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Building Resilient Food Systems in Two Municipalities of Dolpa District in Karnali Province, Nepal

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ABSTRACT

Food insecurity is becoming an alarming global challenge. It is more severe in the Global South. This study aimed to examine the food insecurity in local communities in the Dolpa district of Karnali province, a remote region in northwestern Nepal. The study used a convergent parallel mixed research design to explain food insecurities and community resources to mitigate them in Thulo Bheri and Tripurasundari municipalities in Dolpa. A survey was conducted among 388 households between September to November 2024. A structured questionnaire on food security measurement frameworks was used to evaluate household experiences of food insecurity. Six key informant interviews supplemented the survey results. The study found that factors such as remoteness, ruggedness, inaccessibility, and low crop variety determine the state of food security in the isolated municipalities of the Himalayan region. These factors also determine local food production, consumption, and nutritional intake. Therefore, due to an uncertain state of local food availability, food insecurity remains high in the study area, especially in the Thulo Bheri municipality, with only 46.13% of households sustaining for 7-9 months annually for sufficient food. Despite these situations, food resilience is achieved by local households through the long-standing economic opportunities and resources within communities. Community resources include earnings from herbs, food aid, and barter systems among households during shortages and high-demand times of the year. The study concludes that strengthening long-standing local options and targeted food supply systems can form food resilience in the region.

1. INTRODUCTION

Food insecurity is an alarming global issue challenging public health, peace, and sustainable development. Studies estimated that about 2.4 billion people worldwide are experiencing either moderate or severe food insecurity. Reports show that nearly 9 percent of the global population is undernourished in 2023. The highest percentage of the population living in hunger is in Africa (20.4%), while Asia has the highest number of people (384.5 million) facing hunger. Studies indicate that, as in several other sustainable development indicators, the Global South is far behind in maintaining the state of food security.

Nepal's Food insecurity impedes achieving the Sustainable Development Goals by 2030. According to the Nepal Demographic and Health Survey 2022, over half of the households (52%) are food insecure, with 20% mildly food insecure, 22% moderately food insecure, and 10% severely food insecure. Malnourishment among children under 5 years is 36%. In the Global Hunger Index (GHI), Nepal is at 69th position out of 125 countries (NPC, 2023). Despite slow progress in the hunger index, Nepal still lies in the red zone of food insecurity because of its disaster-prone geography, geographic challenges, rain-fed agriculture, disproportionate growth of the market, low technology, and climate vulnerabilities (NPC, 2023). Karnali Province is the most food-insecure region of Nepal, with all ten of its districts classified as highly vulnerable (Adhikari et al., 2023). Dolpa District, situated in the province's remote northwest, experiences acute levels of food insecurity due to harsh climatic conditions, rugged topography, and minimal market integration. Within Dolpa, this study focuses on two municipalities—Thulo Bheri and Tripurasundari—which vary in terms of their physical accessibility and economic infrastructure.

This study addresses the following research questions:

- What are the key manifestations and drivers of food insecurity in remote areas of Nepal's Himalayan region?
- To what extent do local economic practices and food sources contribute to food system resilience in these isolated settings?

By situating the analysis within the broader discourse on food security and resilience, this study aims to contribute empirical insights into how geographically marginalized communities in South Asia cope with chronic food shortages and structural vulnerabilities.

1.1 Context of the Study

Among the seven provinces, Karnali province is considered the most food-insecure in Nepal (Adhikari et al., 2023). Inadequate infrastructure, harsh climate, high incidence of poverty, and limited economic opportunities exacerbate food insecurity, resulting in significant malnutrition rates. The region's economic instability also prompts out-migration, further reducing local agricultural output (Regmi et al., 2023).

Results from the UN Food Insecurity Experience Scale survey 2018 showed that 28% of the households had moderate and severe levels of food insecurity, and 7% of total households had severe food insecurity in the province. Moderate and severe food insecurity is most prevalent in the mountain districts of the province, where municipalities and settlements are less accessible, with a 60% prevalence rate against a lower 16% in the hill districts (Regmi et al., 2023). Studies also show that a high level of dependencies, support service deficiencies, and feminization of agriculture lead to food insecurity. These symptoms suggest that there are both structural as well as operational challenges that demand a high level of commitment and strategic plans to improve the situation (Thapa, 2020). Its remote location, harsh climate, and poor infrastructure add to other layers of food insecurity in the province. Additionally, lower agricultural productivity, higher poverty, and limited economic opportunities exacerbate malnutrition and drive migration, perpetuating a cycle of poverty and food scarcity (Sapkota, 2022). These challenges perpetuate the region's financial instability, creating a cycle of poverty and food insecurity that is difficult to break without substantial improvements in infrastructure, agricultural practices, education, job opportunities, and healthcare services (Sampson et al., 2021).

Among eight municipalities in the Dolpa district, two municipalities, Thulo Bheri and Tripurasundari, were selected for this study. Although these two municipalities cover over half of the district's total population (51%) (GoN, 2021), they are the least accessible due to rugged terrain and limited transportation infrastructure. The district was only connected to the national road network (the Karnali Highway) in 2023. Due to harsh climate-caused landslides, the road's operation is possible for four months during winter. Geographic isolation contributes to food security vulnerability, as it affects the availability and accessibility of food sources (Smith, Obeid, & Jensen, 2000).

Comparing the two municipalities, Thulo Bheri is more advantageous in terms of accessibility than Tripurasundari because in the former lies Jufal Airport and Dunai, the district's headquarters. The Jufal Bazaar and Dunai are the only two service centers in the district. Even though 16 km of the Karnali Highway now runs through Tripurasundari municipality, a significant part of it is rugged mountains, isolated small valleys, and settlements of over a hundred. People from the municipality visit either Jufal or Dunai to receive services, including purchasing food and healthcare essentials.

The demographic structure of these two municipalities is predominantly rural and belongs to marginalized ethnic groups such as the Dolpo communities. Additionally, agriculture is the primary livelihood source for the residents of Dolpa, including those in Thulo Bheri and Tripurasundari municipalities. The region's agricultural productivity is heavily dependent on rain and is impacted by climate change, including erratic rainfall, droughts, and floods (Thapa, 2020).

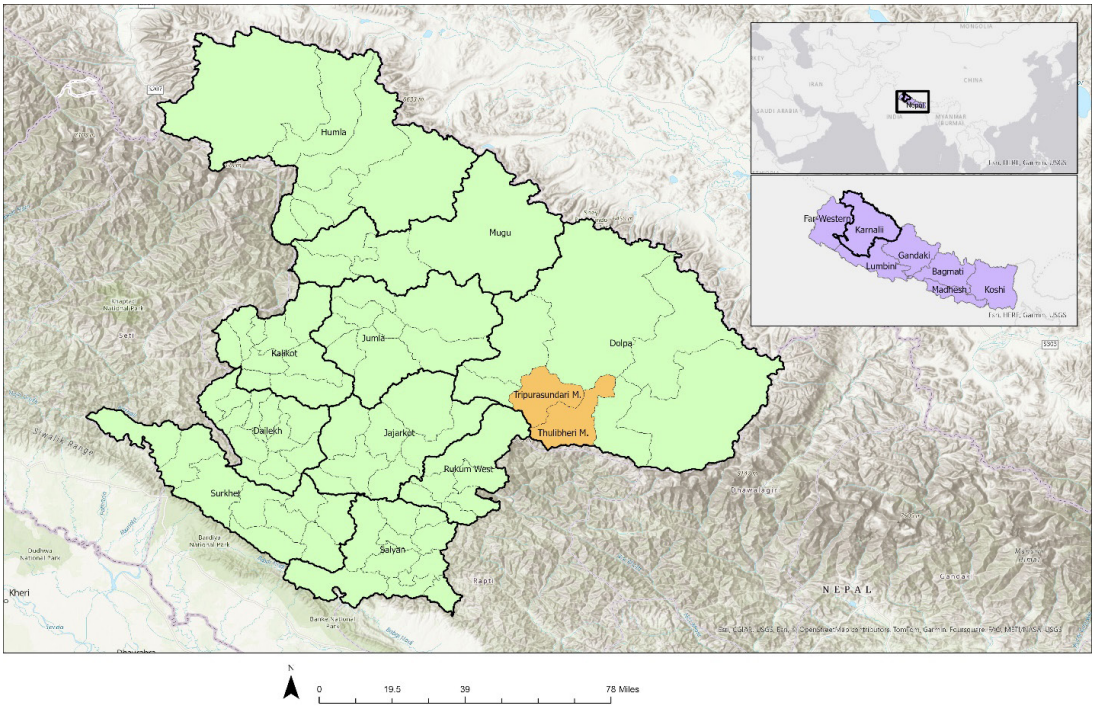

FIG 1 Thulo Bheri and Tripurasundari Municipalities

To explore the research questions mentioned above, this study examined the food consumption patterns and food insecurity experiences of the households in the Thulo Bheri and Tripurasundari municipalities of the Dolpa district of the Karnali Province. To define food security, this study followed World Food Summit, 1996 which stated that food security is defined as when all people, at all times, have physical as well as economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996).

2. REVIEW OF LITERATURE

2.1 Food Insecurity: Definitions, Causes, and Effects

Food security is a multi-dimensional concept encompassing food availability, access, utilization, and stability. Maxwell and Smith (1992) define food security as securing food access by all people at all times for a healthy and active life. This definition emphasizes the food security dimensions as accessibility, universality, and sustainability, highlighting that all individuals must consistently have access to adequate food that supports a healthy and active lifestyle without temporal or demographic limitations. The Food and Agriculture Organization (FAO) (1996) describes food security as enough food access by all people at all times for an active, healthy life. It defined food security as consistent access to sufficient, safe, and nutritious food for an active, healthy life, emphasizing food quality. FAO's definition

of food security not only stresses the importance of accessibility and consistency but also integrates the economic, social, and individual aspects that influence an individual's ability to secure adequate food (Alonso, Cockx, & Swinnen, 2018). Sen (1981) conceptualizes food security as "entitlements," which are the set of commodity bundles over which people have their choices for food. This dimension emphasizes the ability to access food through various means, such as production, purchase, or social safety nets, highlighting the economic and social mechanisms that ensure food access.

Experiencing food insecurity means facing uncertainty or difficulty in accessing adequate food due to economic, social, or environmental constraints. Individuals or households may experience reduced quality, variety, or desirability of diet and may face disruptions in eating patterns or reduced food intake (Cole et al., 2018).

The FAO (1996) explained four dimensions of food security: availability, accessibility, utilization, and food stability. Food availability refers to the physical presence of food in a region, which is influenced by domestic production, imports, food aid, and stock levels. This dimension is often assessed by examining agricultural productivity, supply chains, and the balance between food production and population growth (Prosekov & Ivanova, 2018).

Food accessibility, the second dimension, encompasses individuals' economic and physical ability to obtain adequate food for a nutritious diet. This dimension is influenced by income levels, food prices, social protection measures, and infrastructure (Mbow et al., 2020). Physical access, on the other hand, can be hindered by inadequate transportation networks, market inefficiencies, or conflict. Rural areas in developing countries frequently face market access challenges, leading to higher food prices and reduced variety. Addressing economic and physical barriers is essential to improving food security, particularly for vulnerable populations (Cole et al., 2018).

Food utilization, the third dimension, refers to the proper biological use of food, requiring a diet that meets individuals' nutritional needs and the ability to process and store food properly. This dimension is intertwined with health, sanitation, education, and food safety (McCarthy et al., 2018). It involves the ability of individuals to meet their nutritional needs and preferences (Pinstrup-Andersen, 2009).

Stability, the fourth dimension, pertains to the consistency and reliability of food availability, access, and utilization over time. This dimension considers the risks and vulnerabilities that might disrupt food security, such as economic shocks, climate change, natural disasters, and political instability (Cole et al., 2018).

Food insecurity can arise from a combination of complex and interconnected factors. Valdes (2019) highlights poverty as the primary cause, while Fung et al. (2018) describe unemployment and underemployment as the factors causing food insecurity. Fluctuations in food prices, influenced by factors such as global markets and climate events affecting

agricultural production and transportation costs, can also impact food affordability (Mbow et al., 2020). Several studies found that climate variability, extreme weather events (e.g., droughts, floods), and environmental degradation can reduce crop yields and livestock losses and increase food insecurity (Pawlak & Kołodziejczak, 2020; Yobon). Limited access to land, water, seeds, technology, and agricultural inputs can hinder agricultural productivity and food production (Mbow et al., 2020). Insufficient or ineffective social safety nets, such as food assistance programs, social pensions, and nutritional support, fail to protect vulnerable populations from food insecurity during economic hardship or crises (Pinstrup-Andersen, 2009).

Muriuki et al. (2023) also found a causal relationship between armed conflict and household food insecurity. Studies also highlight geographic isolation and remoteness as the determinants of food insecurity. Smith, Obeid, and Jensen (2000) explored that poverty-ridden South Asian countries in Sub-Saharan Africa face severe food insecurity, which is further complicated by low national food availability and health and care services. In isolated islands, households face food insecurity due to limited cultivable lands, high reliance on food imports, unbalanced diets, and remoteness.

2.2 Food Insecurity Measurements

Multiple approaches and models were established to measure and quantify food insecurity. Manicas et al. (2023) evaluated 78 publications that covered the food security measurement indicators, and these publications used the household calorie intake as a major indicator of food security. The authors argue that the experience-based measurement of food security is more suitable for rapidly assessing food security at the household level.

The global food security measurement uses the Food Insecurity Experience Scale (FIES). It is a measurement of food access at the individual or household level that quantifies the severity of food insecurity based on self-reported constraints in obtaining adequate food. Unlike other food security measurements based on food availability or malnutrition indicators, FIES directly captures personal experiences of food insecurity (Ballard et al., 2013). It was developed from the U.S. Household Food Security Survey Module and the Latin American and Caribbean Food Security Scale, comprising eight yes/no questions (Nord et al., 2016; Cafiero et al., 2018). These questions represent three key domains: uncertainty/anxiety, food quality changes, and food quantity reductions; thus enabling respondents to be classified by severity of food insecurity (Smith et al., 2017). It has particular potential as a cross-disciplinary indicator capable of promoting the link between different sectoral perspectives, i.e., the link between nutrition and agriculture. It is an experience-based metric of the severity of food insecurity that relies on people's direct responses to questions regarding their access to adequate food. It has the potential to provide valid and reliable population estimates of food insecurity in different countries (Ballard et al., 2013).

The US Department of Agriculture (USDA) uses the four categories of food security in the United States. The upper two scales are high food security and marginal food security, whereas

the two lower scales for food insecurity are low and very low. High food security includes households without any indication of food insecurity, whereas marginal category households have one or two indications of food insecurity. Low food security includes households with reduced quality, quantity, and diet choices, and very low food security includes households with multiple incidents and evidence of disrupted eating patterns.

Lack of micro-level indicator testing and lack of coordination and collaboration have resulted in global inconsistencies and delays in food security measurements (Carleto, Zezza, & Benergi, 2013). There is a need for small dashboard indicators in higher frequencies to better measure food insecurities at different levels. This study tests the variety of food security indicators and local resources to resolve insecurities in isolated mountain areas.

2.3 Food Resilience in the Mountains of Nepal

Food resilience is a system that produces, supplies, and avails food for people with abundant food, with no disruptions. Changes in food production processes, distribution disruption, and response to these disturbances impact the food system resilience (Tendal et al., 2015). In order to maintain the supply, quality, and response to the disruption, the food system should have three Rs as resilience-building options. They are robustness, recovery, and reorientation (Zurek et al. 2022). Such resilience involves adapting to changing circumstances, resisting the growing supply vulnerabilities and disruptions, and adapting to alternative options for food supply and maintenance (Ingram et al., 2023).

In the unique territories of the Himalayas, the food system resilience is directly associated with the geography, supply systems, and local productivity. They are not extensively discussed in the established literature on food system resilience. However, several studies presented a risky state of food system resilience in Karnali Province that impacted the community's well-being in remote locations. They have used the socioeconomic, demographic, and geographic characteristics of places and residents in these analyses.

In a study, Janak et al. (2023) found a strong correlation between household food security and socio-demographic factors such as ethnicity, family size, wealth, education level, and province of residence in Nepal. The gender of the household head, marital status, the number of U-5 children living at home, and ecological zone, however, had no discernible impact on the household's food security. Paudel et al. (2023) discovered a significant correlation between respondents' careers, education, and household food insecurity in Nepal. Pandey and Fusaro (2020) found that more than two third Dalit women experienced food insecurity in Nepal. The study revealed that ethnicity is highly associated with food insecurity. Dalit women were 82, 85, 89, and 92% more likely to face food insecurity compared to Muslims, Brahmin/Chhetri, Terai Indigenous, and Hill indigenous people, respectively. Sapkota (2022) explored that regarding food security, the Terai (plain area of Nepal) region was in a better situation than the hill and mountain regions, and the urban area was more secure than the rural ones. Karnali Province did poorly.

Localization of food insecurity is rampant in the Himalayas. Thapa and Hussain (2021) discovered that most households in the Jumla district of Karnali province have limited dietary diversification, with 42% experiencing food insecurity. Thapa (2020) found natural disasters and structural causes responsible for food and nutrition insecurity in the Karnali province. The structural causes include insufficient investment in agriculture, geographic isolations, the feudal land tenure system, poor infrastructure development, mismanagement of food, weak distribution system, poor governance, lower gender sensitivity, and shortage of agricultural labor.

The geographic isolation and deprivation of services have created a higher dependency on government-provided food in the Himalayan districts. Gautam (2019) examined the dependency narrative in light of empirical data produced by a mixed-method study conducted in Humla district, a highly food-insecure district in the Karnali province. Bhandari (2018) found that food security status significantly varied by province in Nepal. Compared to households in other provinces, people residing in Karnali and Far-West provinces experienced higher levels of food insecurity. Singh et al. (2018) revealed that abandoned cultivable lands, unplanned development, limited agriculture and deforestation, and limited transportation and market facilities have left agriculture in this province far behind, and climate change, as an emerging danger, has further jeopardized food security in the region.

Food security is connected with the resilience of local food systems. Bene (2020) has identified that local diversification, connectivity, and substitutions are some of the options to develop food security during the severe disruption of the food system. The author has used the food system disruption created by COVID-19 (Bene, 2020). Local farming has a significant role to play when there is a disruption in the production, supply, and distribution systems. In such situations, local farms have retained various indigenous crops, and contemporary agricultural innovation has boosted on-farm crop diversification, leading to higher food resilience in these districts. There are limited studies about the role of local crops and farming systems in boosting food system resilience, especially in geographically isolated rural areas.

3. RESEARCH METHODS

3.1 Research Design

This study employed a convergent parallel mixed methods design (Creswell and Clark, 2009) to examine food insecurity patterns and local resilience mechanisms in Thulo Bheri and Tripurasundari municipalities in Dolpa District, Karnali Province, Nepal. The design integrated quantitative data from a household survey with qualitative data from key informant interviews. The descriptive component focused on the extent of food availability, food skipping behaviors, and household coping strategies, while the exploratory strand investigated local production systems and accessibility constraints.

Food insecurity was analyzed as a function of several independent variables, including household food production, geographic remoteness, demographic characteristics, and local adaptation practices. The comparison between Thulo Bheri and Tripurasundari municipalities

served as the key dependent variable in assessing geographic and systemic disparities in food access and resilience.

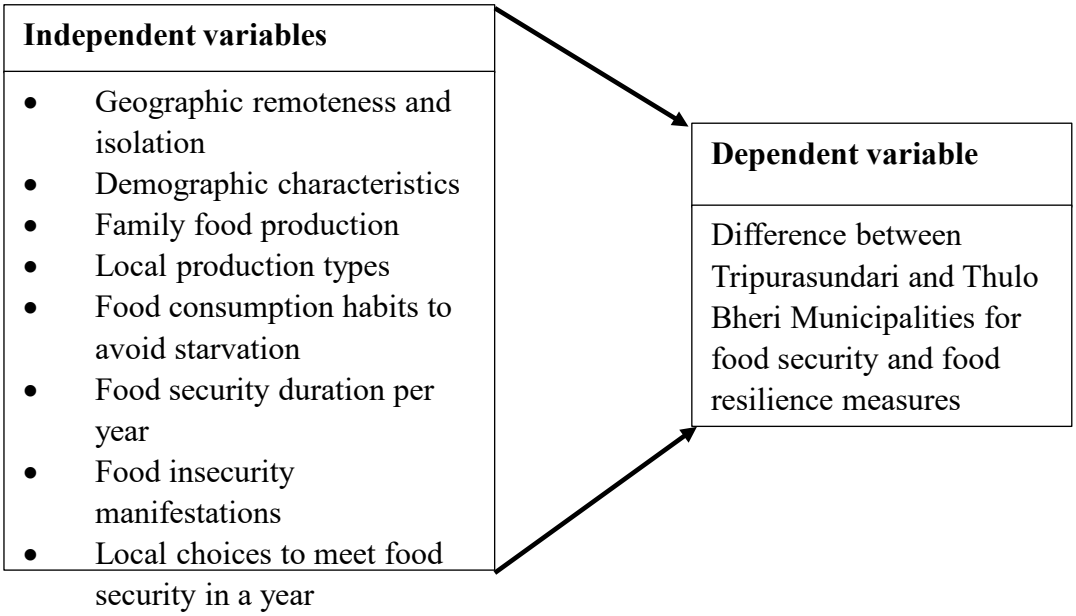

FIG 2 Conceptual framework of the Study

3.2 Sampling Procedure and Sample Size

The total number of households in Thulo Bheri and Tripurasundari municipalities of Dolpa district is the universe of this study. According to the government of Nepal (GoN) (2021), there are altogether 4,949 households (2,622 in Tripurasundari and 2,327 in Thulo Bheri) in the two municipalities. This study applied a stratified sampling method for sample selection by grouping the strata of households of the two municipalities (Mohajan, 2020). A lottery method was applied for the sample selection from each stratum, where the household's identity number was the basis of identification. Under the stratified sampling method, the non-proportional method was implemented in the study.

This study approached 388 households, more than the theoretical minimum sample size required. The individual respondents are considered the sample unit because the survey instruments were applied to the members of the sampled households.

The sampling process began with identifying primary sampling units (PSUs), consisting of wards of Thulo Bheri and Tripurasundari Municipalities. Municipal maps containing geographical divisions of wards were obtained, and Households of both municipalities were divided into two strata for each municipality. From each stratum, a certain number of wards were drawn randomly. After the selection of strata, the sample was identified using the lottery method, and according to this identification, researchers visited the households and

conducted scheduled interviews with the household head or older member (if the household head was absent). The sample of 388 households is proportionately divided among the wards the total households in the ward.

3.3 Instruments of Data Collection

The survey questionnaire is the primary data collection tool of the study. The first part of the survey included demographic data like ethnicity, gender, family types, and main family occupation using a categorical scale; the second part consisted of questions related to land holding, irrigation facilities, and distance to the market, vital variables to determine food insecurity. The study focused on examining the food insecurity experiences of the households in the study area. The scale is an experience-based metric that measures the severity of food insecurity by the individual or the respondent's household. The scale has eight 'yes' and 'no' items. Therefore, this study applied a dichotomous scale for the identification of food insecurity experiences in households. The questionnaires were sent to two experts for internal validation before finalization.

Qualitative information was collected through six key informant interviews. Participants included the Mayor of Thulo Bheri Municipality, a social worker who worked in a non-governmental organization, and four farmers. The participants were asked about the trend of food production, consumption, availability, status of food banks, and behavior of food management during the lean season. A checklist was finalized before getting approval from an expert. The fieldwork was conducted between July and September 2023.

3.4 Data Analysis

The data was cleaned in a spreadsheet environment. The cleaned data set was imported into Statistical Package for Social Sciences (SPSS) version 25 and then analyzed using descriptive statistics before summarizing in figures and tables. The data was analyzed focusing on the differences between the two municipalities, where Thulo Bheri is more accessible with multiple road connections to the neighboring districts in the South, and Tripurasundari is remote with a lack of road accessibility and farther away from the airport. The food security differences between these two municipalities were examined using chi-squared and logistic regression models. Both approaches were appropriate for this analysis due to the categorical nature of the data. The differences between these two municipalities in terms of food security and geographic accessibility characteristics were evaluated using the following Chi-Square model (Nikolaos, 2015).

$$X^2 = \sum \frac{(f_o - f_e)^2}{f_e} \quad (1)$$

Where f_o is the observed frequency and f_e is the expected frequency

Additionally, a logistic model is developed to evaluate the extent of differences between two municipalities in terms of their differences in terms of food security and local resilience against food insecure conditions. The survey had questions with dichotomous response options to

assess the food insecurity features and local practices. The following regression model was used (Hosmer & Lemeshow, 2000).

$$logit\{Pr(Y=1|x)\} = log\left\{\frac{Pr(Y=1|x)}{1-Pr(Y=1|x)}\right\} = \beta_0 + x'\beta \quad (2)$$

Where,
Y denotes the two possible values, denoted by 1 and 0,
$x = (x_1,\ldots,x_k)'$ is the vector of explanatory variables,
β_0 is an intercept,
β is the vector of the slope parameter of explanatory variables.

The results show the differences between the two municipalities on food insecurity situations as well as their local practices to overcome these insecurities.

Interview recordings were transcribed in the word processing software. The transcripts were manually coded, focusing on the nodes and themes from the conceptual framework. Similar codes were put together, and separate themes were labeled. Finally, considering the result from the descriptive statistics, the themes were interpreted and compared against the components of food insecurity and resilience. Given the variability of location, access, and services in the two municipalities, data are tabulated separately and comparatively analyzed.

4. RESULTS AND DISCUSSION

This section presents results from quantitative and thematic analysis of data and interview transcripts, complemented by discussion. It begins with respondents' socio-demography, food insecurities in both municipalities, and options that lead to food system resilience in both communities.

4.1 Characteristics of Survey Respondents

Among 388 survey respondents, 217 (55.93%) were female and 171 (44.07%) were male. Similarly, the majority, 292 (75.25%), were Bramin/Chhatri, followed by Dalit 63 (16.23%) and Janajati (Indigenous people) 33 (8.50%). By family type, respondents living in a nuclear and joint family were 46 (11.85%) and 342 (88.14%), respectively. Half (50%) of the respondents had 5 to 6 family members, 143 (36.86%) had more than 6, and 37 (9.54%) had 3 to 4 family members. Additional socioeconomic characteristics of survey respondents are in Table 1.

Table 1

Demographic Characteristics of Survey Respondents (N=388)

Variable	Category	Thulo Bheri		Tripurasundari		Total
		Count	%	Count	%	
Gender	Female	49	22.60	168	77.40	217
	Male	55	32.20	116	67.80	171
Family Type	Joint	90	26.30	252	73.70	342
	Nuclear	14	30.40	32	69.60	46
Ethnicity	Brahmin and Chhetri	87	29.80	205	70.20	292
	Dalit	16	25.40	47	74.60	63
	Jana Jati	1	3.00	32	97.00	33
Family Main Occupation	Farming	17	30.36	39	69.64	56
	Livestock	80	25.48	234	74.52	314
	Private business	1	50.00	1	50.00	1
	Service, job and labour	6	37.50	10	62.50	16
Family Main Income Source	Sells of Herbs	43	19.46	178	80.54	221
	Selling livestock and their products	41	33.06	83	66.94	124
	Foreign employment	3	25.00	9	75.00	12
	Service, Job or labour	16	59.26	11	40.74	27
	Private business	1	25.00	3	75.00	4

4.2 Food Self-sufficiency in Thulo Bheri and Tripurasundari Municipalities

This study analyzed food availability for consumption from households' own production, as shown in Table 2. It found that a majority of the respondents, 179 (46.13%), had food available for consumption for 3 to 6 months from their own production, followed by 111 (28.61%) and 60 (15.46%) households for 1 to 3 and 9 to 11 months, respectively. Only 32 (8.24%) households had food available for consumption for the whole year from their own production.

Table 2

Food Sufficiency in a year from Own Production in Thulo Bheri and Tripurasundari (Chi-Square)

Food sufficiency from own production	Thulo Bheri		Tripurasundari		Total		Chi-Sq.	Prob.
	Number	Percent	Number	Percent	Number	Percent	25.18	0.0001
0 month	0	0	3	1.06	3	0.78		
1 to 3 months	44	42.31	67	23.59	111	28.61		
3 to 6 months	30	28.85	149	52.46	179	46.13		
6 to 9 months	0	0	3	1.06	3	0.78		
9 to 11 months	23	22.12	37	13.03	60	15.46		
Whole year	7	6.73	25	8.80	32	8.24		

The statistically significant association between food availability from households' own production throughout the year in two municipalities shows the food insecurity in them. Most households (More than 60% of surveyed households) in these municipalities have less than a 6-month supply of food from their own production. Further details of the differences are shown in Table 2.

4.3 Food Insecurity and Resilience Options

The survey data and interviews have shown both food insecurity situations and options to build resilience in both municipalities. The differences between the two municipalities are shown in Table 3. They significantly differ in food insecurity and resolution options. The Chi-Square values show that the composition of the caste system is significantly different between them. Elite castes (Bramin and Chhetri) are higher in the Tripurasundari. Some of the food insecurity symptoms in both municipalities are household members eating less due to insufficient food, households running out of food, household members skipping meals due to insufficient food, and food sufficient for three months or less.

Both municipalities are significantly different for various vegetables in respondents' kitchen gardens. In terms of food insecurity overcoming strategies, there is a significant difference between the two municipalities for having a kitchen garden in households, having sufficient vegetables from the kitchen garden for six months of the year, Himalayan herb collection as a strategy to overcome food insecurity situations, and borrowing money to buy food for the family. The details of the Chi-Square test results are shown in Table 3.

Table 3

Difference between Thulo Bheri and Tripurasundari Municipalities for food insecurity experiences and local agricultural practices (Chi-Square)

Responses	Thulo Bheri	Tripurasundari	Total	Chi.Sq.	Prob.
Caste system				5.3791	0.0204
Minority Castes	17	79	96		
Elite Castes	87	205	292		
Total	104	284	388		

Have a kitchen garden				10.9957	0.0009
No	56	100	156		
Yes	48	184	232		
Total	104	284	388		
Sufficient vegetables from the kitchen garden for six months				6.7619	0.0093
Yes	42	157	199		
No	62	127	189		
Total	104	284	388		
A single variety of vegetables in the kitchen garden				14.0755	0.0002
Yes	59	101	160		
No	45	183	228		
Total	104	284	388		
Household members received support for fruit planting				38.3627	<.0001
Yes	10	123	133		
No	94	161	255		
	104	284	388		
Sufficient food for 3 months or less in a year				9.9638	0.0016
Yes	44	73	117		
No	60	211	271		
Total	104	284	388		
Sufficient food for 6 months a year				17.0881	<.0001
Yes	30	149	179		
No	74	135	209		
Total	104	284	388		
Herb collection as a choice to meet food insecurity				29.5443	<.0001
Yes	73	111	184		
No	31	173	204		
Total	104	284	388		
Off-farm employment as a choice to meet food insecurity				0.0897	0.7646
Yes	40	114	154		
No	64	170	234		
Total	104	284	388		
Loan is the choice to meet food insecurity				8.9797	0.0027
Yes	36	147	183		
No	68	137	205		
Total	104	284	388		
HH member skipped meals due to food insecurity				6.138	0.0132
Yes	15	75	90		
No	89	209	298		
Total	104	284	388		

HH members ate less due to food insecurity				20.7988	<.0001
Yes	90	177	267		
No	14	107	121		
Total	104	284	388		
HH ran out of food due to insecurity				23.0847	<.0001
Yes	23	140	163		
No	81	144	225		
Total	104	284	388		

The logistic regression models further evaluated food insecurity situations and the local potential to overcome these insecurities in Thulo Bheri and Tripurasundari municipalities. The results of these models are shown in Table 4 below, where the dependent variable is the Thulo Bheri municipality.

Table 4

Food insecurity and resilience in Thulo Bheri and Tripurasundari Municipalities (Dependent: Being Thulo Bheri Municipality)

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Point Estimate	Confidence Intervals		Pr > ChiSq
						Lower	Higher	
Intercept	1	-4.3245	0.6553	43.5481				<.0001
Not Ethnic Minorities	1	1.0955	0.3584	9.342	2.991	1.481	6.037	0.0022
Eaten greens for 3 months last year	1	-0.4629	0.3535	1.7149	0.629	0.315	1.258	0.1903
Received Support for Fruit planting	1	-1.5877	0.4138	14.7216	0.204	0.091	0.46	0.0001
Received training on agroecological farming	1	1.0759	0.5377	4.0031	2.933	1.022	8.413	0.0454
Sufficient own produced food for three months	1	0.837	0.3411	6.0218	2.309	1.184	4.507	0.0141
Herb collection as no. 1 choice to meet food deficit	1	2.2236	0.4561	23.7689	9.241	3.78	22.591	<.0001
Office employment as no. 1 choice to meet food deficit	1	1.4313	0.6286	5.1841	4.184	1.22	14.344	0.0228
Borrowing as no. 1 choice to meet annual food deficit	1	1.7438	0.5787	9.0785	5.719	1.839	17.78	0.0026
Family member ate less than needed in last 12 months due to lack of food	1	1.7822	0.3657	23.7553	5.943	2.902	12.169	<.0001
Family ran out of food due to lack of money or other sources	1	-1.2223	0.3236	14.2703	0.295	0.156	0.555	0.0002

Table 4 shows the situations of food insecurity and resolution options in both municipalities. Thulo Bheri Municipality is 2.99 times more likely to have non-ethnic minorities than Tripurasundari. Although Thulo Bheri was 20.5% and 62.9% less likely to eat greens for three months and receive external support on fruit planting than Tripurasundari, respectively, it is 2.93 times more likely to receive training courses on agroecological farming than Tripurasundari. This shows higher capacity building among elite demographics in Thulo Bheri Municipality. In terms of the food insecurity situation, Thulo Bheri is 5.94 times more likely to have family members eating less than needed compared to Triburasundari. Still, residents of Thulo Bheri have better access to money and other resources for food. Thulo Bheri residents are 15.6% less likely to run out of food due to a lack of money and other monetary sources compared to Tripurasundari. This allows families in Thulo Bheri to be better prepared to deal with food insecurity situations.

Regarding strategies to deal with food insecurities, three major options were evaluated: herb collection, office employment, and borrowing from formal and informal sources. Thulo Bheri municipality had a better situation to access all three strategies compared to Tripurasundari. Thulo Bheri respondents identify herb collection as 9.24 times as important as respondents from Tripurasundari to overcome the food deficit in the year. Similarly, having employment in an office and borrowing were 4.18 times and 5.71 times more likely to be in Thulo Bheri than in Tripurasundari. These relationships show that Thulo Bheri municipality has stronger and more options to overcome food insecurity in a year while building food system resilience.

4.4 Interview Analysis – Local Alternatives for Food Resilience

The in-depth interview with the key informants revealed a mixed picture of food production, consumption, and the food security situation in both municipalities. Key informant interview results have supplemented the logistic regression results in this regard.

Local Food Production: Achieving Food Resilience Amongst Unique Challenges

In the two municipalities, the arable land is extremely limited. It is 20% of the total land in Thulo Bheri Municipality and 15% in Tripurasundari Municipality that is arable (DAO, 2018). Irrigation covers less than a quarter of the total land. Therefore, people produce crops that grow on the high slope, dry, and sandy soil. In high-mountain areas, people produce wheat, maize, millet (Kodo), proso millet (Chino), buckwheat, tertiary buckwheat, and rice. They are grown in both municipalities. To respond to food insecurity, households produce beans and potatoes and supplement the deficit of staple foods. Households experienced decreasing trends in food production due to environmental change. One female participant explained food production and harvesting patterns as:

We harvest wheat during the first half of Shrawan [June-July] month. Wheat is the first staple food crop harvest in the New Year in the district. Maize and proso millet (Chino) are harvested during the second half of Bhadra [July-August] month. Similarly, paddy, millet and buckwheat are harvested during the second half of Ashoj [August – September] and the first half of Kartik [September – October] month. Potatoes and beans are harvested during the

second half of Ashoj [August – September] and the first half of Kartik month respectively. But the farm yields do not meet family needs. And that all the all the yields cannot be harvested and stored.

In isolated settlements, people adopt a food system resilience strategy. It means that they manage whatever they need, ranging from basic food items, because the markets and facility centers are far away. Interview participants in the two municipalities said that households grow vegetables and meat, but their production cannot meet the families' requirements for year around, but helps to secure critical food supplies. Most of the households produce green vegetables sufficiently for a few months (<6 months) and consume potatoes as a vegetable during the other months. Normally, green vegetables produced are broadleaf mustard, coriander, radish (Choti), carrot, cabbage, pumpkin, eggplant, tomato, and chilies. Fruits and nuts grown in the districts are apples, walnuts, peaches, wild apricots, plums, and citrus fruits. Most people have very few varieties of fruit trees and consume seasonal fruits and nuts occasionally. Due to limited arable land, households grow vegetables and fruits just for a few months. In view of the participants, the vegetables as well as fruits production would partially respond to the household's food insecurity situation.

Food Consumption during the Lean Period

Local people consume what they produce from their own land in different months, and the deficit is supplemented by the white rice purchased from the nearby market. The lean period in the district spans almost four months from Magh (January – February) to Baishakh (April – May). But, the peak, most difficult, harsh lean period is Chaitra (March–April) and Baishakh (April–May). One participant explained how people cope with the harsh situation and attempted to build a food resilient system:

> *People grind wheat in the watermill to obtain flour and cook wheat "Roti" (bread) in the morning and consume with vegetable or with ground mixture of salt and chilies. They also mill millet flour and cook mixed "Roti" of wheat and millet. "Roti" eaten with vegetable and/ or ground mixture of salt and chilies is most common dish we eat in the morning as there is always a hurry to go to work in the farmland. They carry some "Roti" along with ground mixture of salt and chilies to the farmland to eat as mid-day light meal when they are hungry.*

Inaccessibility hinders households from arranging food for the deficit season. Interview participants in Tripurasundari municipality said that it takes three days on foot (both ways) from their village to reach the nearby markets, Dunai and Jufal, to buy white rice during food insecurity. Because these two markets lie in Thulo Bheri municipality, this time shortens for the residents in Thulo Bheri. The trip also includes expenses on logistics, including lodging and food. Besides travel expenses, Tripurasundari residents pay a high price for the food in the market. The subsidized price of 1 kg of white rice was Rs. 65 (USD 0.50) in 2023, which was expensive for the local people, given their lower per capita income. The average food price in the local market is 2-2.5 times higher than in Nepalgunj (the nearest metropolitan area), where goods are transported to Dolpa. Road transportation for carriers takes 15 hours

from Nepalgunj to Dunai/Dolpa. Since the under-construction Karnali highway operates for just six months a year and stops during the rainy season, the only means is air transport in Dolpa.

Low Nutrition Intake

Low nutrition intake is the result of low production, a lack of crop varieties, being far from the market, and low consumption options. Local people consider evening/night meals as the main course for the family. Carbohydrates hold the major portion of the meals, followed by protein and fiber. People consume meat occasionally, and when they do, they prefer to cook and eat it with the evening/night meal. One old male participant said:

> *Generally, people cook "Bhat" (boiled cereal grains) of rice or proso millet or the "Dhindo" (thick sticky porridge) of maize and/or buckwheat flour at night depending upon the economic condition. High class rich households mostly consume "Bhat" of rice or proso millet. Middle class households consume "Bhat" of proso millet and sometimes "Dhindo" of maize and/or buckwheat. Poor households cook "Dhindo" of maize and/or buckwheat and "Bhat" of proso millet…. Economic condition determines the thickness of the "Dhindo". Better off households cook thick "Dhindo" whereas the poor household cook thin "Dhindo".*

This reveals that the experiences of food insecurity are disproportionate with respect to socio-economic factors such as income, caste, and accessibility.

Households manage food insecurities by adopting a nutritious consumption pattern with the availability of choices to be more resilient. This offered communities the chance to deal with the situation while optimally using the locally available resources, as explained by one participant:

> *People raise livestock and produce meat, milk and milk products. They consume meat very rarely. People use milk for producing ghee and consume only buttermilk on the day and thereafter the curd/yoghurt is churned into ghee. Beans Dal is not cooked if there is buttermilk in the house. They eat milk and/or yoghurt occasionally during festivals or other special occasions.*

Participants' experience shows that people have a mundane food consumption pattern. Due to low availability, people rarely diversify their food consumption. If the firewood (cooking fuel) supply is adequate, there will be a high frequency of cooking, and therefore, eating frequency will also be higher, depending on the availability of firewood. A shortage of food supply in a household is achieved by selling Himalayan herbs and purchasing food items. Apart from remoteness and geographic isolation, people's nutrition consumption is also affected by high food prices and low access to nutritious food in both municipalities and in the region.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study investigated the state of food insecurity, food consumption patterns, and household resilience strategies in Thulo Bheri and Tripurasundari municipalities of Dolpa District, Karnali Province, Nepal. Through a mixed-methods approach integrating survey data from 388 households and qualitative interviews with local stakeholders, the research provides empirical evidence of the chronic and multi-dimensional nature of food insecurity in high-mountain Himalayan regions.

The findings underscore that food insecurity is particularly severe in areas with limited arable land, rugged topography, and inadequate infrastructure. Only 46.13% of surveyed households were able to sustain themselves with food from their own production for 7–9 months annually. Thulo Bheri, with marginally better accessibility, showed relatively greater resilience through herb-based income, kitchen gardening, and off-farm employment. However, even in this comparatively advantaged setting, households reported reduced food intake and limited nutritional diversity.

Geographic remoteness remains a critical barrier to food security. In Tripurasundari, the absence of market centers and the logistical burden of food transportation result in higher food prices and lower access to essential staples. Households often rely on low-diversity diets, irregular meal frequencies, and informal coping strategies such as barter, loans, and seasonal migration. Nutritional disparities are further exacerbated by socio-economic stratification, with poorer and marginalized households facing the greatest food insecurity.

Despite these challenges, local communities demonstrate considerable adaptive capacity. Household-level strategies—such as seasonal vegetable cultivation, livestock rearing, and herb collection—play a significant role in mitigating acute food shortages. These practices, while limited in scale, represent important building blocks for food system resilience.

Policy Implications

Enhance Accessibility and Infrastructure: Strategic investments in road connectivity, transportation systems, and local marketplaces are essential to reduce logistical bottlenecks and lower food prices in remote districts such as Dolpa.

Support Local Production Systems: Expanding irrigation coverage, promoting agroecological farming practices, and introducing climate-resilient crops could improve agricultural productivity in high-altitude areas.

Strengthen Local Food Systems: Policies that support kitchen gardening, fruit tree planting, and livestock management can bolster community-level food security and reduce reliance on external aid.

Target Social Protection: Food aid and subsidies should be designed with attention to geographic disadvantages and caste-based marginalization. Adaptive safety nets and targeted interventions can address structural inequalities.

Invest in Nutrition Education and Services: Community-based nutrition programs are needed to promote dietary diversity, especially among vulnerable populations. These should be linked to broader rural development and health initiatives.

This study was limited by its cross-sectional design, which captured food security status at a single point in time. Longitudinal studies are needed to assess seasonal variations and long-term trends. Additionally, while this study focused on local production and coping strategies, future research could explore the role of remittances, migration, and institutional food programs in mitigating household-level food insecurity. Comparative studies across ecological zones could further illuminate regional disparities and inform national food policy.

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