or seeds collected from seed banks.	Smallholder farmers, Community Seed Banks, Agrovet services, NGOs/ INGOs, Agriculture Development Office (ADO), NARC	Limited agrovet services Farmers rely on saved seeds due to limited access to quality seeds. Poor road connectivity and seasonal inaccessibility	Strengthen community seed banks by training farmers in seed selection and preservation Collaboration with research institutions like NARC to introduce disease-resistant varieties Training farmers on climate-resilient agronomic practices
Production	Field preparation using traditional tools. Farmers mix 3-4 different landraces of beans to combat pests and diseases. Manual harvesting of beans. Government institutions act as technology extension services providers for production.	Smallholder farmers, NARC, NGO technical assistants	Climatic impacts have reduced the viability of traditional landraces. Prevalence of pests and infestations of spider mites, and stem borers	Training on climate resilient farming practices (e.g., Intercropping with staple crops, use of IPM)
Post-harvest handling	Manual harvesting of beans is often done by women. Beans are traditionally grown by mixing different varieties and harvested as a mixture (Palikhey et al., 2016). Threshing/dehusking is carried out by beating with a stick (Palikhey et al., 2016).	Smallholder farmers, Agricultural cooperatives, Storage facilities, Community seed banks that also act storage centres	Inadequate storage facilities Lack of skilled personnel for proper post-harvest management Vulnerability to pest infection during storage	Capacity building training on post-harvest management practices Introduction of appropriate storage bags to maintain moisture content

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Processing and value addition	Manual grading and packaging of beans Initiatives such as Mountain Partnership Products (MPP) with FAO have been introduced to certify origin and quality.	Smallholder farmers, Small-scale processing units, NGO/INGOs	Lack of large-scale processing facilities for beans Limited knowledge of processing techniques	Organic certification highlighting the unique qualities of beans from this region Training on processing and quality control
Marketing and distribution	Farmers and cooperatives act as traders in the value chain of beans. Beans are sold in local markets of Bajura such as Martadi and Kolti, where regional traders from Jumla also come to buy produce. Transport is done via backload, mules, or pickup vans.	Smallholder farmers, cooperatives, wholesalers (buy directly from farmers or cooperatives), regional traders, retailers (final point of sale)	Limited availability of collectors Market inaccessibility due to challenging terrain Price fluctuations due to irregular supply	Establish collection centres Market expansion through branding and use of social media for broader distribution
Consumption	Consumption as a primary protein source in high-altitude regions Seasonal consumption of *Kwati* (mixed beans) for festivals	Households, wholesalers	Lack of proper storage facilities has led to post-harvest loss	Promotion of diverse and unique varieties of beans for enhanced nutritional benefit

5.3 Vegetables value chain

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Input supply	Farmers rely on a mix of local and hybrid cultivars. Farmers buy seeds, fertilisers, and tools from local agrovets.	Local nurseries (often informal), individual farmers, ADO, NARC, agrovets NGO/INGOs	Limited availability of agrovets that provide essential inputs Poor quality seeds provided by local organisations Limited variety and quantity of essential agri-inputs	Collaboration between NGOs/INGOs and local entities to improve access to inputs, capacity-building training Increased connectivity between regional markets and smallholder farmers
Production	Land preparation using traditional tools Intercropping and crop rotation of vegetables to maintain soil fertility and manage pest outbreaks	Smallholder farmers, Cooperatives, NGOs/ INGOs (technical assistants), NARC	Disruption of transplanting schedules due to irregular and delayed monsoon rains Reduced yield due to drought. Increased prevalence of pests and diseases	Adoption of climate-smart agriculture technologies (e.g., Shade nets, drought-resistant varieties, integrated pest management, etc (Chapagain Tika Ram et al., 2023).

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Post-harvest handling	Sorting and grading of vegetables Packaging using sacks or crates Storage and transport	Smallholder farmers, cooperatives, collection centres, Storage facility providers	Lack of proper storage facilities Lack of cold storage facilities for perishable vegetables Damage during transport of vegetables to distant markets	Establishment of collection centres and cold storage units Use of appropriate packaging according to vegetable in the shade before transport Training programs on the principles of storage (e.g., proper temperature and humidity management)
Processing and value addition	Pickling of vegetables such as radish and cucumber for local sale on a small scale Fermentation of leafy vegetables to make gundruk	Smallholder farmers, Cooperatives, NGOs/ INGOs, Local women's groups	Inadequate infrastructure for processing and packaging Poor cold chain infrastructure	Establish crop-specific processing facilities and training programmes
Marketing and distribution	Vegetables are transported to collection centres or haat bazaars	Smallholder farmers, farmer cooperatives, Local traders (middlemen), wholesalers	Low-volume production Poor market and transport infrastructure Price fluctuations	Establish territorial markets by improving local road access Highlighting the nutritional benefits of indigenous vegetables
Consumption	Consumers purchase from local markets and wholesalers	Households, wholesalers	Price fluctuations due to seasonality, climatic factors	Establish mobile app to monitor price and availability of vegetables

5.4 Walnut value chain

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Input supply	Supply of grafted walnut saplings (hard-shelled, soft-shelled), organic fertilisers, bio-pesticides, irrigation systems, and farm equipment	Local nurseries (often informal), smallholder farms smallholder farmers, cooperatives, ADO, NARC agrovets, NGO/ INGOs	Limited input suppliers Scarcity of input suppliers has led to higher prices for grafted walnut saplings that exceed government rate. Incidence of natural disaster hinders timely access to inputs.	Promote local nurseries for climate-resilient varieties (soft-shelled walnuts). Promote work with horticultural research centres such as NARC to facilitate walnut grafting techniques. Strengthen linkages between farmers and input suppliers through agricultural extension services and centralised market for agrovets.

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Production	Soil preparation Plantation of seedlings and grafted/budded plants with spacing Manuring and fertilisation rain-fed irrigation with supplemental stream/ snowmelt irrigation Organic pest management (limited)	Smallholder farmers, ADO extension workers, AKC, NARC, NGOs technical assistants	Erratic rainfall patterns, increased frequency of extreme weather events (e.g., hailstorms, droughts, floods, landslides, etc.) Production of soft-shelled walnuts is too low for commercial sale.	Climate-resilient farming practices (e.g., hail nets, frost protection) Capacity building on improved orchard management techniques, promotion of integrated pest management (IPM) using local resources Development of water harvesting systems, irrigation using renewable energy
Post-harvest handling	Basic manual sorting and grading, manual dehusking of harvested walnuts, washing, drying, and storage.	Smallholder farmers, cooperatives	10-15% post-harvest losses due to rotting of the inner part of walnuts Lack of skilled personnel for post-harvest management Absence of storage facilities	Training programs to improve walnut storage practices
Processing and value addition	Initiatives have been taken to develop efficient oil extraction methods.	Smallholder farmers, local municipalities	Limited knowledge regarding walnut oil processing, limited access to modern processing equipment	Two Swiss students introduced a walnut cracking machine in Jumla that would mechanise oil extraction. The cracking machine is powered by a bicycle that can substantially reduce women's drudgery, coinciding with rural electrification in Jumla.
Marketing and distribution	Local markets (Khalanga) Local haat bazaars Limited transport to Surkhet and Nepalgunj; low volume of hard-shell nuts sold to Kathmandu	Smallholder farmers (often involved in marketing), village-level collectors	Limited market access due to remoteness, price fluctuations due to seasonal availability, lack of market information, reliance on middlemen, limited access to formal markets	Establishment of farmer cooperatives for collective marketing, development of market information systems (e.g., mobile apps) Promotion of direct marketing to consumers, development of branding and certification (e.g., organic, geographical indication), exploring e-commerce platforms.
Consumption	Consumers buy walnut from local retailers and wholesalers.	Local retailers and wholesaler	High cost of walnuts, limited market access, inadequate processing capacity has led to inconsistency in quality.	Strengthening connection between local producers and external markets. Promotion of territorial markets

5.5 Potato value chain

Value chain stage	Key activities	Actors	Challenges	Opportunities
Input supply	Farmers retain almost half of their seeds while buying the rest from local agrovets and cooperatives. Farmers source seed tubers from their own stock, neighbouring farmers, and from open market/seed groups.	Smallholder farmers, cooperatives, local agrovets, narc, NGO/ INGOs, akc	Limited availability of agrovets Unavailability of quality seeds and fertilisers	Promotion of community seed banks Certification of seed tubers to ensure quality Training agrovets to supply biopesticides and ipm tools
Production	Land preparation using traditional tools and methods Sowing, weeding and harvesting	Smallholder farmers, cooperatives, NGO/ INGOs technical assistants	Winter yields are lower due to lack of irrigation. Erratic rainfall and unpredictable rainfall have affected production. Drought has reduced potato yields by lowering soil moisture, affecting tuber formation and size.	Use of plastic mulching to improve soil fertility and increasing tuber yields (Timilsina et al., 2022) On-farm training on drought preparedness and other climate-resilient agricultural practices with ngo and government technical assistance
Post-harvest handling	Manual harvesting using traditional tools Initial sorting of potatoes based on quality Manual grading according to size and quality Use of jute sacks or plastic stacks for packaging	Smallholder farmers, cooperatives, storage facilities	Lack of standardised grading system Lack of proper handling leads to spoilage and bruising Highest level of post-harvest loss in picking, storage, collection, and transport Lack of skilled personnel and training on post-harvest management	Introduction of standardised grading practices Capacity building programmes on post-harvest handling and storage
Processing and value addition	Producers are involved in grading, sorting, and packaging potatoes in sacks and large bags. Potato chips or snacks production (limited).	Smallholder farmers, farmer groups	Limited processing facilities that primarily focus on grading and sorting	Potential for exploring products such as potato chips and potato flour on a larger scale
Marketing and distribution	Small-scale traders are the first point of contact, who then sell to large-scale traders in the wholesale market	Small-scale and large-scale retailers, wholesalers	Obstruction in transportation due to an increase in natural disasters such as floods and landslides	Integrating digital apps to link producers and traders Localised collection centers with storage and packaging support
Consumption	Consumers buy potatoes from local retailers, where they pay a variable price depending on the area.	Households, large-scale consumers, wholesalers, local retailers	Limited access to value-added potato products like chips or flour	Establishment of local processing units Training programs for women and farmers' groups on value-added products

5.6 Apple value chain

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Input supply	Supply of quality apple saplings (Red Delicious, Royal Delicious, Golden Delicious, Fuji, Gala, Red Jonaprince) Organic fertilisers, bio-pesticides, irrigation systems, and farm equipment	Local nurseries (often informal), Smallholder farmers, Cooperatives, ADO, NARC agrovets, NGO/INGOs	Limited access to certified Jumli saplings High transportation costs for inputs Limited access to frost-resistant rootstocks Reliance on traditional and often insufficient organic fertilizers Limited availability of modern irrigation systems	Promote local nurseries for climate-resilient varieties (e.g., Jumli, Marpha) Subsidize drip irrigation systems to combat water scarcity Train farmers on bio-fertilizers preparation (e.g., vermi compost, vermi wash, improved compost).
Production	Traditional orchard management Minimal pruning Reliance on natural pollination (bees, wind) Rain-fed irrigation with supplemental stream/ snowmelt irrigation Organic pest management (limited)	Smallholder farmers, Jumla Apple Producers' Cooperative, ADO extension workers, beekeepers, NGO technical assistants	Erratic snowfall and late frosts are damaging blossoms. Soil nutrient depletion due to monocropping. Pests like woolly aphids and diseases like apple scab.	Frost protection farming practices Capacity building on improved orchard management techniques Promotion of IPM
Post-harvest handling	Basic manual sorting and grading Traditional bamboo baskets for transportation Limited on-farm storage (often rudimentary) Road transportation	Cooperatives, storage facility providers, Jumla Cold Storage Project (limited), local traders	30–40% post-harvest losses due to lack of cold storage Due to poor roads, transportation to markets (e.g., Nepalgunj, Surkhet) is delayed, leading to bruising and spoilage.	Solar-powered cold storage units (Jumla has high solar potential). Train farmers on grading standards for premium pricing. Cooperative-led collection centers to reduce middlemen.
Processing and value addition	Traditional sun-drying of apples ("Sukeko Syau") Limited production of apple juice and jam (mostly for local consumption), wine making, potential for cider and vinegar production	Jumla Women's Cooperative, local processors, processing industries with capacity of 18-20 tonnes, Nepal Food Corporation, two wine manufacturing industries	Manual processing leads to inconsistent quality No certification for organic/geographical indication (GI) products Inconsistent quality of processed products Lack of market linkages for processed products	Establishment of small-scale processing units (e.g., solar dryers, juice extractors) Training on food processing and quality control, development of value-added products with unique Jumli apple flavours, branding and packaging of local products, and market linkage support for processed products.

Value chain stage	Key activities	Actors involved	Challenges	Opportunities
Marketing and distribution	Local markets (Khalanga) Local haat bazaars Transport to Surkhet and Nepalgunj Reliance on traders for onward distribution	Jumla Apple Festival; Farmers sell apples at 70-80 NPR per kg, and local traders sell them at 110-190 NPR per kg; wholesalers, retail shops in Khalanga	Limited market access due to remoteness Price fluctuations due to seasonal availability Lack of market information Reliance on middlemen, limited access to formal markets Limited external traders	Establishment of farmer cooperatives for collective marketing Development of market information systems (e.g., mobile apps) Promotion of direct marketing to consumers, development of branding and certification (e.g., organic, geographical indication), exploring e-commerce platforms. GI tagging for "Jumla Apple e-market platforms (e.g., Hamri Bahini) for direct sales. Contract farming with hotels/ airlines
Consumption	Fresh apple consumption (seasonal) Consumption of dried apples Limited consumption of processed products, potential for tourism-related consumption.	Households, Nepal Army (bulk buyer), Kathmandu retailers, local residents, tourists visiting Jumla	High cost of imported apples in Jumla Limited awareness of the nutritional value of Jumli apples Seasonal availability leading to price fluctuations Processed products seen as low quality	'Eat Jumla Apple' campaigns in urban Nepal

5.7 Indigenous crops (buckwheat and millet) value chain

Value chain stage	Key activities	Actors	Challenges	Opportunities
Input supply	Farmers rely on traditional tools and local cultivars. Farmers use retained and informal sources of seeds (farm saved or from relatives/neighbours). Farmers use bio-fertilisers, but the use of chemical fertilisers is rare.	Smallholder farmers, Agrovets, Cooperatives, Seed banks, NARC, NGO/ INGOs technical assistants	Lack of research and extension support Limited availability of quality seeds, fertilizers, pesticides, and irrigation	Training programs on seed management practices (seed selection criteria) Linking formal and informal seed systems through seed banks
Production	Farmers use traditional cultivation techniques that have been passed down from generations.	Smallholder farmers, Cooperatives, NGOs/INGOs (technical assistants), NARC	Drought and water availability Diseases and pests cause loss of production. Farmers have limited resources, leading to low production volume. Farmers are shifting towards cash-generating crops.	Buckwheat can produce higher grain yields compared to other cereal crops. On-farm experiments to raise awareness about different landraces and their characteristics such as disease resistance, days to maturity, and productivity.

Value chain stage	Key activities	Actors	Challenges	Opportunities
Post-harvest handling	Millet grains are dehusked for flouring Grains are stored in traditional storage containers and sacks	Smallholder farmers, Cooperatives, NGO/INGOs technical assistants	Millets are labor-intensive and require manual, harvesting, threshing, dehulling, milling, and processing Challenges in protecting harvest from rat infestation	Mechanisation of dehusking and threshing Government or community-based training on proper cleaning, drying, and storage techniques
Processing and value addition	Processing is manual and labor intensive. Grains processed to make roti, bhat, kheer.	Smallholder farmers, cooperatives, mill operators, NGO/INGOs	Labour-intensive processing Lack of processing infrastructures Low-volume production for value added products Knowledge and skill gap in value addition techniques	Improved processing technologies such as solar or mechanical dryers, small-scale threshers and dehuskers Development of value-added products such as buckwheat noodles, cookies, flour, millet nutritional bars Promote agrotourism through indigenous crops and local dishes made using these crops
Marketing and distribution	Indigenous crops are collected by local traders who sell them to regional wholesalers (e.g., Surkhet, Nepalgunj)	Smallholder farmers, local and regional traders, Nepal Food Corporation, wholesalers	Limited traders due to low volume of indigenous crops Education and awareness level is low Rice and wheat are perceived as superior grains	Advertisements about the nutritional value of buckwheat and millet Linking farmers and local trader with e-market platforms
Consumption	Harvest is consumed by farmers at home. Consumers buy buckwheat and millet from local retailers and wholesalers.	Households, wholesalers, retailers	Limited consumer knowledge on nutritional benefits of indigenous crops Post-harvest loss and storage issues decreases quantity and quality	Promotion of indigenous crops through government channels

CHAPTER 6

Pre and post-harvest loss analysis

The assessment of pre and post-harvest losses[1] across the identified crop value chains revealed challenges and critical inefficiencies in processing, storage and transport. Jumli Marshi Rice has a relatively low post-harvest loss of around 10% of volume. These losses mainly occur due to poor cutting and handling practices, inefficient threshing and winnowing methods, as well as damage and spillage during transportation. Beans have an estimated post-harvest loss of approximately 10% of volume due to humid storage conditions, inefficient handling after harvest, and over-drying that leads to splitting and breakage. Walnut loss of approximately 10% is due to uneven drying, lack of proper cracking and de-husking equipment, and limited knowledge of post-harvest management. Indigenous crops like buckwheat and millet experience lower post-harvest losses of around 10%, likely due to traditional farming practices. However, poor storage conditions after harvest shorten their shelf life, leading to early mould growth and insect infestations. Vegetables face the highest losses at around 30% due to improper harvesting , poor packaging, lack of grading, inadequate transport and storage, road blockages from landslides, and limited knowledge of processing. Potato and apples experience high levels of post-harvest loss at around 25% and 20% respectively of their volume.

Lack of adequate knowledge of post-harvest techniques has contributed to significant post-harvest loss of apples in Jumla (Thapa et al., 2024). Early sprouting in young tubers, combined with infestations by potato tuber moths and red ants, has significantly contributed to potato yield losses. In Bajura, these challenges are compounded by the lack of proper storage and transport facilities. Apple losses are caused by immature or over-mature harvesting. Additional losses result from poor grading, manual harvesting, piling fruits under sunlight, inadequate cold storage facilities with unstable electricity, and improper transportation using ordinary trucks, all of which degrade quality across collection centres and marketing channels.

TABLE 5 **POST-HARVEST LOSS ACROSS ALL MUNICIPALITIES**

Crop	Crop yield (kg/ha)	Post-harvest loss (kg/ha)
Jumli Marshi rice	2500-3500	300-350 (~10%)
Beans	1500-2500	200-400 (~15%)
Vegetables	3000-7000	700-2000 (~30%)
Walnut	1500-2500	200-400 (~15%)
Potato	10000-15000	2000-3800 (~25%)
Apple	5000-10000	1000-2000 (~20%)
Indigenous crops (buckwheat, millet)	1000-2500	100-300 (~10%)

[1]Losses were estimated across the following stages: cutting and handling, manual threshing, sun drying, open storage, village-level milling, and small-scale retailing

6.1 Proposed interventions

Based on the findings of the value chain analysis and post-harvest loss analysis, a set of interventions were developed to identify solutions for each stage of the value chain. These interventions were designed to boost agricultural productivity, improve market access, increase value addition, and strengthen the livelihoods of farmers.

TECHNICAL AND INPUT SUPPORT

- Establish centralised markets for agricultural inputs to improve farmer access
- Facilitate easy access to quality inputs, including seeds, equipment, and agrovet services
- Promote low-interest loans and financial incentives to support input purchases

PRODUCTION STAGE

- Implement climate-resilient agriculture (CRA) practices, including IPM, rainwater harvesting, and mulching, to build resilience against natural calamities
- Provide training and equipment support for sustainable and climate-resilient farming techniques
- Introduce incentives and low-interest loans to encourage youth participation and address the shortage of skilled labor

PROCESSING STAGE

- Establish crop-specific processing centres for value addition, particularly for walnuts and potatoes
- Enhance post-harvest handling through proper grading, cleaning, and basic processing facilities to minimize losses

MARKET ACCESS STAGE

- Develop specific market locations with reliable collectors to provide accurate pricing and ensure demand and supply certainty
- Create centralised marketing systems to streamline crop sales and input distribution
- Establish a mechanism for determining a fixed selling price and cost price to address price fluctuations
- Strengthen transportation infrastructure to improve market connectivity and reduce post-harvest losses

POST-HARVEST STAGE

- Introduce proper storage facilities to minimize post-harvest losses and ensure off-season crop availability
- Facilitate cooperative and local government support for storage and market stabilisation

ENABLING ENVIRONMENT

- Ensure effective management of existing credit providers for seamless loan access
- Provide low-interest loans and crop insurance options to encourage investments in agriculture
- Enhance access to financial services through cooperatives and banks to support farmers at all stages of the value chain
- Establish local government bodies to uniformly disseminate market price information to all stakeholders
- Offer subsidies, training, and technical assistance to promote sustainable practices and improve crop production

CHAPTER 7

Conclusions and recommendations

7.1 Conclusions

The assessment of agricultural practices in five municipalities (Tatopani, Patarasi, Budhinanda, Swamikartik, and Triveni) highlighted challenges such as market access, transportation issues, and post-harvest losses, particularly for apples, potatoes, and onions. Climate change impacts, including reduced snowfall and erratic weather, have led farmers to shift from apple farming to walnut cultivation as an adaptive response. Despite the growing adoption of walnuts and other crops, there are significant post-harvest losses and infrastructure challenges, particularly due to the lack of storage and processing facilities.

7.2 Recommendations

Based on the findings of the FGDs, KIIs, and value chain analysis, the following recommendations are made to address the challenges in the agricultural value chain of Jumla and Bajura districts:

1. ESTABLISH SPECIFIC MARKET LOCATIONS:

- Centralised markets: Collaborate with local authorities to create dedicated market hubs where farmers can directly sell their produce.
- Market infrastructure: Invest in basic infrastructure such as stalls, storage facilities, and weighing stations to support these market locations.

2. INTRODUCE RELIABLE COLLECTORS WITH SPECIFIC PRICING:

- Fair pricing mechanisms: Establish a system of reliable collectors to ensure consistent and fair pricing for farmers. Transparent processes for price determination should be implemented, considering production costs, market demand, and fair profit margins.
- Training and regulation: Train collectors and regulate their activities to maintain trust and fairness in transactions.

3. PROMOTE TECHNOLOGY ADOPTION:

- Training programs: Provide farmers with training on modern agricultural practices and technologies, particularly in walnut cultivation, short-term vegetables, and off-season production.
- Technology access: Facilitate access to relevant technologies, such as irrigation systems, pest management tools, and climate-resilient farming techniques.

4. ENSURE PRICE STABILITY:

- Stable pricing policies: Develop policies that ensure stable and fair pricing for all crops, protecting farmers' incomes against market fluctuations.
- Market information systems: Implement systems to provide farmers with up-to-date market information, helping them make informed decisions about when and where to sell their produce.

5. RAISE AWARENESS ON CLIMATE-RESILIENT AGRICULTURE:

- Climate-resilient practices: Promote the adoption of climate-resilient agricultural practices, such as mulching, water harvesting, and IPM.
- Training and resources: Provide training and resources to farmers on these practices and

support the development of infrastructure for water conservation and climate-controlled farming.

6. IMPROVE STORAGE FACILITIES:

- Cold storage solutions: Collaborate with cooperatives and local governments to establish proper cold storage facilities to reduce post-harvest losses.
- Alternative energy sources: Invest in solar and wind power to support cold storage facilities, addressing electric power shortages.
- Training in storage management: Provide training in effective storage management to enhance the efficiency and lifespan of stored produce.

7. ENHANCE TRANSPORTATION INFRASTRUCTURE:

- Transportation services: Work with traders and transporters to improve the availability and reliability of transportation services.
- Infrastructure development: Invest in the development and maintenance of roads and transportation networks to facilitate the movement of goods between producers and consumers.

8. EXPAND CREDIT AND LOAN SERVICES:

- Access to finance: Streamline the process for obtaining credit and loans at low-interest rates, enabling farmers to invest in productivity-enhancing technologies and practices.
- Financial literacy: Provide financial literacy training to farmers, helping them manage their finances effectively and make informed investment decisions.

9. SUPPORT POST-HARVEST MANAGEMENT AND PROCESSING:

- Training in post-harvest management: Offer training programs for producers, collectors, and traders on effective post-harvest management practices.
- Grading and processing facilities: Introduce grading machines and support the establishment of processing facilities to add value to agricultural produce and reduce post-harvest losses.

10. ENHANCE POLICY AND PROMOTE INVESTMENT:

- Supportive policies: Advocate for district and provincial policies that support investment in agricultural processing activities and infrastructure development.
- Investment opportunities: Create opportunities for private sector investment in storage, processing, and transportation, encouraging the participation of SMEs and cooperatives.

References

Adhikari, L., Hussain, A., & Rasul, G. (2017). Tapping the Potential of Neglected and Underutilized Food Crops for Sustainable Nutrition Security in the Mountains of Pakistan and Nepal. *Sustainability*, *9*(2), 291. https://doi.org/10.3390/su9020291

Bajura - PHASE Worldwide. (n.d.). Retrieved February 13, 2025, from https://phaseworldwide.org/locations/bajura/

Budha, D. B. (2023, March 26). Disease-resistant Jumli Marshi rice being readied for cultivation. *The Kathmandu Post* . https://kathmandupost.com/money/2023/03/26/disease-resistant-jumli-marshi-rice-being-readied-for-release-1679838155

Chapagain, T. R., Karki, T., Shah, P., & Acharya, G. D. (2023). *Climate-smart agriculture technologies and practices in Nepal*. SAARC Agriculture Centre (SAC). https://c-sucses.sac.org.bd/wp-content/uploads/2023/11/Nepal_CSA-Technologies-and-Practices.pdf

Devkota, M., Singh, S., Raj Nairaula, L., Subedi, D., Khanal, A., Joshi, H., & Kumar Yadav, P. (2022). MARKETING AND VALUE CHAIN ANALYSIS OF JUMLI MARSHI RICE IN NEPAL. *RJOAS*, *11*(131). https://doi.org/10.18551/rjoas.2022-11.19

Fuglie, K., Gautam, M., Goyal, A., & Maloney, W. F. (2020). *Harvesting Prosperity: Technology and Productivity Growth in Agriculture*. The World Bank. https://doi.org/10.1596/978-1-4648-1393-1

Gauli, P., Bhatta, S., Singh, S. K., Shrestha, K., Nidal, B., & Atreya, K. (2022). Farming in the mountains of Nepal: crops, soil fertility, livelihoods and farm-forest linkages. *Archives of Agriculture and Environmental Science*, *7*(3), 463–472. https://doi.org/10.26832/24566632.2022.0703021

Gautam, K. P. (2024, October 17). Karnali is growing more apples, but unreliable roads hinder market access. *The Kathmandu Post*. https://kathmandupost.com/money/2024/10/17/karnali-is-growing-more-apples-but-unreliable-roads-hinder-market-access

Gautam, R., Kandel, B. P., Chalaune, S., & Koirala, B. (2022). Importance of world high altitude Jumli Marshi rice with cultivation practices. *Heliyon*, *8*(2), e08885. https://doi.org/10.1016/j.heliyon.2022.e08885

Ghimire, S. (2017). Status of Jumli Marshi in Nepal. *Journal of Pharmacognosy and Phytochemistry*, *6*(6S), 294–295. https://www.phytojournal.com/archives/2017.v6.i6S.2585/status-of-jumli-marshi-in-nepal

Giri, Y. P., Dangi, N., Aryal, S., Sporleder, M., Shrestha, S., Budha, C. B., & Kroschel, J. (2013). *Biology and management of potato insect pests in Nepal: Training guide for extension officers*. International Potato Center (CIP). https://doi.org/10.4160/978-92-9060-426-6

Government of Nepal, Ministry of Agriculture & Livestock Development. (2022). *Statistical information on Nepalese agriculture 2077/78 (2020/21)*. Planning & Development Cooperation Coordination Division, Statistics and Analysis Section. https://moald.gov.np/wp-content/uploads/2022/07/STATISTICALINFORMATIONONNEPALESEAGRICULTURE207778.pdf

Joshi, S. R., & Gurung, B. R. (2009). *Value Chain Analysis of Dairy in Merak and Sakteng*. Ministry of Agriculture and Forests, Royal Government of Bhutan. https://www.yumpu.com/en/document/view/5171155/value-chain-analysis-of-dairy-in-merak-and-sakteng

Joshi, S. R., Rasul, G., & Shrestha, A. J. (2016). *Pro-poor and Climate Resilient Value Chain Development: Operational Guidelines for the Hindu Kush Himalayas* (ICIMOD Working Paper 2016/1). https://doi.org/10.53055/ICIMOD.641

Kafle, S. (2022, May 17). *Climate change exacerbates food crisis in Nepal's poorest region*. Eco-Business.

Khadka, N., Chen, X., Sharma, S., & Shrestha, B. (2023). Climate change and its impacts on glaciers and glacial lakes in Nepal Himalayas. *Regional Environmental Change, 23*. https://doi.org/10.1007/s10113-023-02142-y

Kumar, G., Rattan, U. K., & Singh, A. K. (2016). Chilling-Mediated DNA Methylation Changes during Dormancy and Its Release Reveal the Importance of Epigenetic Regulation during Winter Dormancy in Apple (Malus x domestica Borkh.). *PLOS ONE*, *11*(2), e0149934. https://doi.org/10.1371/journal.pone.0149934

Luitel, B. P., Khatri, B. B., Choudhary, D., Paudel, B. P., Jung-Sook, S., Hur, O.-S., Baek, H. J., Cheol, K. H., & Yul, R. K. (2015). Growth and Yield Characters of Potato Genotypes Grown in Drought and Irrigated Conditions of Nepal. *International Journal of Applied Sciences and Biotechnology*, *3*(3), 513–519. https://doi.org/10.3126/ijasbt.v3i3.13347

M4P. (2008). *Making Value Chains Work Better for the Poor: A Toolbook for Practitioners of Value Chain Analysis* (Version 3). Making Markets Work Better for the Poor (M4P).

Miller, Calvin, Jones, & Linda. (n.d.). *Agricultural Value Chain Finance*.

National Planning Commission. (2014). *Nepal Human Development Report 2014*. https://hdr.undp.org/system/files/documents/nepalnhdr2014-final.pdf

National Planning Commission. (2021). *Nepal towards an equitable, resilient and sustainable food system*.

Ministry of Health and Population [Nepal], New ERA, & ICF. (2023). *Nepal Demographic and Health Survey 2022*. Ministry of Health and Population. https://www.dhsprogram.com/pubs/pdf/FR379/FR379.pdf

Neupane, N., Paudel, S., Sapkota, R., Joshi, Y. P., Rijal, Y., & Chalise, A. (2022). Enhancing the resilience of food production systems for food and nutritional security under climate change in Nepal. *Frontiers in Sustainable Food Systems*, *6*. https://doi.org/10.3389/fsufs.2022.968998

Neven, D. (2014). *Developing Sustainable Food Value Chains: Guiding Principles*. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/sustainable-food-value-chains/library/details/en/c/265156/

Palikhey, E., Sthapit, S. R., Gautam, S., Gauchan, D., Bhandari, B., Joshi, B. K., & Sthapit, B. R. (2016). *Integrating traditional crop genetic diversity into technology : using a biodiversity portfolio approach to buffer against unpredictable environmental change in Nepal Himalayas : baseline survey report*. Local Initiatives for Biodiversity, Research and Development. https://hdl.handle.net/10568/92460

Pandey, V. P., Sharma, A., Dhaubanjar, S., Bharati, L., & Joshi, I. R. (2019). Climate Shocks and Responses in Karnali-Mahakali Basins, Western Nepal. *Climate*, *7*(7), 92. https://doi.org/10.3390/cli7070092

Risal, A., Urfels, A., Srinivasan, R., Bayissa, Y., Shrestha, N., Paudel, G. P., & Krupnik, T. J. (2022). Impact of Climate Change on Water Resources and Crop Production in Western Nepal: Implications and Adaptation Strategies. *Hydrology*, *9*(8), 132. https://doi.org/10.3390/hydrology9080132

Salami, A. W., Mohammed, A. A., Abdulmalik, Z. H., & Olanlokun, O. K. (2014). Trend Analysis of Hydro-meteorological Variables using the Mann-Kendall Trend Test: Application to the Niger River and the Benue Sub-Basins in Nigeria. *International Journal of Technology*, *5*(2), 100. https://doaj.org/article/5807fd8b9a3e4f9988f84b3d987c6624

Sapkota, S., Paudel, M. N., Thakur, N. S., Nepali, M. B., & Neupane, R. (2010). Effect of Climate Change on Rice Production: A Case of Six VDCs in Jumla District. *Nepal Journal of Science and Technology*, *11*, 57–62. https://doi.org/10.3126/njst.v11i0.4124

Sen, P. K. (1968). Asymptotic normality of sample quantiles for *m*dependent processes. *The Annals of Mathematical Statistics, 39*(5), 1724–1730. https://doi.org/10.1214/aoms/1177698155

Slavchevska, V., Doss, C., Mane, E., Kaaria, S., Kar, A., & Villa, V. (2020). *Rural outmigration and the gendered patterns of agricultural labor in Nepal*. https://doi.org/10.2499/p15738coll2.134190

Tamang, S., Paudel, K. P., & Shrestha, K. K. (2014). Feminization of Agriculture and its Implications for Food Security in Rural Nepal. *Journal of Forest and Livelihood*, *12*(1), 13–13. https://www.nepjol.info/index.php/JFL/article/view/65678

Thapa, R., Ghimire, S., Bhattarai, P., Acharya, S., Poudel Chhetri, B., & Kushma Tharu, R. (2024). A Comprehensive Assessment of Apple Production in Jumla District, Nepal: Status, Economics, Marketing and Challenges. *Turkish Journal of Agriculture - Food Science and Technology*, *12*(2), 159–178. https://doi.org/10.24925/turjaf.v12i2.159-178.6452

Thapa, S., & Hussain, A. (2021a). Climate change and high-altitude food security: a small-scale study from the *Karnali* region in Nepal. *Climate and Development*, *13*(8), 713–724. https://doi.org/10.1080/17565529.2020.1855099

Thapa, S., & Hussain, A. (2021b). Climate change and high-altitude food security: a small-scale study from the *Karnali* region in Nepal. *Climate and Development*, *13*(8), 713–724. https://doi.org/10.1080/17565529.2020.1855099

Timilsina, S., Khanal, A., Timilsina, C., & Poon, T. (2022). Effect of mulch materials on potato production and soil properties in high hill of Parbat, Gandaki Province, Nepal. *Journal of Agriculture and Natural Resources*, *5*(1), 19–26. https://doi.org/10.3126/janr.v5i1.50362

Tiwari, P. C. (2000). Land-use changes in Himalaya and their impact on the plains ecosystem: Need for sustainable land use. *Land Use Policy*, *17*, 101–111. https://doi.org/10.1016/S0264-8377(00)00002-8

Upadhyay, B. (2012). *Food Security in the Context of Climate Change in Martadi VDC of Bajura District of Far-Western Region, Nepal*. https://www.academia.edu/1962476/Food_Security_in_the_Context_of_Climate_Change_in_Martadi_VDC_of_Bajura_District_of_Far_Western_Region_Nepal

Ministry of Forests and Environment (MoFE), Government of Nepal. (2021). *Vulnerability and risk assessment and identifying adaptation options in GESI, livelihood and socioeconomic sector in Nepal*. Ministry of Forests and Environment. https://giwmscdntwo.gov.np/media/pdf_upload/VRA%20Report%202021%20GESI%2C%20Livelihoods%20and%20SocioEconomics_znwpweg.pdf

Walker, C., DeMatteis, L., & Lienert, A. (2021). *Selecting value chains for sustainable food value chain development*. Food and Agricultural Organization of the United Nations (FAO). https://doi.org/10.4060/cb7623en

World Food Programme. (2024). *Assessing the Impact of the Global Crisis and Multiple Shocks on Household Food Security and Livelihoods in Nepal*.

Yogi, L. N., Thalal, T., & Bhandari, S. (2025). The role of agriculture in Nepal's economic development: Challenges, opportunities, and pathways for modernization. *Heliyon*, *11*(2), e41860. https://doi.org/10.1016/j.heliyon.2025.e41860

Annexes

ANNEXE 1: NUMBER OF KEY INFORMANTS FROM EACH MUNICIPALITY

Municipality	Number of KIIs
Tatopani Rural Municipality	8
Patarasi Rural Municipality	5
Budhinanda Municipality	8
Swamikartik Rural Municipality	10
Triveni Municipality	7

ANNEXE 2: ATTRACTIVENESS MATRIX – TATOPANI, JUMLA DISTRICT

FGD1	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Buckwheat, Marshi rice, beans, walnut, apple, potato, chilli, tomato
		Medium	Maize	Millet, wheat, barley, soyabean, cabbage, bitter gourd	Carrot, turnip, brinjal
		Low	Proso millet, foxtail millet, amaranth, lentils, tuber	Garlic, black lentil	Horse gram, capsicum
			Low	Medium	High
		Potential market demand/growth			
FGD2	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Soyabean, potato	(Most attractive)
					Buckwheat, amaranth, beans, wheat, walnut, apple
		Medium	Millet, pumpkin	Proso millet, foxtail millet	Chilli, horse gram
		Low	Wheat, amaranth	Maize, carrot, mung beans, cauliflower	Turnip, black lentil
			Low	Medium	High
		Potential market demand/growth			
FGD3	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Marshi rice, beans, apple, walnut, mustard, Himalayan wild cherry
		Medium		Millet, barley, wheat, maize	Buckwheat,proso millet, foxtail millet, amaranth, potato, carrot, peanuts, garlic, lotus stem
		Low	Chayote squash, capsicum, tuber	Soyabean, red lentil, cabbage, cauliflower, mung beans, apricot	Chilli, garlic, gahat, black lentil
			Low	Medium	High
		Potential market demand/ growth			

FGD4	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Buckwheat, Marshi rice, beans, apple, walnut, garlic, horse gram
		Medium			Millet, porso millet, foxtail millet, soybean, potato, mash, pea, mustard
		Low			Amaranth, barley, wheat, maize, lentil
			Low	Medium	High
		Potential market demand/ growth			
FGD5	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Vegetables	(Most attractive)
					Marshi rice, beans, barley, potato, apple, walnut, chilli, garlic, pea, radish, horse gram
		Medium		Millet, wheat, maize, soybean, cabbage, cauliflower, brinjal, pumpkin	Buckwheat, onion, tomato
		Low	Latte, lentil, bitter gourd	porso millet, foxtail millet, carrot, capsicum, black lentil, mung beans	
			Low	Medium	High
		Potential market demand/ growth			

ANNEXE 3: ATTRACTIVENESS MATRIX – PATARASI, JUMLA DISTRICT

FGD 1	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Maize	(Most attractive)
					Potato, beans, buckwheat, carrot, chilli, apple, walnut, mustard
		Medium			Vegetables, garlic, radish, cucumber
		Low	Naked barley, barley, wheat, chayote squash, pea, pumpkin, soybean	Millet, barley	Black marshi rice, garlic, radish, cucumber
			Low	Medium	High
		Potential market demand/ growth			
FGD 2	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Vegetables	(Most attractive)
					Beans, apple, chayote squash, walnut, mashi rice, potato, carrot, chilli
		Medium		Cucumber, foxtail millet	
		Low	Barley, wheat, naked barley, chayote squash, radish, turnip, pumpkin, maize, millet	Mustard	Bukwheat, tomato
			Low	Medium	High
		Potential market demand/ growth			

FGD 3	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Apple, walnut, beans, potato, buckwheat, marshi rice, porso millet, foxtail millet, vegetable seed
		Medium			Millet, maize, garlic, cauliflower, vegetables
		Low	Chayote squash, naked barley, barley, wheat		
			Low	Medium	High
		Potential market demand/ growth			
FGD 4	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Maize, buckwheat, walnut, porso millet, foxtail millet, soybean, barley, wheat	(Most attractive)
					Beans, potato, apple
		Medium			Vegetables
		Low	Millet		
			Low	Medium	High
		Potential market demand/ growth			
FGD 5	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Maize, millet, barley, wheat	(Most attractive)
					Potato, beans,
		Medium			Porso millet, foxtail millet, buckwheat, apple, walnut, garlic
		Low		Mustard	Marshi rice, black marshi rice
			Low	Medium	High
		Potential market demand/ growth			

ANNEXE 4: ATTRACTIVENESS MATRIX – BUDHINANDA, BAJURA DISTRICT

FGD 1	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Wheat, paddy		(Most attractive)
					Millet, beans, maize, potato
		Medium	Pumpkin, radish	Barley, soyabean, onion	Pulses, cauliflower, tomato, cucumber, chilly
		Low	Yam, taro	Turmeric, small green peas	Buckwheat, Amaranth, foxtail millet, porso millet, walnut
			Low	Medium	High
		Potential market demand/ growth			

FGD 2	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Millet, maize, olive, peach, bitter gourd		(Most attractive)
					Wheat, beans, apple, potato, paddy, cabbage, chilly, lemon, spinach, onion
		Medium		Soyabean, broadleaf mustard, pumpkin, small green peas, papaya, radish, brinjal, coriander	
		Low	Amaranth, barley, cardamom, mushroom, mango, sorrel, kiwi, broccoli, snake gourd, avocado, fenugreek, pear, amaranth		Buckwheat, foxtail millet, porso millet, pulses, walnut, cauliflower, turmeric, tomato, cucumber, bitter gourd, carrot, grapes, pomegranate
			Low	Medium	High
		Potential market demand/ growth			
FGD 3	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Millet, wheat, beans, maize, potato, barley, paddy
		Medium	Radish	Soyabean, cauliflower, cabbage, broadleaf mustard, tomato, cucumber, garlic	Apple, pulses, chilly
		Low	Buckwheat, amaranth, foxtail millet, porso millet, pumpkin, small green peas, spinach, garden cress, cardamom, sugarcane, sunflower, brinjal, papaya	Carrot, radish, lemon, guava, almond	Turmeric, walnut, olive, onion, orange, pomegranate, mango, grapes, ginger, mustard, banana
			Low	Medium	High
		Potential market demand/ growth			
FGD 4	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Maize	(Most attractive)
					Millet, wheat, paddy, beans, apple, potato, pulses, cauliflower, cabbage, broadleaf mustard, tomato, cucumber, chilly
		Medium		Foxtail millet, porso millet, barley, soyabean, walnut, pumpkin, small green peas, spinach, radish, carrot, red radish, bitter gourd, taro	
		Low	Turmeric, buckwheat, amaranth, olive, garden cress, cardamom		
			Low	Medium	High
		Potential market demand/ growth			

FGD 5	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Millet, wheat, paddy, foxtail millet, buckwheat, barley		(Most attractive)
					Onion, cauliflower, cabbage, garlic, carrot, apple, spinach, potato, beans, small green peas, tomato, chilly, walnut, broadleaf mustard, cucumber, orange, lemon
		Medium	Maize, broad beans, soyabean, pumpkin, peach		
		Low	Millet, turmeric, kiwi		
			Low	Medium	High
		Potential market demand/ growth			

ANNEXE 5: ATTRACTIVENESS MATRIX – TRIVENI, BAJURA DISTRICT

FGD 1	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Millet, peach, guava	Maize	(Most attractive)
					Foxtail millet, ginger, soyabean, potato, lemon, cabbage, onion, mustard, radish, cucumber, banana
		Medium	Paddy, wheat, bitter gourd, pumpkin, kiwi	Okhar, tomato, almond, bitter gourd	Coriander, cauliflower
		Low	Barnyard millet, pear, garlic, turmeric, papaya, sweet lime, sour leafy green, sponge gourd	Cardamom, barley, grapes	Horse gram, orange, round chilli, pigeon pea, sesame, mustard, black gram, red lentil, carrot, apple
			Low	Medium	High
		Potential market demand/ growth			
FGD 2	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Pear		(Most attractive)
					Millet, ginger, soyabean, potato, maize, lemon, coriander, cabbage, onion, small green peas, broadleaf mustard
		Medium		Barnyard millet, black gram, turmeric	Beans, walnut, orange, cauliflower, tomato, paddy, wheat, yam
		Low	Sweet orange		Buckwheat, foxtail millet, horse gram, round chilli, cardamom, kiwi, mushroom, barley, almond, sugarcane, carrot, wild leafy green
			Low	Medium	High
		Potential market demand/ growth			

FGD 3	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Millet, ginger, soyabean, beans, potato, maize, cauliflower, cabbage, onion, soyabean, wheat, paddy, banana, tomato, brinjal, cardamom, Szechuan pepper, leafy green
		Medium		Barnyard millet, horse gram, orange, lemon, coriander, pear, red lentil, turmeric, broadleaf mustard, spinach, cucmber, radish, soapnut, guava	
		Low	Buckwheat, foxtail millet, walnut, cardamom, vine spinach, round chilli, black gram, nettle leaves, yam, wild leafy green, sesame, apple, carrot, sugarcane, grapes		
			Low	Medium	High
		Potential market demand/ growth			
FGD 4	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Millet, maize, wheat, paddy, potato, onion, soyabean
		Medium		Orange, okhar, lemon, cauliflower, cabbage, barley, pear, nettle leaves, pigeon pea, radish	Ginger, turmeric, garlic, red lentil, black gram, Szechuan pepper
		Low	Guava, wild leafy green	Beans, mustard, coriander, sesame, carrot, garden cress	Buckwheat, foxtail millet, barnyard millet, round chilli, horse gram, kiwi, cardamom
			Low	Medium	High
		Potential market demand/ growth			
FGD 5	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Barnyard millet, ginger, orange, paddy, kiwi, cucumber, pumpkin, gourd, tomato		(Most attractive)
					Buckwheat, soabean, beans, potato, maize, lemon, round chilli, turmeric, red lentil, wheat, mustard, onion, millet, sweet lime
		Medium	Coriander, leafy green	Spinach, wild spinach (goosefoot)	
		Low	Foxtail millet, pear, cauliflower	Nettle leaves, pigeon pea	Horse gram, walnut, cabbage, cardamom, perilla, sesame, mango, pomegranate, apple, grapes, watermeon, papaya, black gram, mung beans
			Low	Medium	High
		Potential market demand/ growth			

ANNEXE 6: ATTRACTIVENESS MATRIX – SWAMIKARTIK, BAJURA DISTRICT

FGD 1	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High			(Most attractive)
					Millet, apple, barley, porso millet, maize, onion, buckwheat, beans, Marshi rice, horse gram, banana, kiwi, dragon fruit
		Medium		Walnut, black lentil, pear	Lemon, pomegranate, mango, mustard, carrot, chilly, cucumber, brinjal, lady's finger, bitter gourd, wheat, walnut, foxtail millet
		Low	Sorghum, mung beans, pear, sweet lime, banana, red pepper, soapnuts, watermelon, pumpkin, snake gourd, sponge gourd		Orange, guava, sunflower, gourd, Himali tomato
			Low	Medium	High
		Potential market demand/ growth			
FGD 2	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Wheat, millet, maize, paddy	(Most attractive)
					Apple, walnut, onion, beans, potato, banana, lemon, pomegranate, mustard, cauliflower, cabbage, radish, carrot
		Medium		Soyabean, red lentil, small green peas, mango, papaya, orange, pear	
		Low	Olive, bajra, porso millet, foxtail millet, sorghum, barley, amaranth, buckwheat, naked barley, barnyard millet, black lentil, horse gram, pigeon peas, sour leafy greens, citron, peach, plum		
			Low	Medium	High
		Potential market demand/ growth			
FGD 3	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Olive, millet, porso millet, foxtail millet, maize, sorghum, barley, naked barley, rough lemon, appricot, pumpkin	Wheat, buckwheat, peach, soyabean, pigeon pea, spinach	(Most attractive)
					Apple, walnut, onion, beans, horse gram, banana, orange, lemon, papaya, mango, black lentils, potato, cauliflower, cabbage, coriander, spinach, garden cress, broadleaf mustard, tomato
		Medium		Pear, turnip, guava, mustard	Red lentil, turmeric, radish, paddy, pomegranate
		Low	Bajra, amaranth, Marshi rice, barnyard millet	Carrot	
			Low	Medium	High
		Potential market demand/ growth			

FGD 4	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High	Wild leafy greens	Millet, maize, barley, red radish, peach, bitter gourd, pumpkin	(Most attractive)
					Olive, carrot, porso millet, foxtail millet, apple, walnut, onion, potato, beans, horse gram, banana, lemon, cauliflower, cabbage, mustard, cucmber, tomato, chilly
		Medium		Amaranth, plum, pear, guava, papaya	Buckwheat, paddy, soyabean, black lentil, red lentil, orange, pigeon pea, mango
		Low	Sorghum		Small green peas, pomegranate
			Low	Medium	High
		Potential market demand/ growth			
FGD 5	Potential to increase rural income through smallholders and Micro, Small, and Medium Enterprises (MSMEs) engagement	High		Millet, maize	(Most attractive)
					Wheat, millet, apple, barley, walnut, onion, soyabean, black lentil, red lentil, beans, broadleaf mustard, coriander, fenugreek, carrot, potato, banana, grapes, mango
		Medium		Red radish, radish	Olive, bitter gourd
		Low	Sorghum, amaranth, barnyard millet, naked barley, horse gram, mung beans, pigeon peas, pumpkin, broad leaf mustard greens, pear, paddy rice, guava	Porso millet, foxtail millet, buckwheat, apricot, peach, finger millet	Lemon
			Low	Medium	High
		Potential market demand/ growth			

ANNEXE 7: SCORING AND RANKING – TATOPANI, JUMLA DISTRICT

Main criteria (Wt %)	Sub-criteria	Wt (Sc)	Beans (Sc)	Beans (Wt Sc)	Walnut (Sc)	Walnut (Wt Sc)	Apple (Sc)	Apple (Wt Sc)	Marshi rice (Sc)	Marshi rice (Wt Sc)	Millet (Sc)	Millet (Wt Sc)
Market demand and local supply (20%)	Existing and potential market demand	10	5	0.5	5	0.5	5	0.5	5	0.5	4.8	0.48
	Production potential to meet the market demand	10	4.4	0.44	4	0.4	3.8	0.38	3.4	0.34	3.6	0.36
Production and productivity (20%)	Potential to increase production areas	10	4.6	0.46	4.8	0.48	4.2	0.42	3.4	0.34	3.8	0.38
	Enhancement of productivity	5	4.2	0.21	4	0.2	4.2	0.21	3.6	0.18	3.2	0.16
	Access and adoption of technology for productivity	5	2.6	0.13	3.4	0.17	3.8	0.19	2	0.1	2.6	0.13
Value addition and local economy (20%)	Local processing and marketability	5	3	0.15	3.2	0.16	3.8	0.19	3	0.15	2.8	0.14
	Economic impact on local communities	5	5	0.25	4.6	0.23	4.6	0.23	4.4	0.22	3.8	0.19
	Opportunity to deploy energy for value chain development	5	3.6	0.18	3.4	0.17	4.2	0.21	3.4	0.17	2.6	0.13
	Opportunity of value addition along the VC	5	4.4	0.22	4.4	0.22	4.6	0.23	4.8	0.24	3.2	0.16
Consumption behavior and preferences (20%)	Promotion of indigenous food diversity	10	4.2	0.42	3.8	0.38	4.2	0.42	4	0.4	4.2	0.42
	Alignment with consumption trends	10	4.4	0.44	4	0.4	4.2	0.42	4.2	0.42	3.6	0.36
Rural employment and value chain linkage (20%)	Reduction of imported food consumption	10	4	0.4	3.6	0.36	3.4	0.34	3.8	0.38	2.8	0.28
	Extent to benefit women and minorit y community (employment)	5	4.6	0.23	4.2	0.21	4.8	0.24	4.6	0.23	3.4	0.17
	Linking with other value chains	5	3.8	0.19	4	0.2	4.4	0.22	3.8	0.19	3.2	0.16
Total max score		-	-	4.22	-	4.08	-	4.2	-	3.86	-	3.52

Wt Weight **Sc** Score

ANNEXE 8: SCORING AND RANKING – PATARASI RM, JUMLA DISTRICT

Main criteria (Wt %)	Sub-criteria	Wt (Sc)	Beans (Sc)	Beans (Wt Sc)	Walnut (Sc)	Walnut (Wt Sc)	Apple (Sc)	Apple (Wt Sc)	Potato (Sc)	Potato (Wt Sc)	Green veg (Sc)	Green veg (Wt Sc)
Market demand and local supply (20%)	Existing and potential market demand	10	4	0.4	5	0.5	5	0.5	4.8	0.48	4.2	0.42
	Production potential to meet the market demand	10	4	0.4	4	0.4	4.2	0.42	3.4	0.34	3.8	0.38
Production and productivity (20%)	Potential to increase production areas	10	4.2	0.42	4.4	0.44	4.6	0.46	4.8	0.48	4	0.4
	Enhancement of productivity	5	4	0.2	3.8	0.19	4.4	0.22	3.8	0.19	3.8	0.19
	Access and adoption of technology for productivity	5	2.4	0.12	2.6	0.13	3.4	0.17	2.2	0.11	3	0.15
Value addition and local economy (20%)	Local processing and marketability	5	2.8	0.14	2.6	0.13	3.6	0.18	3.2	0.16	2.2	0.11
	Economic impact on local communities	5	3.4	0.17	4.4	0.22	4.6	0.23	4.6	0.23	3.6	0.18
	Opportunity to deploy energy for value chain development	5	3	0.15	2.6	0.13	3.8	0.19	3.8	0.19	2.8	0.14
	Opportunity of value addition along the VC	5	3.4	0.17	4	0.2	4.4	0.22	4.8	0.24	3.6	0.18
Consumption behavior and preferences (20%)	Promotion of indigenous food diversity	10	3.2	0.32	3.8	0.38	3.6	0.36	3.2	0.32	3.4	0.34
	Alignment with consumption trends	10	3.4	0.34	4	0.4	3.6	0.36	3.4	0.34	3	0.3
Rural employment and value chain linkage (20%)	Reduction of imported food consumption	10	2.8	0.28	3.4	0.34	3.4	0.34	4	0.4	3	0.3
	Extent to benefit women and minorit y community (employment)	5	3.8	0.19	4.2	0.21	4.8	0.24	3.6	0.18	3.6	0.18
	Linking with other value chains	5	2.8	0.14	3.6	0.18	4.2	0.21	4.2	0.21	3	0.15
Total max score		-	-	3.44	-	3.85	-	4.1	-	3.87	-	3.42

Wt Weight **Sc** Score

ANNEXE 9: SCORING AND RANKING – BUDHINANDA, BAJURA DISTRICT

Main criteria (Wt %)	Sub-criteria	Wt (Sc)	Beans (Sc)	Beans (Wt Sc)	Walnut (Score)	Walnut (Wt Sc)	Apple (Score)	Apple (Wt Sc)	Potato (Sc)	Potato (Wt Sc)	Green veg (Sc)	Green veg (Wt Sc)
Market demand and local supply (20%)	Existing and potential market demand	10	4	0.4	5	0.5	5	0.5	4.8	0.48	4.2	0.42
	Production potential to meet the market demand	10	4	0.4	4	0.4	4.2	0.42	3.4	0.34	3.8	0.38
Production and productivity (20%)	Potential to increase production areas	10	4.2	0.42	4.4	0.44	4.6	0.46	4.8	0.48	4	0.4
	Enhancement of productivity	5	4	0.2	3.8	0.19	4.4	0.22	3.8	0.19	3.8	0.19
	Access and adoption of technology for productivity	5	2.4	0.12	2.6	0.13	3.4	0.17	2.2	0.11	3	0.15
Value addition and local economy (20%)	Local processing and marketability	5	2.8	0.14	2.6	0.13	3.6	0.18	3.2	0.16	2.2	0.11
	Economic impact on local communities	5	3.4	0.17	4.4	0.22	4.6	0.23	4.6	0.23	3.6	0.18
	Opportunity to deploy energy for value chain development	5	3	0.15	2.6	0.13	3.8	0.19	3.8	0.19	2.8	0.14
	Opportunity of value addition along the VC	5	3.4	0.17	4	0.2	4.4	0.22	4.8	0.24	3.6	0.18
Consumption behavior and preferences (20%)	Promotion of indigenous food diversity	10	3.2	0.32	3.8	0.38	3.6	0.36	3.2	0.32	3.4	0.34
	Alignment with consumption trends	10	3.4	0.34	4	0.4	3.6	0.36	3.4	0.34	3	0.3
Rural employment and value chain linkage (20%)	Reduction of imported food consumption	10	2.8	0.28	3.4	0.34	3.4	0.34	4	0.4	3	0.3
	Extent to benefit women and minorit y community (employment)	5	3.8	0.19	4.2	0.21	4.8	0.24	3.6	0.18	3.6	0.18
	Linking with other value chains	5	2.8	0.14	3.6	0.18	4.2	0.21	4.2	0.21	3	0.15
Total max score		-	-	3.44	-	3.85	-	4.1	-	3.87	-	3.42

Wt Weight **Sc** Score

ANNEXE 10: SCORING AND RANKING – TRIVENI, BAJURA DISTRICT

Main criteria (Wt %)	Sub-criteria	Wt (pts)	Maize (Sc)	Maize (Wt)	Soybean (Sc)	Soybean (Wt)	Potato (Sc)	Potato (Wt)	Onion (Sc)	Onion (Wt)	Millet (Sc)	Millet (Wt)
Market demand (20%)	Existing and potential demand	10	4.2	0.42	4.4	0.44	4.6	0.46	4.2	0.42	4.4	0.44
	Production potential	10	4.2	0.42	3.2	0.32	3.8	0.38	3.4	0.34	3.6	0.36
Production (20%)	Area increase potential	10	4.2	0.42	4.4	0.44	4.2	0.42	4	0.4	4	0.4
	Productivity enhancement	5	4	0.2	3.2	0.16	3.8	0.19	3.2	0.16	3.8	0.19
	Tech adoption	5	2.8	0.14	2.4	0.12	3.6	0.18	2.8	0.14	2.6	0.13
Local economy (20%)	Processing/marketability	5	3	0.15	3	0.15	3.4	0.17	3.2	0.16	3.2	0.16
	Community impact	5	3.6	0.18	3.4	0.17	4	0.2	3.4	0.17	2.8	0.14
	Energy for VC	5	3	0.15	2.4	0.12	3.6	0.18	2.6	0.13	3.6	0.18
	Value addition opportunities	5	3.2	0.16	3.6	0.18	3.6	0.18	3	0.15	2.4	0.12
Consumption (20%)	Food diversity	10	3	0.3	3.2	0.32	3.2	0.32	3.8	0.38	3.6	0.36
	Consumption trends	10	4.2	0.42	3.2	0.32	3.8	0.38	3	0.3	3.4	0.34
Employment (20%)	Import reduction	10	3.2	0.32	3.2	0.32	4	0.4	3.4	0.34	4	0.4
	Women/minority benefit	5	3.6	0.18	3.2	0.16	4	0.2	3.2	0.16	4	0.2
	VC linkages	5	2.6	0.13	2.8	0.14	3.4	0.17	3	0.15	3.2	0.16
Total max score				3.6		3.4		3.8		3.4		3.6

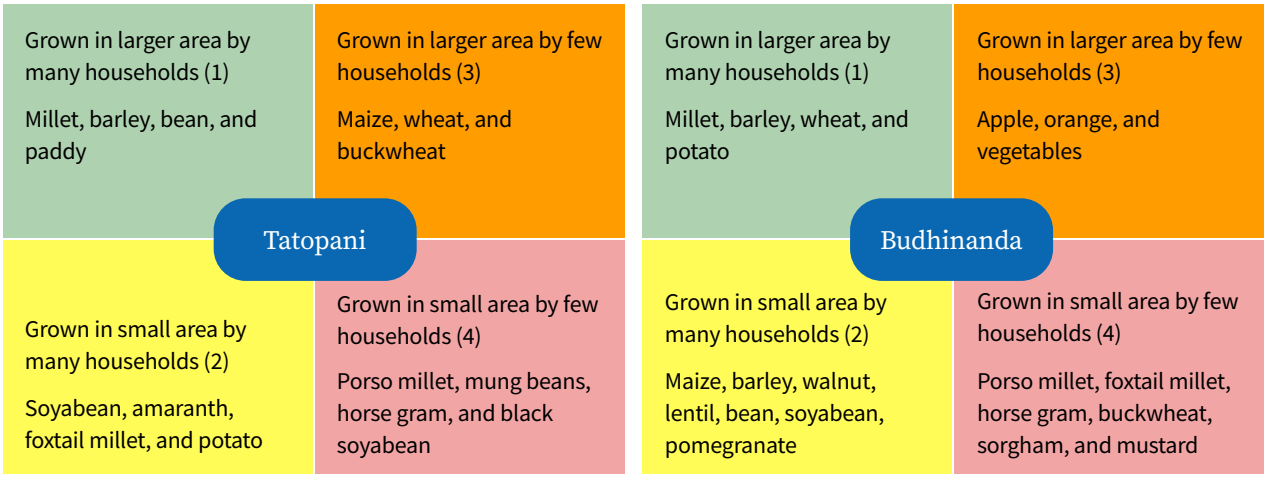
Wt Weight **Sc** Score

ANNEXE 11: SCORING AND RANKING – SWAMIKARTIK, BAJURA DISTRICT

Main criteria (Wt %)	Sub-criteria	Wt (pts)	Apple (Sc)	Apple (Wt)	Onion (Sc)	Onion (Wt)	Beans (Sc)	Beans (Wt)	Walnut (Sc)	Walnut (Wt)	Banana (Sc)	Banana (Wt)
Market demand (20%)	Existing and potential demand	10	5	0.5	4.6	0.46	5	0.5	4.6	0.46	5	0.5
	Production potential	10	4.8	0.48	4.6	0.46	4	0.4	3.4	0.34	3.2	0.32
Production (20%)	Area increase potential	10	5	0.5	4.6	0.46	4.4	0.44	4.4	0.44	4	0.4
	Productivity enhancement	5	4.4	0.22	4.6	0.23	4.2	0.21	3.8	0.19	4.2	0.21
	Tech adoption	5	3	0.15	2.6	0.13	1.8	0.09	1.6	0.08	2.4	0.12
Local economy (20%)	Processing/marketability	5	3.6	0.18	2.6	0.13	3.8	0.19	2.8	0.14	2.8	0.14
	Community impact	5	4	0.2	4	0.2	4	0.2	3.8	0.19	3.8	0.19
	Energy for VC	5	3	0.15	2.8	0.14	3	0.15	2.6	0.13	3.2	0.16
	Value addition opportunities	5	3.4	0.17	3.4	0.17	3.8	0.19	3	0.15	3.2	0.16
Consumption (20%)	Food diversity	10	4.4	0.44	4.2	0.42	4.6	0.46	3.2	0.32	4	0.4
	Consumption trends	10	3.4	0.34	4	0.4	4.2	0.42	4	0.4	4.2	0.42
Employment (20%)	Import reduction	10	3.4	0.34	2.8	0.28	4.2	0.42	3.8	0.38	3.4	0.34
	Women/minority benefit	5	4.2	0.21	4.6	0.23	4.2	0.21	4	0.2	4.2	0.21
	VC linkages	5	4.2	0.21	2.6	0.13	2.8	0.14	2.4	0.12	3.2	0.16
Total max score				4.09		3.84		4.02		3.54		3.73

Wt Weight **Sc** Score

ANNEXE 12: FOUR-CELL ANALYSIS OF LOCAL CROPS IN TATOPANI AND BUDHINANDA MUNICIPALITIES



ANNEXE 13: POST-HARVEST LOSS DURING THE PROCESSING STAGE OF THE FIVE IDENTIFIED CROPS IN DIFFERENT MUNICIPALITIES

Palikas	Crops	Post-harvest processing	Estimated weight loss
Tatopani	Marshi Rice	Combine harvesting, threshing, sundry	7%
	Apple	Picking, storage, collection, transport	16-19%
	Walnut	Picking, storage, collection, transport	2%
	Beans	Picking, storage, collection, transport	1%
	Buckwheat	Picking, storage, collection, transport	15%
Patarasi	Apple	Combine harvesting, threshing, sundry	10-14%
	Walnut	Picking, storage, collection, transport	2-3%
	Vegetables	Picking, storage, collection, transport	10-20%
	Potato	Picking, storage, collection, transport	13-17%
	Beans	Picking, storage, collection, transport	2-5%
Budhinanda	Apple	Picking, storage, collection, transport	20%
	Potato	Picking, storage, collection, transport	10%
	Beans	Picking, storage, collection, transport	15%
	Paddy	Picking, storage, collection, transport	10%
	Vegetables	Picking, storage, collection, transport	5%
Triveni	Maize	Combine harvesting, threshing, sundry	14%
	Soybean	Picking, storage, collection, transport	22%
	Potato	Picking, storage, collection, transport	13%
	Onion	Picking, storage, collection, transport	4%
	Millet	Picking, storage, collection, transport	15%
Swamikartik	Onion	Picking, storage, collection, transport	20%
	Apple	Solar drying, electric dryer	20%
	Bean	Picking, storage, collection, transport	15%
	Banana	Picking, storage, collection, transport	10%
	Walnut	Picking, storage, collection, transport	5%

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